

Hovedfagsoppgave for graden cand. pharm.

**A literature survey of studies
performed by master students at
Département de Médecine
Traditionnelle (DMT) in Bamako,
Mali**

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III Abbreviations

AI -	Atherogen Index = (Total cholesterol/HDL)
Ara -	Arabinose
ASA -	Acetyl salicylic acid
CNRST –	The National Centre for Scientific Technological Research
CNS -	Central Nervous System
DCM -	Dichloromethane
DMT –	Departement de Médecine Traditionnelle
DPPH –	1,1-diphenyl-2-picryl-hydrazyle
EtOAc -	Ethyl acetate
EtOH -	Ethanol
FID -	Flame Ionization Detector (used for gas chromatography)
Fuc -	Fucose
Gal -	Galactose
GalA -	Galacturonic acid
Glc -	Glucose
GlcA -	Glucuronic acid
H ₂ -	Hydrogen gas
H ₂ O –	water
HDL -	High Density Lipoprotein (cholesterol)
HPLC –	High Pressure Liquid Chromatography
IC ₅₀ -	Inhibition concentration of 50 % cells
ICH ₅₀ -	Inhibition concentration of 50 % heamolysis
LD ₅₀ -	Lethal Dose for 50 % death
Man -	Mannose
mAU -	milli-absortion units (used in HPLC chromatography)
NMR –	Nuclear Magnetic Resonance
NUFU –	The Norwegian Council for Higher Education's Program for Development Research and Education
O ₂ -	Oxygen gas
Rha -	Rhamnose
Rf -	Retention factor
SGOT –	serum Glutamate Pyruvate Transaminase
SGPT -	serum glutamic pyruvic transaminase
sp. -	species (one)
spp. -	species (several)
UV –	Ultra violet
WHO –	World Health Organisation
Xyl -	Xylose

1. INTRODUCTION

1.1 Traditional medicine

Traditional medicine refers to health practice, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines to treat, diagnose and prevent illnesses or maintain well-being. 80 % of the population in Africa uses traditional medicine for primary health care. In Ghana, Mali, Nigeria and Zambia, the first line treatment for 60 % of children with high fever resulting from malaria is the use of herbal medicines at home. WHO launched a traditional medicine strategy in 2002. This strategy is meant to help countries to document traditional medicines and remedies, and to ensure the safety and efficacy of these remedies (WHO, 2003).

Cooperation between developing countries and western countries can be beneficial in helping to fulfill the goals of the traditional medicine strategy. The University of Oslo has been cooperating with The National Centre for Scientific Technological Research (CNRST) in Mali since 1989 and more specifically with the Department of Traditional Medicine (referred to as DMT in the rest of this thesis) since 1996. These projects have been possible thanks to The Norwegian Council for Higher Education's Program for Development Research and Education (NUFU) (SIU, 2002).

1.2 The NUFU projects

Several NUFU projects involving traditional medicine have been completed or are still going on in Mali. 1996-2001: Contribution to phytochemical and pharmacological studies of six medicinal plants from the Gourma. 2002-2006: Medicinal plants in Mali: Ethnobotany, phytochemistry and biological activity (SIP, 2001). During these periods several Norwegian master students and professors have been to Mali performing both field work and laboratory work. The leader of DMT, Drissa Diallo, has spent time in Oslo, Norway working on his doctorate thesis and doing laboratory and administrative work for the projects, while three doctorate students from Mali have spent periods working on their thesis, taking classes and doing laboratory work here.

1.3 Mali and traditional medicine

Mali, the largest country in West Africa, is bordered by 7 countries. Algeria is situated to the north and north east, Nigeria to the east, Burkina Faso to the south east. The Ivory Coast is to the south, while Senegal and Mauritania are to the west. The capital is called Bamako. Mali has no coast line, but the river Niger passes through most of the country so only the northern areas are very dry. The northern desert parts are a part of the Sahara desert. The number of inhabitants is nearly 12 million (2004) belonging to different ethnical groups. Life expectancy at birth is 45,28 years. An average of 64 % of the population is living below the poverty line (2001) (CIA, 2004). The most common diseases are malaria and other infections, including schistosomiasis and fungal infections, diabetes in some areas, and different kinds of wounds (SIU, 2002).

Mali was a French colony until 1960 and the use of traditional medicine was illegal under

French rule. Luckily the traditions were still conserved in secret so at least parts of the knowledge still exists, and it is now being recorded by the DMT. DMT has also developed several so called Improved Traditional Medicines (IMT). They contain standardized amounts of one or more herbs with long tradition in traditional medicine, and are a cheap alternative to pharmaceuticals from western countries. Current IMTs are as follows:

Table 1.3.a Current IMTs used in Mali

Name	Indication	Plant(s)
Balembo	Cough	<i>Crossopteryx febrifuga</i>
Dysenteral	Dysentery	<i>Euphorbia hirta</i>
Psorospermin	Dermatosis	<i>Psorospermum guineense</i>
Hepatisan	Hepatitis	<i>Combretum micranthum</i>
Laxia-cassia	Obstipation	<i>Cassia italica</i>
Malarial	Malaria	<i>Cassia occidentalis</i> , <i>Lippia chevalierii</i> , <i>Spilanthes oleracea</i>
Gastrosedal	Stomach ulcer	<i>Vernonia kotschyana</i>

2. OBJECTIVES AND METHODS

2.1 Objectives

The main objective is to help improve the health care situation in Mali. This can for example be done by checking plants for active and/or toxic ingredients, and by helping with development of new ITMs.

More specific objectives of this thesis are:

- to compile and translate the results of some of the scientific work performed in Mali between 1993 and 2003 by master students.
- to detect plants with medical properties that have not yet been thoroughly examined.

This thesis is meant to be a summary of the results from the examined theses. Because of this a brief introduction of the respective theses is included for each plant.

2.2 Literature

15 master theses written from 1993 to 2003 at Department of Traditional Medicine (DMT) in Bamako, Mali were examined. All theses were written in French so translation errors might exist. Other sources were different articles and other literature survey theses on some of the plants have been used (see results and reference list).

A short introduction of the known traditional uses of each plant is added if available.

Most of this information is found in the “Pharmacopée sénégalaise traditionnelle – plantes médicinales et toxiques” by Kerharo and Adam (1974). Senegal is Mali's neighbour to the west and the vegetation in the two countries is very similar. Small differences between species might of course occur.

2.3 Field work

The project (see 1.2) comprises both field work and laboratory work. So even though this thesis basically is a literature survey (theoretical), the stay in Mali included a field trip for 5 days.

2.3.1 Objectives

- Identify plants used against dermatosis.
- Identify the uses of 6 specific plants:
 - *Biophytum petersianum* (see 3.1.31.1)
 - *Cola cordifolia* (see 3.1.40.1)
 - *Combretum glutinosum* (see 3.1.15.2)
 - *Lannea velutina* (see 3.1.2.2)
 - *Opilia celtidifolia* (see 3.1.30.1)
 - *Ximenia americana* (see 3.1.29.1)

2.3.2 Description

The field work was done in the Kolokani district, 30 kilometers north of Bamako. The following villages were visited: N'Tjobougou, Massantola and Didieni. Healers from the villages and areas surrounding them were interviewed. They were first asked which plants they used to treat dermatosis¹. Then they were asked how they used the plants mentioned in 2.3.1. All results are included in 3.1 under the respective plant.

N'Tjobougou: 5 healers were interviewed.

Didieni: 6 healers were interviewed.

Massantola: 14 healers were interviewed.

All interviews were performed using the local language Bambara and translated to English by Drissa Diallo. Information might have been lost or misunderstood during translation.

Results: se 3.1

2.4 Selection of plants

The selected plants consist of all plants subjected to one or more tests in the theses and all plants recorded from the interviews during the field trip. The number of plants tested in one thesis was between 1 and 18. Some were reviewed by Aasberg (2001) and Tran (2004) and for these, only the results from the Malian theses were recorded. Diallo (2000) performed an ethnopharmacological survey of medicinal plants in Mali and phytochemical study of four of the identified plants. This is noted after the respective plants.

For the rest of the plants a quick search using the commercial search site www.google.com and the scientific search site www.PubMed.com was performed to check the amount of available literature. This gives an indication of the amount of available literature. The quality of content on the identified sites was not checked, but we may consider the articles found using PubMed.com to be of higher scientific importance. The plants are listed alphabetically after family, then after plant name. A total of 82 plants from 42 families were included.

Genus and family were identified by using W³TROPICOS (<http://mobot.mobot.org/W3T/Search/vast.html>).

2.4.1 Methods for analysis

Extraction(s) are described for each plant.

The phytochemical tests performed are as far as possible described in the appendix (A.1). The other tests can be found in the respective theses, some are however briefly described in this thesis.

2.4.2 Excluded plants:

From the field work *Vitex spp.* was identified (no species name). A survey of all *Vitex* species is beyond the scope of this thesis.

¹ Dermatitis is here defined as all diseases affecting the skin.

3. RESULTS

3.1 Plants

3.1.1 Aizoaceae

3.1.1.1 *Glinus oppositifolius* (L.) Aug. DC.

Thesis: Bah (1998)

Some traditional uses:

In Mali, pulverized stems with leaves are put into food as a treatment for abdominal pain and jaundice. It is used together with *Echinochloa stagnina* (Rets.) P. Beauv. to treat malaria, dizziness and to stimulate appetite (Diallo et al, 1999). It has also been used for wound healing, as anti-inflammatory and analgesic agent and against diarrhoea (Diallo, 2000). Debes (Debes 1998) identified the following uses of this plant after interviews with healers in Gao and Gourma in Mali: malaria, head ache, weight loss, nausea, pain (externally and in the joints), skin-diseases, constipation, diarrhoea, wounds, jaundice, stomach ache (parasites) and high fever. Malaira is the most cited indication for this plant.

Bah (1998):

This author studied the larvicidal effects of 10 different plant extracts on *Anopheles gambiae*, one of the intermediate hosts in malaria. As mosquitoes are developing resistance to an increasing number of chemical insecticides, it is important to search for new and possibly less toxic agents from plants to try and control the disease. *Anopheles gambiae* mosquitoes were collected in Mopti. For the tests, larvae were elevated and collected in the laboratory, from full grown females collected at one specific date. Larvae were fed with Whiskas ® cat food. The plant material was collected in Diré in June 1996, and was dried and pulverized before analysis. The whole plant was used.

Extractions:

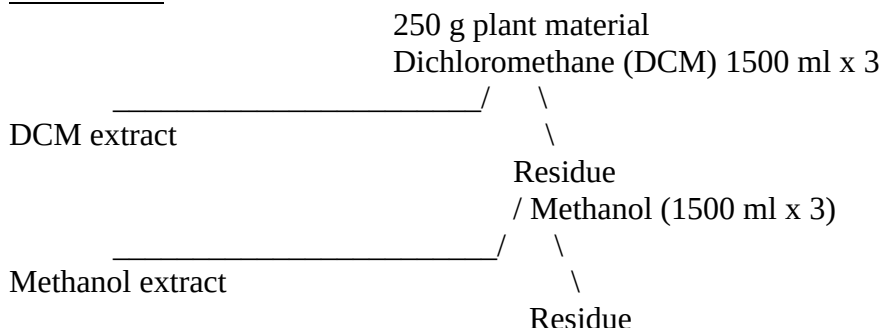


Figure 3.1.1.1.a Extraction with solvents of different polarity

50 g plant material + water (500 ml x 24 hours x 3)

/

Water extract

Figure 3.1.1.2.b Maceration

All extracts were concentrated and lyophilized before use. They were diluted with distilled water to the appropriate concentrations before the larvicidal test was performed.

Tests:

Extracts were tested on groups of 8 x 25 larvae. The extracts were tested at concentrations from 0,015 mg/ml to 0,06 mg/ml (preliminary tests) and from 1 mg/ml to 50 mg/ml later. Dead or dying larvae were registered as they floated to the surface of the test container.

Well known chemical insecticides (ex. permethrine) were tested on full grown mosquitos. The results from these tests can not be compared to the results from the tests performed on the larvae.

Results:

- from the preliminary tests:

The DCM extracts gave 1 % mortality for 0,015 mg/ml and 0,03 mg/ml and 4 % mortality for 0,06 mg/ml. Only the methanol extract at 0,06 mg/ml showed activity, with 1 % mortality. None of the water extracts showed any effect.

-from the extended tests:

Table 3.1.1.1.a Methanol extract

Concentration mg/ml	Number of larvae tested	Number of deaths	Mortality (%)
1	200	42	21
5	125	35	28
10	200	49	24,5
25	200	67	33,5
50	200	81	40,5
Negative control	500	5	1

Table 3.1.1.1.b DCM extract

Concentration mg/ml	Number of larvae tested	Number of deaths	Mortality (%)
1	200	18	9
5	200	39	19,5
10	200	60	20
25	200	85	42,5
50	200	140	70
Negative control	500	5	1

The DCM extracts show the strongest activity.

This plant showed the strongest insecticide activity together with *Limeum pterocarpum* (3.1.1.2). This might be caused by saponins, terpenes or alkaloids formerly identified in the plant. From the 10 tested plants this was the only one that went through extended tests.

Diallo (2000) did a phytochemical study and a review of this plant. He found the same larvicidal effect as Bah as well as antioxidant, antifungal and molluscicidal effects and effect on the complement system. Inngjerdingen (2000) studied the structure and activity of the polysaccharids found in this plant.

3.1.1.2 *Limeum pterocarpum* (Gay.) Heimerl.

Thesis: Bah (1998)

Some traditional uses:

In Mali, leaves and stem are used against malaria. The whole plant is crushed and boiled in water until it changes color. The solution is drunk for 3 days to cure malaria (Diallo et al, 1999). In the Gourma-district in Mali, this plant is used to treat heart diseases and scorpion-bites in addition to the use against malaria (Diallo et al, 1992).

Bah (1998)

This author studied the larvicidal effects of 10 different plant extracts on *Anopheles gambiae*, one of the intermediate hosts in malaria. As mosquitoes are developing resistance to an increasing number of chemical insecticides, it is important to search for new and possibly less toxic agents from plants to try and control the disease. *Anopheles gambiae* mosquitoes were collected in Mopti. For the tests, larvae were elevated and collected in the laboratory, from full grown females collected at one specific date. Larvae were fed with Whiskas® cat food. The plant material was collected in Douentza in September 1995, and was dried and pulverized before analysis. Twigs and fruits from *L. pterocarpum* were analyzed.

Extractions:

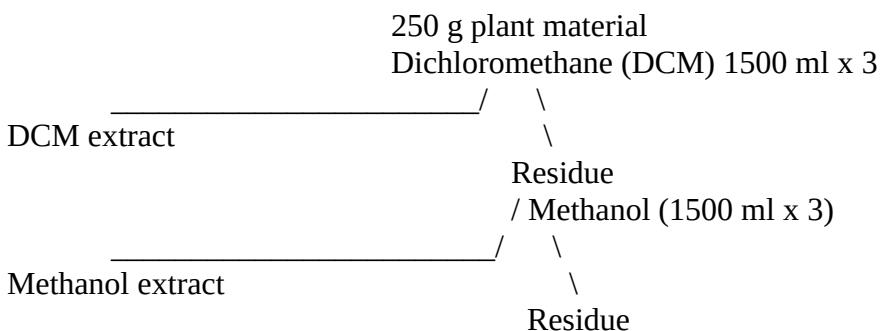


Figure 3.1.1.2a Extraction with solvents of different polarity

50 g plant material + water (500 ml x 24 hours x 3)
/
Water extract

Figure 3.1.1.2b Maceration

All extracts were concentrated and lyophilized before use. They were diluted with distilled water to the appropriate concentrations before the test was performed.

Test:

Extracts were tested on groups of 8 x 25 larvae. The extracts were tested at concentrations from 0,015 mg/ml to 0,06 mg/ml. Dead or dying larvae were registered as they floated to the surface of the test container.

Results:

DCM extracts: 0,015 mg/ml and 0,03 mg/ml gave respectively 1 % and 2 % mortality while 0,06 mg/ml gave 6 % mortality.

Methanol extracts: 0,03 mg/ml and 0,06 mg/ml gave respectively 2 % and 2,5 % mortality while the extract at 0,015 mg/ml showed no effect.

Water extracts: No activity was seen.

Even though this plant showed the best larvicidal activity of the 10 tested plants it did not go through extended tests.

Diallo et al (1992) did a phytochemical screening of this plant. The following substances were identified: coumarins, alkaloids (0,30 %), sterols and/or triterpenes, mono- and polysaccharides, mucilages and cardiac glycosides.

Diallo et al (1999) identified traditional uses of this plant doing an ethnobotanical survey in the Gourma district in Mali.

3.1.2 Anacardiaceae

3.1.2.1 *Lannea microcarpa* Engl.

Thesis: Sanogo (1999)

Some traditional uses:

In Senegal, this plant is often confounded with and used in the same ways as *Lannea velutina* A. Rich (see 3.1.2.2). It is however considered to have weaker effect than *L. velutina*. Both plants are used against diarrhoea, externally in baths for children with rickets, and for adults with generalized pain without any apparent cause. (Kerharo and Adam, 1974). The gum from the plant has traditionally been used to treat dysentery (Sanogo 1999).

Sanogo (1999)

This author did a survey of gums found from different plants in Mali and their commercial and medicinal uses. The collection of plant material took place between November 1997 and February 1998 in Bamako and Banankoro. This specific gum was collected in December 1997 in Banankoro.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances, and with the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was used to confirm the content of monosaccharides.

All gums were tested for possible content of *Escherichia coli* and *Salmonella spp.*

They were also examined for content of starch and starch derivatives.

Results:

From the phytochemical tests the following substances were found:

Coumarins, tannins, mono- and polysaccharides, mucilages, sterols and/or triterpenes, and cardiac glycosides. The content of water was between 7 and 7,95 %. Ashes insoluble in HCl were 3,29 %, total ash content was 3,69 % and sulphur containing ash was 5,69 % (Table 3.2).

Thin layer chromatography:

The tested extracts gave matching Rfs with galactose, galacturonic acid and glucuronic acid (they all had the same Rf here) and arabinose. In addition to this there was detected one spot that did not correspond with any of the references sugars.

Gas chromatography:

7 monosaccharides: Galactose (70,38 %), arabinose (14,23 %), galacturonic acid (7,85 %), glucuronic acid (5,33 %), mannose (1,11 %), rhamnose (0,66 %) and glucose (0,44 %). Only the 4 largest groups were detected with the thin layer chromatography.

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of gum.

The test for starch and starch derivatives was also negative.

Field work:

While asking about the uses of *Lannea velutina* this information was given:

A parasite on *Lannea microcarpa* is used for preparation of a decoction, this is used against headache. The vapour from the boiling decoction is inhaled.

For more information about this plant see Aasberg (2001) and Diallo et al (Diallo 2002).

3.1.2.2 *Lannea velutina* A. Rich.

Theses: Kanta (1999), Ouologuem (1999) and Samake (2000).

Some traditional uses:

In Senegal, preparations from the stem and roots are used internally against diarrhoea, externally in baths for children with rickets and for adults with generalized pain without any apparent cause (Kerharo and Adam, 1974).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were identified after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words vaginal discharge and vaginitis. 18 of these plants were collected the 19th of November 1998 in the Tienfala forest 30 km from Bamako and 10th December 1998 in mount Manding in Siby, 60 km from Bamako.

Stem bark from *Lannea velutina* was analyzed. An extract was made with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*, but it did not have any effect against these microorganisms.

Ouologuem (1999)

This author tested the larvicidal effects of different extracts of 11 Malian plants. Larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were used. 6 of the plants were tested on both species, while 5 were only tested on *C. quinquefasciatus*.

Larvae from second and third generation *Anopheles gambiae* collected in Mopti were used. Larvae from *Culex quinquefasciatus* were collected in N'Tomikorobougou and Darsalam, in the Bamako district. Leaves from *Lannea velutina* were collected in Tienfala. The leaves from this plant were chosen for further testing because of their good larvicidal properties (see results).

Extraction:

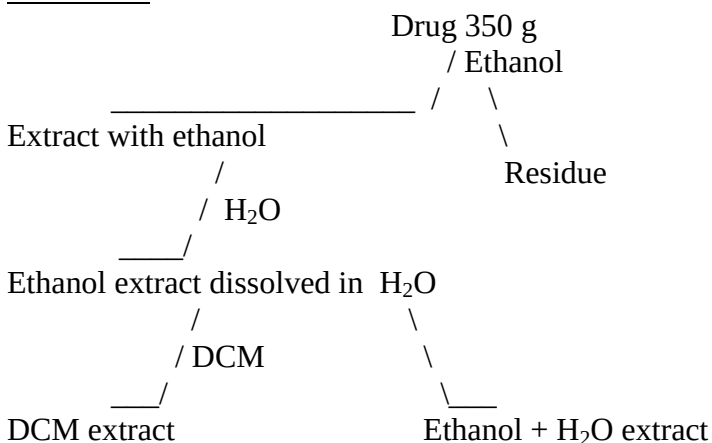


Figure 3.1.2.2.a Extraction with solvents of different polarity

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Column chromatography was performed on the DCM-extract.

For the first column, the following solvent system was used: N-hexane : Isopropanol (14:1 – 10:1 – 4:1 – 2:1 – 1:1 – 1:2).

The fractions were tested on thin layer chromatography with the following solvent system: CHCl₃:MeOH (10:1).

Interesting fractions were tested on a second column with solvent systems of MeOH and CHCl₃ at different concentrations. These fractions were also tested for larvicidal activity. All fractions were tested using thin layer chromatography. The plates were treated with Godins reagent and examined at 250 and 366 nm.

HPLC was performed at the University of Lausanne

Specifications:

Injected volume: 10 µl

A system of acetonitrile and water at different proportions were used; from 25-100% for 30 minutes, 100 % for 10 minutes and 100-25% for 30 minutes.

All tested solutions were dissolved in methanol at a concentration of 1 mg/ml.

NMR was performed at the University of Lausanne.

Specifications:

¹H-NMR spectra were done at a frequency of 499 85 MHz.

All tested solutions were dissolved in pyridine deuteride 5.

Tetramethylsilane was used as internal standard. The values for the chemical displacement were expressed in ppm compared to the internal standard.

Tests on larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were done on 5,5 mg extract dissolved in 110 µl of a suitable solvent; water for the water and ethanol extracts and dimethylsulfoxide (DMSO) for the methanol, ether and DCM-extracts. The tests were performed on 5x20 larvae. Larvae that had fallen to the bottom of the tubes or were immobile were considered dead.

The DCM extracts from *Lannea velutina* leaves and *Cussonia arborea* roots, methanol extract from *Diospyros abyssinica* leaves and ether extract from *Cissus quadrangularis* twigs were tested at different concentrations. The extended tests were only performed on *Culex quinquefasciatus* larvae, as these are considered to be more resistant than larvae from *Anopheles gambiae*.

Results:

From the phytochemical tests performed at DMT the following substances were found: Coumarins, tannins, mono- and polysaccharides, mucilages, sterols and/or triterpenes, leucoanthocyanins, reducing compounds, flavonoids and cardiac glycosides. The content of water was between 6 and 6,10 %. Ashes insoluble in HCl were 8,70 %, total ash content was 5,2 % and sulphur containing ash was 8,0 % (Table 3.2).

Larvicidal tests:

Table 3.1.2.2.a *Culex quinquefasciatus* - % deaths at 500 ppm

	Plant extract					
Time of exposure	L.v.l. Methanol	L.v.l. DCM	L.v.b. Methanol	L.v.b. DCM	L.v.r. H ₂ O	L.v.r. DCM
30 minutes	5	95	0	0	10	0
1 hour	15	100	0	5	10	0
24 hours	40	100	65	15	35	10

Table 3.1.2.2.b *Anopheles gambiae* - % deaths at 500 ppm

	Plant extract					
Time of exposure	L.v.l. Methanol	L.v.l. DCM	L.v.b. Methanol	L.v.b. DCM	L.v.r. H ₂ O	L.v.r. DCM
30 minutes	85	50	0	80	90	95
1 hour	90	70	5	80	90	95
24 hours	100	100	60	100	95	100

L.v.l. *Lannea velutina* leaves

L.v.b. *Lannea velutina* bark

L.v.r. *Lannea velutina* roots

Extended tests at different concentrations:

L.v.l. *Lannea velutina* leaves

C.a *Cussonia arborea* roots

D.a.l. *Diospyros abysscinia* leaves

C.q. *Cissus quadrangularis* twigs

Table 3.1.2.2.c *Culex quinquefasciatus* - % deaths at 250 ppm

	Plant extract				
Time of exposure	L.v.l. DCM	C.a. DCM	D.a.l. Methanol	C.q. Ether	Distilled water
30 minutes	5	0	35	30	0
1 hour	15	25	40	40	0
24 hours	100	95	100	85	0

Table 3.1.2.2.d *Culex quinquefasciatus* - % deaths at 125 ppm

	Plant extract				
Time of exposure	L.v.l. DCM	C.a. DCM	D.a.l. Methanol	C.q. Ether	Distilled water
30 minutes	0	0	15	0	0
1 hour	30	5	30	0	0
24 hours	85	30	80	5	0

Table 3.1.2.2.e *Culex quinquefasciatus* - % deaths at 62,5 ppm

	Plant extract				
Time of exposure	L.v.l. DCM	C.a. DCM	D.a.l. Methanol	C.q. Ether	Distilled water
30 minutes	0	0	0	0	0
1 hour	0	0	0	0	0
24 hours	60	0	25	0	0

Table 3.1.2.2.f *Culex quinquefasciatus* - % deaths at 31,25 ppm

	Plant extract				
Time of exposure	L.v.l. DCM	C.a. DCM	D.a.l. Methanol	C.q. Ether	Distilled water
30 minutes	0	0	0	0	0
1 hour	0	0	0	0	0
24 hours	50	0	0	0	0

Column chromatography:

Fractions 2, 7, 9 and 11 from the first column were tested separately on column 2.

Fraction 2 seems to have good larvicidal effect at all tested times, followed by fraction 4.

Fraction 11 shows best effect after 24 hours.

HPLC:

A top was observed at 1050 mAU after 28,50 minutes of elution and another top after 12 minutes of elutions. Chlorophyll was observed at 254 and 366 nm.

3 visible tops were observed at 366 nm, they came after 16 mn, 19,20 mn and 21 mn of elution. Most compounds were eluted between 10 and 30 minutes.

Substance LV5 (13 minutes of elution) was isolated, its UV spectrum showed maximum absorption at 210, 225.

NMR:

Substance LV5: the proton spectrum is characterized by aliphatic chains between 0 and 3 ppm, a sugar at 4,5 ppm and an aromatic ring at 7 ppm. This substance (LV5) seems to be a glycosylated substance with lateral chains and an aromatic ring of triterpene type.

The DCM extract of *Lannea velutina* leaves showed the best larvicidal effect of the tested plants.

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analysis.

Extraction:

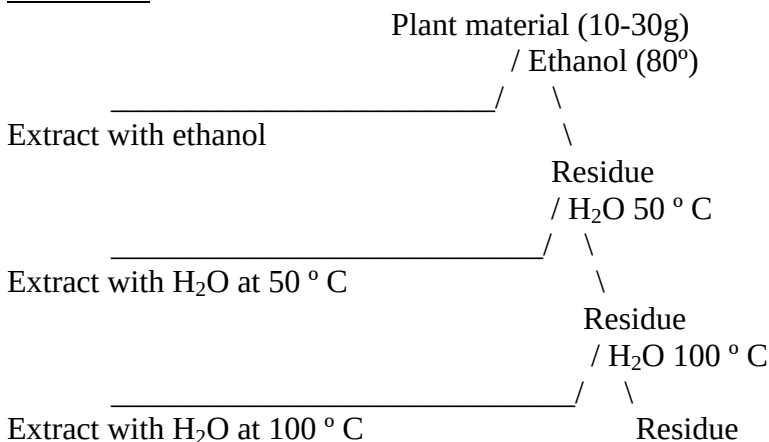


Figure 3.1.2.2.b

A dialysis was performed on all extracts, followed by lyophilization.

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.2.2.g **Extracts tested with known sugars as references and ICH₅₀**

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
L.v. 50°C	Stem bark	+	+	+	0	+	+	+	+	+	40
L.v. 100°C	Stem bark	+	+	+	0	0	+	+	+	+	50

L.v. = *Lannea velutina*

Gas chromatography:

Table 3.1.2.2.h Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C	Extract at 100°C
	Sugar ratio (%)	Sugar ratio (%)
Arabinose	19	24
Rhamnose	12	8
Xylose	1	0
Mannose	2	2
Galactose	47	38
Glucose	2	15
Glucuronic acid	5	3
Galacturonic acid	12	10
Total	100	100
Polysaccharide content	81 %	47 %

Field work:

N`Tjobougou, 5.2.04

Djokin Diarra:

L. velutina is used against a kind of dermatosis: small boils all over the body that are itching (could be scabies). The bark is used for preparation of a decoction. It is used as bath and is also drunk. If the skin infection start with dysentery and the decoction is drunk in the beginning, the dysentery will stop. Drink half a cup (200ml). For boys less than 4 years use approximately 50 ml. Used for all ages.

Bourama Traoré:

The plant is against a skin disease that starts with small boils. A liquid then forms, and when the boils open the liquid will make new boils. This is dangerous for children. Take trunk bark and divide it in two. The first half is pound and dried to a fine powder, the second half is used to make a decoction. Use the latter for a bath and apply the powder on the boils afterwards.

Konimba Traoré:

The stem bark is powdered and applied on the wound. The wound is first washed with water and is healed within a week.

N`Pankourou Fané:

L. velutina is used against a disease that is called Sainiama n`kononiam ntorianama. This gives convulsions with fever. Take the leaves and the stem bark and make a decoction. Take a bath and drink the decoction, this is done 2-3- times per day.

Djenfa Koumaré:

Lannea velutina is used against chronic wounds. Dry the trunk bark, make a powder, wash the wound and apply the powder on the wound once per day.

Uses against dermatosis:

Bourama Toure is using the bark from the plant on black dermatitis; it appears on the skin in a round shape and itches in the beginning. The bark is dried, pound to a fine dry powder, mixed with oil and applied on the skin.

The same healer has also another recipe for the same black dermatosis.

When the dermatosis itches a lot, the bark of *Pterocarpus erinaceus* and *Afzelia africana* is used to make a powder. This powder is mixed with the powder of the bark of *L. velutina*. One part is used for making a decoction that is used to wash the skin and the other part is mixed with oil and applied on the dermatosis once per day until it is completely cured.

Didieni-region, 6.2.04

Doneke Traore:

The trunk bark is used for the preparation of a decoction. The decoction is used for a bath once per day to treat small pox.

Diotin Traore:

A decoction of trunk bark is used against wounds. Powder is applied on the wound after washing with the decoction.

Balla Sissoko:

L. velutina is used against female infertility. Powder of the bark is mixed with water and drunk

Konimba Keita:

A decoction of the stem bark is used as a bath to treat small pox.

Tietin Coulibaly:

The decoction of the trunk bark is used as a bath against itching

Cho Fane:

A decoction of the bark is drunk and also used as a bath against itching caused by small boils on the body.

Massantola-region, 7.2.04

Fah Diarra:

L. velutina is used against dysentery, but only if there is blood in the faeces. Make a decoction of the rootbark and drink this.

Soundje Coulibaly:

The plant is used against gastric ulcer. A powder of the trunk bark is mixed with salt and eaten.

N`tiokon Traore:

A decoction of the trunk bark is made and used to treat small boils on the body. It is used for washing the body or as a bath. The local name for the disease is “Niama”.

Soungalo Traore:

Powder of the stem bark is applied on wounds.

N`gogna Coulibaly:

A decoction of powdered trunk bark is used against dysentery. The decoction is drunk morning and evening.

Dossere Diarra:

L. velutina is used against inflammation. The juice of the trunk bark is applied on the inflammation.

Naoba Diabati:

A decoction of the trunk bark is used as a bath against itching (small boils on the body).

Baba Diarra:

The plant is used against head ache. A decoction of the leaves is used to take a vapour bath and to wash the head.

Deese Coulibaly:

A decoction of the leaves is used for washing the eyes to treat conjunctivitis.

H`toriké Coulibaly:

L. velutina is used on small boils. A decoction of the leaves is used to wash the area. Powder of trunk bark is then applied.

N`kodjiri Traoré

Dysentery and haemorrhoids; a decoction of the stem bark is drunk.

Stem bark and/or leaves were the plant parts used by all the interviewed healers. 14 of the healers use *L. velutina* to treat different skin diseases, from wounds to small pox. 3 use it against dysentery, especially with blood in faeces. It is also used to treat head ache, conjunctivitis and haemorrhoids. 3 of the interviewed healers did not use this plant.

A search using www.google.com gave 40 hits and www.PubMed.com gave only 1 hit (25.02.2005).

Sory Diallo is currently examining several *Lannea* species. The results can be found in a thesis that should be finished by the end of 2004 or the beginning of 2005.

3.1.2.3 *Mangifera indica* L.

Thesis: Aouissa (2002)

Some traditional uses in Senegal:

Different astringent preparations made from the bark and leaves are used against diarrhoea and dysentery. It is often recommended to eat the young leaves with a “white kola nut”. The leaves are said to be used in the treatment of mental disorders. (Kerharo and Adam, 1974). The fruits, mangos, are also widely known and used especially as food.

Aouissa (2002):

This author studied toxicity and other pharmacological properties of *M.indica* with the purpose of using this plant in an ITM. Leaves from *Mangifera indica* have been used combined with *Fagara zanthozylodes* and *Securidaca longependunculata* to treat mouth- and teeth disorders (Aouissa).

The plant material was collected in the “Quartier du fleuve”-district in Bamako in November 2001. It was dried in shadow and crushed to a fine powder when dry. All animal tests were performed on female and male mice from Oncins France Souche 1 (OF1) with a mass between 19 and 25 g.

Extractions:

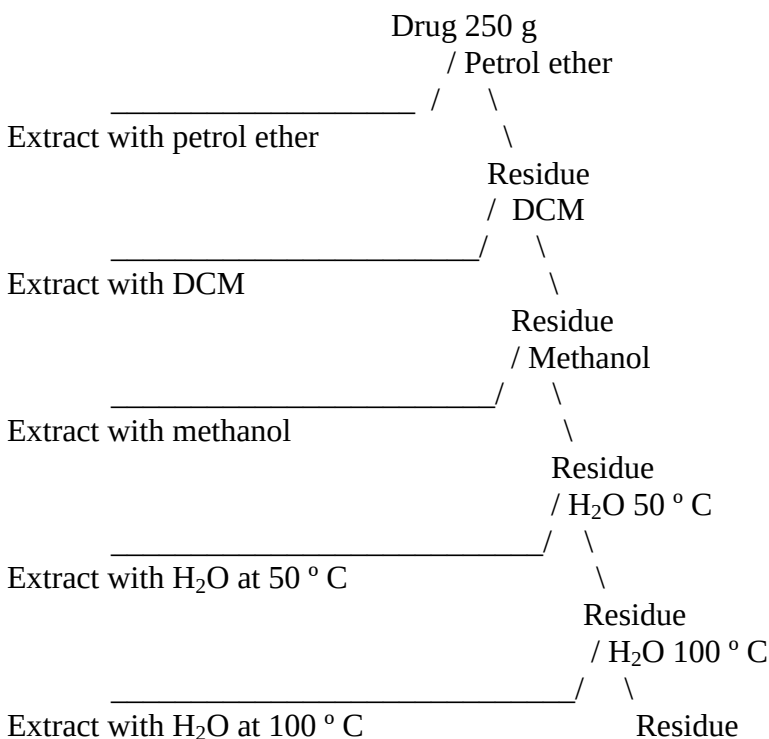


Figure 3.1.2.3.a Extraction with solvents of different polarity

In addition to this, a maceration and a decoction with water were made. A liquid-liquid separation was performed with 30 g of the lyophilized solution from the decoction. The liquids used were petrol ether, ethyl acetate and butanol.

Tests:

Standard phytochemical tests (A.1.1) were performed earlier at DMT.

Thin layer chromatography was performed with all the extracts by using one of the following solvent systems:

Water and methanolic extracts: Ethyl acetate:methyl ethyl ketone:formic acid:water (50:30:10:10).

Petrol ether and DCM extracts: Ligroine:ethylacetate (2:1).

All plates were treated with Godins reagent and examined using UV light at 254 and 366 nm.

The total content of polyphenolic compounds in the drug was measured.

The antioxidant properties of the extracts were tested by using thin layer chromatography combined with DPPH.

Antifungal activity was tested using the agar-overlay method

Haemostatic activity was tested by measuring coagulation time on full blood and recalcification of blood plasma.

Toxicity: LD₅₀ was determined after oral and intraperitoneal administration.

Analgetic effect was tested using “Hot plate” and “Writhing” tests.

Anti-inflammatory effect was tested using Carrageenan oedema test.

Results:

From the phytochemical tests performed at DMT the following substances were found: Flavonoids, tannins, mono- and polysaccharides, mucilages, sterols and/or triterpenes, leucanthocyanines and cardiac glycosides. The content of water was between 5,18 and 5,60 %. Ashes insoluble in HCl were 2,52 %, total ash content was 4,88 % and sulphur containing ash was 5,83 %.

Thin layer chromatography:

A spot with R_f = 0,55: intense yellow/orange fluorescence at 366 nm, intense yellow color with Godin at 254 nm. Spots with R_f = 0,55; 0,6; 0,66; 0,72; 0,8 and 0,85 are visible at 254 and 366 nm in the polar solvents. They have a brown to purple fluorescence. Some are colored with Godin. This indicates the presence of flavonoids in the extracts.

Spots with $R_f = 0,13$ and $0,2$ with blue to brown fluorescence at 366 nm is found in all extracts except the ethyl acetate extract. The blue color might indicate the presence of coumarins in the polar extracts. The results from the thin layer chromatography correspond well with the result from the phytochemical tests. Most of the spots were found in the polar extracts. This means that most of the substances are water soluble.

Content of polyphenolic compounds:

The content of polyphenols was calculated by using a standard curve. It was found to be 106,8 mg per 1 gram dried plant powder.

Antioxidant activity:

Table 3.1.2.3.a Results from tests on antioxidant activity

Extract	Number of spots
Water (decoction?)	5
Ethyl acetate	8
Buthanol	4
Saturated water, water at 50 °C and at 100°C	1
Water maceration	3
Methanol	7

Fungistatic activity: no activity was observed.

Table 3.1.2.3.b Haemostatic activity

Extracts	Coagulation time for blood (minutes)							
	Tube	Drop	Tube	Drop	Tube	Drop	Tube	Drop
	10 µl		25 µl		50 µl		100 µl	
Negativ control	12,38	12,07	12,38	12,07	12,38	12,07	12,38	12,07
Decoction	17	---	4,3 (65 %)	5,3 (56 %)	---	10,30 (14 %)	H	H
Petrol ether	7 (43 %)	---	8 (35 %)	9 (25 %)	7 (43 %)	14	10 (19 %)	---
Saturated extract	6,30 (49 %)							

H = haemolytic activity was observed instead of haemostatic activity.

Table 3.1.2.3.c Plasma recalcification time

Test number	Negative control	Decoction (10 µl)
1	3,30	2,30
2	3,30	2,30
3	3,30	2,30
4	3,30	3,00
5	4,30	3,30
6	5,00	3,30
7	5,30	4,00
8	6,00	4,00
9	5,30	4,00
10	5,30	4,00

Mean 4,44±1,06 3,25±0,75*
 Percentage reduction: 26,8 %
 Student t test: *P < 0,0001 (very significant).

Coagulation time for milk:

The test was positive. This, and the positive results from the other tests on haemostatic activity, might be caused by tannins in the leaves. Tannins have astringent properties that might cause vasoconstriction and thereby influence the haemostasis.

LD₅₀ after oral administration:

No deaths were observed. LD₅₀ is above 3 g extract/kg body weight from lyophilate and hence a bigger LD₅₀ than crude drug. The lyophilate from the decoction of the leaves from *Mangifera indica* is not toxic after administration of single dose taken orally.

Table 3.1.2.3.d LD₅₀ after intraperitoneal administration:

Dose mg/kg	Tested mice	Dead mice	% dead mice
500	6	0	0
750	6	0	0
1000	6	1	16,67
1250	6	5	83,33
1500	6	6	100

LD₅₀ was calculated from the TREVAN curve to be 1100 ± 102, 10 mg/kg body weight. Considering the extraction yield this gives a LD₅₀ of 6,16 g/kg body weight for the crude drug.

Analgetic activity:

Table 3.1.2.3.e Results from “Hot plate” test

Treatment	Dose (mg-mg/kg)	Before administration.	After administration. Reaction time in seconds and % increase in reaction time.			
		10 min	30 min	60 min	90 min	120 min
Water	25	7,35 ± 1,63	3,24±1,20	5,17±0,06	7,55±3,20	3,78±1,89
M.indica	1000	2,75 ± 0,82	3,50±1,54	2,22±0,64	2,15±1,18	2,57±1,03
Tramadol	5	4,17 ± 0,81	18,3±4,2 338,84 %	24,67±4,70 491,6 %	22,18±6,49 431,89 %	9,88±3,79 136,93 %

The extract shows no effect on CNS except a slight reduction in reaction time compared with the negative control test. The author believes this might be caused by saponins in the plant.

Table 3.1.2.3.f Results from “Writhing” test

Treatment	Dosage ml or mg/kg	Number of “torsions” mean and sd	% inhibition
Distilled water	25	71,17 ± 6,49	---
<i>M. indica</i>	500	48,17 ± 8,37*	32,32
<i>M. indica</i>	1000	46,53 ± 9,85*	34,19
<i>M. indica</i>	1500	41,33 ± 7,37*	41,92
Indometacin 25 mg	5	33,67 ± 3,5*	52,69
Tramadol	5	30,50 ± 6,71*	57,14

*P<0,01 Student t test

The extracts give some protection against chemically induced pain. The effect is comparable to indometacin (5 mg/kg). The analgesic effect is dose dependent.

Table 3.1.2.3.g Anti inflammatory activity

Treatment	Dosage ml or mg/kg	Mean ± SD	% inhibition
Distilled water	25	0,117 ± 0,008	---
<i>M. indica</i>	250	0,094 ± 0,017**	19,86
<i>M. indica</i>	500	0,094 ± 0,017**	19,86
<i>M. indica</i>	1000	0,075 ± 0,028**	36,14
ASA	100	0,074 ± 0,010**	36,86
Indometacin	5	0,089 ± 0,013**	23,43

The mean is calculated for 6 mice. ** P<0,01 Student t test

All the extracts show anti-inflammatory effects in this test.

Table 3.1.2.3.h Prolonged anti inflammatory activity:

Treatment	Dosage ml or mg/kg	1 hour after injection	3 hours after injection	5 hours after injection
Distilled water	25	0,093 ± 0,134	0,117 ± 0,008	0,091 ± 0,007
<i>M. indica</i>	1000	0,085 ± 0,021 (8,27)	0,075 ± 0,028 (30,52 %)	0,092 ± 0,017 (- 0,36 %)

The anti-inflammatory activity is strongest after 3 hours. The activity after 1 hour is very small, and no activity is seen after 5 hours.

All the tested extracts showed some antioxidant effect. This might be caused by the high content of polyphenolic compounds (tannins and/or flavonoids) in the leaves from *M. indica*. The large number of active spots in the water extracts supports the traditional use of water decoctions from this plant.

All the tested extracts show some haemostatic activity but the activity is not dose dependent. The decoction shows the strongest activity.

A search using www.google.com gave 42900 hits and www.PubMed.com gave only 110 hits (25.02.2005). For more information about this plant see Nguyen (2001).

3.1.2.4 *Spondias mombin* L.

Thesis: Sangare (2003)

Some traditional uses:

In Senegal the juice from fresh leaves is used against eye diseases. A decoction made from the leaves is used to treat dysenteric diarrhoeas, and a maceration from the roots is used against painful colic. A decoction of leaves and bark is used to treat post partum bleeding and to treat women who have had several abortions. (Kerharo and Adam, 1974).

Sangare (2003)

This author tested different parts of plants for activity against *Plasmodium falciparum*. The plants were identified after interviews with several healers in Kendié and Finkolo in January and February 2003. 49 healers were interviewed in Kendié and 30 in Finkolo. They were asked which plants they used to treat malaria, and also what they believed were the cause of the disease. In Kendié 22,45 % believed that mosquito bites caused malaria, while the number was only 10 % in Finkolo.

Leaves from *S. mombin* were collected in Blendi in the Sikasso region in May 2003.

Extractions:

50 g plant material + water (500 ml – 1 hour)

/

Decoction

Figure 3.1.2.4.a Decoction

50 g plant material + water (500 ml x 24 hours x 3)

/

Water maceration

Figure 3.1.2.4.b Maceration with water

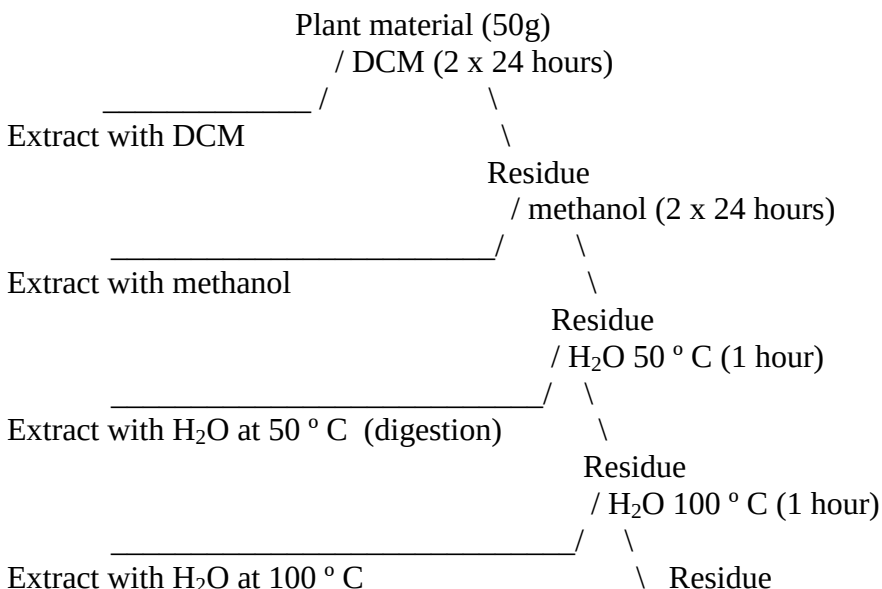


Figure 3.1.2.4.c Extractions with solvents of different polarity

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Activity against *Plasmodium falciparum* was tested.

Thin layer chromatography was performed on some of the decoctions and digestions. Solvent system BAW (60:15:25). The plates were treated with AlCl₃ and Godin's reagent.

Results:

From the phytochemical tests performed at DMT the following substances were found: Flavanoids, tannins, saponins, anthraquinones, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 7 and 9,56 %. Ashes insoluble in HCl were 0,94 %, total ash content was 4,24 % and sulphur containing ash was 4,02 % (Table 3.2).

The thin layer chromatography showed two spots that probably correspond with content of flavonoids.

IC₅₀-concentrations:

DCM extract:	2,57 µg/ml
Methanol extract:	3,92 µg/ml
Maceration with water:	7,66 µg/ml
Decoction:	7,89 µg/ml

Chloroquine: 0,05 µg/ml (reference substance)

All extracts from the leaves of *S. mombin* showed good activity against *P. falciparum*.

For more information about this plant see Diallo et al (2002) and Tran (2004).

3.1.3 Annonaceae

3.1.3.1 *Annona senegalensis* Pers.

Theses: Kanta (1999) and Samake (2000)

Some traditional uses in Senegal:

This medicinal plant is believed to have magical and medicinal properties, and it is widely used because of this. The most common uses are against diarrhoea and dysentery, and the most common formulation is a maceration of the bark from the branches or small branches with leaves or a powder dispersed in liquid (for example milk). The leaves and roots are said to be: antipyretic, antitussive, antiseptic, diuretic, anti-infective and to have several other medical properties. They have been used to treat the following diseases: malaria, respiratory diseases, eye diseases, dermatosis, rheumatism and other diseases. This plant might be used alone or combined with other plants (Kerharo and Adam, 1974).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*, These were identified after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words vaginal discharge and vaginitis. 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and 10th of December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

Extractions:

Leaves, stem bark and root bark from *A. senegalensis* was analyzed. Extracts were made with ethanol, dichloromethane and methanol.

Tests:

All extracts were tested for activity against *Candida albicans* and *Escherichia coli*.

Results:

None of the extracts had effect against *E. coli*. The ethanol extract from the root bark and the dichloromethane extract from the stem bark showed effect against *C. albicans* at 30 mg/ml. Activities: ++ and +++ (maximum activity is marked with +++).

At 10 mg/ml, the dichloromethane extract of the stem bark gave 7 active products using thin layer chromatography plates combined with the same microorganism. The ethanol extract from the root bark gave 3 products using the agar overlay method.

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, and all plant material was dried and pulverized before analysis.

Extractions:

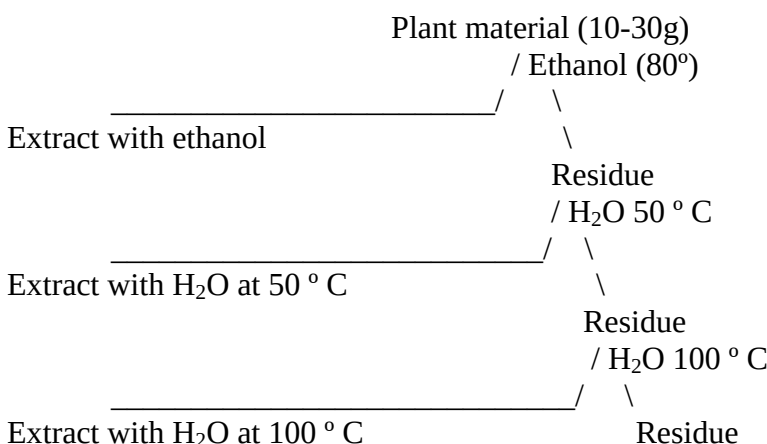


Figure 3.1.3.1.a Extraction with solvent of different polarity

A dialysis was performed on all solutions, followed by lyophilization.

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard here was mannitol.

Activity on the complement system was tested on sheep erythrocytes. ICH₅₀ is the concentration that gives 50 % inhibition lysis of sensible erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.3.1.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
A.s.	Leaves	+	+	+	0	+	+	+	+	0	> 500
A.s.	“	+	+	+	0	+	+	+	+	0	150
A.s.	Root bark	+	+	+	0	+	+	+	+	0	25
A.s.	“	+	+	+	0	+	+	+	+	0	130
A.s.	Stem bark	+	+	+	0	0	+	+	+	0	125
A.s.	“	+	+	+	0	0	+	+	+	0	25

A.s. = *Annona senegalensis*

Table 3.1.3.1.b Amounts of monosaccharides and polysaccharides detected

	Leaves		Root bark		Stem bark	
Monosaccharides	Extract at 50°C	Extract at 100°C	Extract at 50°C	Extract at 100°C	Extract at 50°C	Extract at 100°C
	Sugar ratio (%)	Sugar ratio (%)	Sugar ratio (%)	Sugar ratio (%)	Sugar ratio (%)	Sugar ratio (%)
Arabinose	8	3	28	3	1	5
Rhamnose	29	35	9	1	1	2
Xylose	2	0,5	48	3	2	36
Mannose	1	0,5	4	1	0	0
Galactose	16	17	11	1	2	5
Glucose	7	3	11	92	2	27
Glucuronic acid	0	0	0	0	14	20
Galacturonic acid	37	42	13	0	51	5
Total	100	101*	124*	101*	73*	100
Polysaccharides content	53 %	32 %	44 %	58 %	60 %	35 %

*The only information available is a summary table – basic data needs to be checked.

ICH₅₀ (µg/ml) values for 5 of the 6 tested extracts is under 150. This might be caused by the relatively high content of polysaccharides in all plant parts (32% to 60 %).

For more information about this plant see Aasberg (2001) and Diallo et al (2002).

3.1.4 Araliaceae

3.1.4.1 *Cussonia arborea* Hochst. ex. A. Rich. (Synonym: *Cussonia barteri* Seem.)

Theses: Bouare (2004) and Ouologuem (1999)

Some traditional uses:

Strømmland (Strømmland 2003) interviewed 32 healers in the Dogonland in Mali. The main uses identified from the interviews were: stomach pain, oedema, Hansen's disease (leprosy), mental diseases, constipation, sexually transmittable diseases and flatulens.

Bouare (2004)

This author identified traditional use of *Cussonia arborea*, and recipes based on this plant, by interviewing traditional herbalists/healers in the Dioila area in Mali in February 2003. According to these interviews the following uses were found:

Visual troubles, gonococci, oedema, syphilis, indigestion, stomach ache, toxoplasmosis, Hansen's disease (leprosy), food intoxication, head ache, asthma, to help during child birth and painful menstrual periods, wounds, muscular pain, blackouts, swelling (non specific), bloated stomach and dermatosis.

The plant material was collected in Blendio in the south of Mali. Only the bark from the root was analyzed.

Extractions:

50 g plant material + water (1000 ml – 1 hour)

/

Decoction

Figure 3.1.4.1.a Decoction

50 g plant material + water (500 ml x 24 hours x 3)

/

Water maceration

Figure 3.1.4.1.b Maceration with water

50 g plant material + ethanol (500 ml x 24 hours x 3)

/

Ethanol extract

Figure 3.1.4.1.c Maceration with ethanol

200 g plant material + dichloromethane (DCM) (1500 ml x 24 hours x 3)
/
DCM extract

Figure 3.1.4.1.d Maceration with DCM

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

The antioxidant properties of the extracts were tested by using thin layer chromatography combined with DPPH.

Thin layer chromatography was performed, using the following solvent systems: -
Buthanol:acetic acid:water – 60:15:25 (BAW) for water and ethanol extracts.
Ligroine:ethyl acetate – 1:1 for the DCM extract. The thin layer plates were treated with Godins reagent and examined using UV light at 254 and 366 nm.

Larvicidal activity:

Test on *Anopheles gambiae* and *Culex quinquefasciatus*.

Cytotoxic activity:

Test on *Lombricus terrestris* was performed to measure cellular toxicity.

Molluscicide activity was tested on *Bulinus truncatus* and *Biomphalaria pfeifferi*.

Antibacterial activity was tested on the following organisms:

Acinetobacter calco var anitrat

Citrobacter freundii

Enterobacter agglomerans

Escherichia coli

Klebsiella penumoniae

Proteus mirabilis

Pseudomonas aeruginosa

Salmonella spp

Streptococcus β haemolytic

Antifungal activity was measured using the Agar overlay method.

Results:

From the phytochemical tests the following substances were found:

Flavanoids, leucoanthocyan, tannins, saponins, cardiac glycosides, sterols and/or triterpenes, anthraquinones, coumarins, mono- and polysaccharides and mucilages. The content of water was between 5,37 and 8 %. Ashes insoluble in HCl were 2,8 %, total ash content was 3,26 % and sulphur containing ash was 17,7 % (Table 3.2).

The result from the thin layer chromatography corresponds with the results from the phytochemical tests.

Only a modest antioxidant activity was observed in the water and ethanol extracts. This corresponds well with absence of reducing compounds in the phytochemical tests.

All extract had larvicidal effect on *Anopheles gambiae*. The DCM extract showed the strongest activity with 100 % deaths at a concentration of 250 ppm (0,025 mg/ml). Only the DCM extract showed effect on *Culex quinquefasciatus*. A concentration of 500 ppm (0,05 mg/ml) gave 95 % deaths.

Only the ethanol and DCM extract showed effect on *Lombricus terrestris*. The ethanol concentration gave 100 % deaths at concentration of 3,75 mg/ml while the DCM extract gave 100 % deaths at 1,875 mg/ml.

All extracts showed effect on *Bulinus truncatus* and *Biomphalaria pfeifferi* at a concentration of 400 ppm (0,04 mg/ml).

Bulinus truncatus: the water and DCM extracts gave 100 % deaths at this concentration while the ethanol extract gave 100 % deaths at 200 ppm (0,02 mg/ml).

Biomphalaria pfeifferi: the decoction gave 100 % deaths at 400 ppm (mg/ml), the DCM extract gave 100 % deaths at 200 ppm (mg/ml) and the ethanol extract and the water maceration gave 100 % deaths at 100 ppm (mg/ml).

Table 3.1.4.1.a Antibacterial tests

Species	Measurement of inhibition zones in mm							
	DCM	DCM	EtOH	EtOH	M H ₂ O	M H ₂ O	D H ₂ O	D H ₂ O
	3 µl	4 µl	3 µl	4 µl	3 µl	4 µl	3 µl	4 µl
<i>S.aureus</i>	6,5	7	6,5	7	8	8	6,5	8
<i>Streptococcus</i>	7	7	7	7	7	7	7	9
<i>C.freundii</i>	8	8,5	7	7	0	0	7	9
<i>E.coli</i>	8	8	0	0	0	0	0	0
<i>K.pneumoniae</i>	7	7	6,5	6,5	7	7,5	7	7,5
<i>E.agglomerans</i>	8	9	9	9	6,5	7	7	8
<i>A.c var antiratis</i>	6,5	6,5	9	9,5	7	7	8	9
<i>S.spp</i>	0	0	0	0	0	0	7	9
<i>P.mirabilis</i>	7	7,5	0	0	0	0	7	7
<i>P.aeruginosa</i>	0	0	0	0	0	0	0	0

The decoction showed best antibacterial activity.

Table 3.1.4.1.b Antibacterial activity of reference species

Reference species	Measurement of inhibition zones in mm							
	DCM	DCM	EtOH	EtOH	M H ₂ O	M H ₂ O	D H ₂ O	D H ₂ O
	3 µl	4 µl	3 µl	4 µl	3 µl	4 µl	3 µl	4 µl
<i>S.aureus</i>	10	10	6,5	7	8	8	7	8
<i>E.coli</i>	8	8	0	0	6,5	7	7	7
<i>P.aeruginosa</i>	0	0	0	0	0	0	0	0

Antifungal activity: the DCM extracts gave inhibition zones for 100 µg, 200 µg and 300 µg extracts at Rf 0,93. The diameter of the zones varied with the tested concentration.

Ouologuem (1999)

This author tested the larvicidal effects of different extracts from 11 Malian plants. Larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were used. 6 of the plants were tested on both species, while 5 were only tested on *C. quinquefasciatus*.

Larvae from second and third generation *Anopheles gambiae* collected in Mopti were used. Larvae from *Culex quinquefasciatus* were collected in N'Tomikorobougou and Darsalam, in the Bamako district.

Pre-made extracts were used. DCM, methanol and water extracts from *C. arborea* roots were tested.

Tests:

Tests on larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were done on 5,5 mg extract dissolved in 110 µl of a suitable solvent; water for the water and ethanol extracts and dimethylsulfoxide (DMSO) for the methanol, ether and DCM-extracts. The tests were performed on 5x20 larvae, and larvae that had fallen to the bottom of the tubes or were immobile were considered dead.

The DCM extracts from *Lannea velutina* leaves and *Cussonia arborea* roots, methanol extract from *Diospyros abyssinica* leaves and ether extract from *Cissus quadrangularis* twigs were tested at different concentrations. The extended tests were only performed on *Culex quinquefasciatus* larvae, as these are considered to be more resistant than larvae from *Anopheles gambiae*.

Results:

Larvicidal tests:

Table 3.1.4.1.c *Culex quinquefasciatus* - % deaths at 500 ppm

	Plant extract		
Time of exposure	C.a. H ₂ O	C.a. Methanol	C.a. DCM
30 minutes	10	10	25
1 hour	10	15	65
24 hours	60	20	100

Table 3.1.4.1.d *Anopheles gambiae* - % deaths at 500 ppm

	Plant extract		
Time of exposure	C.a. H ₂ O	C.a. Methanol	C.a. DCM
30 minutes	90	75	55
1 hour	90	80	90
24 hours	95	100	100

C.a. = *Cussonia arborea*

Extended tests at different concentrations: See tables **3.1.2.2.c** - **3.1.2.2.f**.

This plant shows good antibacterial, antifungal and larvicidal effects.

Strømmland (2003) isolated and characterized lowmolecular substances from this plant. See his thesis for more information about *C. arborea*.

Cussonia arborea:

A search using www.google.com gave 95 hits and www.PubMed.com gave 1 hit (25.02.2005).

Cussonia barteri:

A search using www.google.com gave 76 hits and www.PubMed.com gave 3 hits (25.02.2005).

3.1.5 Arecaceae

3.1.5.1 *Borassus flabellifer* L.

Traditional uses:

In Senegal, preparations made from roots of young plants are used to treat sore throat and bronchitis. Palm wine is made from sap and is consumed by non-Muslims as a stimulating agent. It is also a part of most of the aphrodisiac remedies made (Kerharo and Adam, 1974).

Field work:

Uses against dermatosis:

N`Tjobougou, 5.2.04

Djokin Diarra is using the flower from this plant against leaking boils. The flowers was mixed with *Fomes fomentarius* (English: german tinder. Norwegian: kjuke) and carbonized. The powder was mixed with butter from *Butyrospermum parkii*, arachis or palmtrees.

Bourama Toure uses the flower from this plant against black dermatosis; this appears on the skin in a round form and itches in the beginning. The flowers are carbonized into a powder and mixed with butter from *Butyrospermum parkii* before it is applied.

Konimba Traore is using the flower from *B. flabellifer* against dermatosis on the head. Carbonize the flower, mix the powder with oil and apply the mixture on the dermatosis.

Didieni-region, 6.2.04 and Masantola-region, 7.2.04

Donéké Traoré is using the flower from this plant to treat black dermatosis. Dry the flower, carbonize it and mix the powder with the butter from *B. parkii*. Apply 2 times per day.

Diotin Traoré uses the roots from this plant to treat black dermatosis. The flower is carbonized, mixed with the butter from *B. parkii*. The mixture is applied once.

Soungalo Traoré, N`gogna Coulibaly, Naoba Diabati and N`kotjiri Traoré are using the flower from this plant to treat dermatosis. Carbonize the flower, mix with the oil of *B. parkii* and apply on the body.

H`toriké Coulibaly uses the flower from *B. flabellifer* to treat dermatosis. Carbonize the flowers, mix with potash and oil from *B. parkii* and apply on the skin.

10 of the 21 interviewed healers use the carbonized flower from this plant to treat dermatosis. The plant is a palm like tree, and the flowers are quite big. Further examination of their phytochemical content and other properties might be interesting.

A search using www.google.com gave 3500 hits and www.PubMed.com gave 18 hits (25.02.2005).

3.1.6 Asclepiadaceae

3.1.6.1 *Calotropis procera* (Aiton) W.T. Aiton

Some traditional uses:

In Senegal the plant is known to be toxic. The latex, leaves and especially the roots are emetic. It is therefore used as a purgative and emetic remedy and also against poisoning. The root bark is used in the treatment of anxiety and other mental disorders.

The roots are used as a part of a treatment against syphilis and Hansen's disease (leprosy). In all cases the preparations contains only small amounts of the plant since the cardio toxic effect is normally well known. The latex is used externally as antiseptic agent and as a sedative (Kerharo and Adam, 1974).

Field work

Uses against dermatosis:

Didieni-region, 6.2.04

Donéké Traoré is using the stem from this plant to treat black dermatosis. Dry the stem, carbonize it and mix the powder with the butter of *B. parkii*. Apply 2 times per day.

Balla Sissoko uses the stem and leaves from *C. procera* to treat itchy, black dermatosis. Make a decoction and use as a bath.

Konimba Keita uses the leaves from this plant to treat dermatosis. The leaves are carbonized, mixed with the butter from *B. parkii*. This is applied to the skin once daily.

A search using www.google.com gave 7040 hits and www.PubMed.com gave 61 hits (25.02.2005).

3.1.6.2 *Leptadenia hastata* (Pers.) Decne.

Some traditional uses in Senegal:

The easy access to this plant is probably the main reason for its common use.

The latex is used to treat wounds, while a maceration of the roots are used against constipation. The whole plant is used to treat vaginal discharge, while the leaves are used to treat weakness and problems with lactation. Different parts of the plants are used in combination with other plants to treat syphilis, urinary problems, Hansen's disease, constipation, mental diseases and diarrhoea (Kerharo and Adam, 1974).

Field work:

Dideni-region, 6.2.04

Diotin Traoré uses the flower from this plant to treat black dermatosis. The flower is carbonized and mixed with the butter from *B. parkii*. The mixture is applied once.

A search using www.google.com gave 233 hits and www.PubMed.com gave 5 hits (25.02.2005).

3.1.6.3 *Leptadenia pyrotechnica* (Forssk.) Decne.

Thesis: Bah (1998)

Some traditional uses:

In Senegal, *Leptadenia sp.* has been used as a laxative for children that are less than 10 days old. It is also used against pain in the kidneys and sore muscles (Kerharo and Adam, 1974). In Mali, the stem juice is administered twice a day for 4 or more days in the nostrils to cure cough, colds and running nose (Diallo et al, 1999).

Bah (1998)

This author studied the larvicidal effects of 10 different plant extracts on *Anopheles gambiae*, one of the intermediate hosts in malaria. As mosquitoes are developing resistance to an increasing number of chemical insecticides, it is important to search for new and possibly less toxic agents from plants to try and control the disease. *Anopheles gambiae* mosquitoes were collected in Mopti. For the tests, larvae were elevated and collected in the laboratory, from full grown females collected at one specific date. Larvae were fed with Whiskas® cat food.

The plant material was collected in Hombori in June 1996, and was dried and pulverized before analysis. Only the branches from *L. pyrotechnica* were analyzed.

An extract was made with water, 500 ml x 24 hours x 3. The extract was tested at concentrations from 0,015 mg/ml to 0,06 mg/ml on groups of 8 x 25 larvae and the number of dead larvae registered. No deaths were observed at any of the tested concentrations.

The branches from this plant do not show any activity in the performed tests. This plant will not be discussed further in this thesis.

A search using www.google.com gave 358 hits while www.PubMed.com gave no hits (25.02.2005).

3.1.7 Asteraceae

3.1.7.1 *Vernonia colorata* (Willd.) Drake

Thesis: Fane (2002)

Some traditional uses:

This plant is used by healers everywhere it is found. The leaves have a bitter taste that is said to resemble quinine and they are used against fever and stomach aches. Inhalation of decoction from leaves are used in epileptic seizures. It is also comined with other plants in the treatment of schistostomatiosis and sterility (Kerharo and Adam,1974).

Fane (2002)

This author interviewed 110 healers in the Bamako district; 50 men and 60 women. Most were in the age group between 40-70 years. They were asked to name known toxic plants, the use of these plants, toxic effects and possible anti-dotes.

299 examples were mentioned, giving a total of 61 different plants. Maiga et al (2004) did a literature research of the 19 most cited plants.

Phytochemical tests were performed on 5 of these plants and, further biological tests were performed on 3 plants: *Vernonia colorata*, *Afrormosia laxiflora* (3.1.19.1) and *Cassia siberiana* (3.1.11.4). The plants were chosen from both the results from the interviews, but also from the literature about the plants.

Table 3.1.7.1.a The 10 most cited plants (with indication for use) in the interviews:

1. <i>Swartzia madagascariensis</i> (39)	Jaundice, malaria
2. <i>Cassia sieberiana</i> (23)	Stomach ache, malaria
3. <i>Securdiaca longepedunculata</i> (20)	Haemorrhoids, small pox
4. <i>Trichilia emetica</i> (19)	Haemorrhoids, gastric ulcer
5. <i>Cassia alata</i> (17)	Constipation, malaria
6. <i>Entada africana</i> (12)	Malaria
7. <i>Anogeissus leiocarpus</i> (12)	Constipation, malaria
8. <i>Gardenia ternifolia</i> (10)	Jaundice, malaria
9. <i>Acacia senegal</i> (10)	Vulvovaginitis, haemorrhoids
10. <i>Opilia celtidifolia</i> (8)	Malaria, stomach ache

Table 3.1.7.1.b The 10 most cited indications were:

1. Malaria
2. Stomach ache
3. Constipation
4. Jaundice
5. Haemorrhoids
6. Vulvovaginitis
7. Gastric ulcer
8. Vaginal discharge
9. Migraine
10. "Mauvais sort"

Vernonia colorata leaves were collected from the Mambilé school-garden in November 2001. The plant material was dried and pulverized before use.

Other biological material:

- Mice of the strain "Oncins France Souche 1" were used. Their weight was between 20-25 g.
- Refrigerated blood from cattle was collected at the slaughter house in Bamako in March 2002.
- *Anopheles gambiae* larvae (stadium 2) were acquired from the "Department de l'epidemiologi des affections parasitaires" in Bamako.
- Full grown *Lombricus terrestris* were collected by the river bank in Djoliba in June 2002.

Extractions:

A decoction was made with 250 g powdered plant material in 2,5 l distilled water for 3 hours.

A maceration was made with 50 g powdered plant material in 500 ml distilled water for 3x24 hours.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Toxicity:

LD₅₀ orally was tested on groups of 6 mice (3 male and 3 female). Dosage of extracts was from 500 to 5000 mg/kg. Mortality was observed until 3 days after administration.

LD₅₀ intraperitoneal was tested on groups of 6 mice (3 male and 3 female). Dosage of extracts was from 400 to 675 mg/kg. Mortality was observed until 3 days after administration.

Chronic/prolonged toxicity was tested on groups of 16 mice (6 male and 10 female). Extracts were administration orally at a concentration of 42,75 mg/kg body weight for 4 weeks. After 2 weeks, 2 mice from each group were killed and their organs were examined. After the 4th week, the rest of the mice were killed and their organs examined.

Transaminase test.
 Haemolytical tests.
 Larvicidal activity.
 Test of cytotoxic effect on *Lombricus terrestris*.

Results:

From the phytochemical tests the following substances were found:

Alkaloids (0,11 %), flavonoids, tannins, saponins, coumarins, reducing compounds, mono- and polysaccharides, mucilages, sterols and/or triterpenes, leucanthocyanines and cardiac glycosides. The content of water was between 5,65 and 6 %. Ashes insoluble in HCl were 10,27 %, total ash content was 13,6 % and sulphur containing ash was 19,17 %.

Toxicity:

LD₅₀ orally: no deaths observed.

LD₅₀ intraperitoneal: no deaths observed, but the mice showed shaking and had diarrhoea.

Chronic/prolonged toxicity: no deaths observed, but an increase in weight for both male and female mice.

The weights of liver and kidneys from treated mice were comparable to the values for mice that were only given water. One of the female mice got an enlarged pancreas.

Transaminase:

1. Serum from healthy mice
2. Serum from mice that were given distilled water.
3. Serum from mice that were given *Vernonia colorata*

Table 3.1.7.1.c Results from transaminase test

Serum	SGOT	SGPT
1	34	26
2	65	38
3	97	34

Both SGOT and SGPT increased.

Table 3.1.7.1.d Results from larvicidal test on *Anopheles gambiae*

Extracts (500 µg)	Number of larvae	Time	
		24 hours	
		Number of deaths	% dead
Distilled water	20	0	0
Decoction V.c.	20	16	80
Maceration V.c.	20	14	70

V.c = *Vernonia colorata*

No deaths were observed after 30 minutes or after 1 hour.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Molluscicidal activity was tested for all extracts at concentrations from 0,025 mg/ml to 0,4 mg/ml. Tests were performed on *Biomphalaria pfeifferi* and *Bulinus truncatus*.

Results:

From the phytochemical tests performed at DMT the following substances were found: Flavanoids, leucoanthocyanins, tannins, saponins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 7,25 and 8 %. Ashes insoluble in HCl were 7,71 %, total ash content was 8,74 % and sulphur containing ash was 12,21 % (Table 3.2).

Molluscicidal activity:

Only the acetone and ethanol extracts showed activity. A concentration of 0,2 mg/ml of the acetone extract and 0,4 mg/ml of the ethanol extract 100 % deaths for *Biomphalaria pfeifferi*,. A concentration of 0,2 mg/ml for the acetone extract gave 100 % deaths for *Bulinus truncatus*, while the ethanol extract gave 50 % deaths at 0,4 mg/ml.

Bah (1998)

This author studied the larvicidal effects of 10 different plant extracts on *Anopheles gambiae*, one of the intermediate hosts in malaria. As mosquitoes are developing resistance to an increasing number of chemical insecticides, it is important to search for new and possibly less toxic agents from plants to try and control the disease. *Anopheles gambiae* mosquitoes were collected in Mopti. For the tests, larvae were elevated and collected in the laboratory, from full grown females collected at one specific date. Larvae were fed with Whiskas® cat food.

The plant material was collected in Sotuba in 1996, and was dried and pulverized before analysis. Only the “tubercles” from *V. kotschyana* were analyzed.

Extractions were made with dichloromethane, methanol and water and all extracts were tested on groups of 8 x 25 larvae at concentrations from 0,015 mg/ml to 0,06 mg/ml.

None of the extracts showed any activity.

Ouologuem (1999)

This author tested the larvicidal effects of different extracts from 11 Malian plants.

Larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were used. 6 of the plants were tested on both species, while 5 were only tested on *C. quinquefasciatus*.

Larvae from *Culex quinquefasciatus* were collected in N'Tomikorobougou and Darsalam, in the Bamako district.

Pre-made extracts were used. Water, ethanol and acetone extracts from *V. kotchyana* leaves were tested.

Tests:

Tests on larvae from *Culex quinquefasciatus* were done on 5,5 mg extract dissolved in 110 µl of a suitable solvent; water for the water and ethanol extracts and

dimethylsulfoxide (DMSO) for the methanol, ether and DCM-extracts. The tests were performed on 5x20 larvae, and larvae that had fallen to the bottom of the tubes or were immobile were considered dead.

Results:

Larvicidal test:

Table 3.1.7.2 *Culex quinquefasciatus* - % deaths at 500 ppm

Time of exposure	Plant extract		
	V.k. H ₂ O	V.k. Ethanol	V.k. Acetone
30 minutes	10	0	0
1 hour	10	10	10
24 hours	25	50	15

V.k. = *Vernonia kotschyana*

The tested extracts show molluscicidal activity and weak larvicidal activity.

Nergård et al (2004) have done a review of *V. kotschyana* and examined the immunomodulating activities of polysaccharides found in the plant.

A search using www.google.com gave 84 hits and www.PubMed.com gave 2 hits (25.02.2005).

3.1.8 Balanitaceae

3.1.8.1 *Balanites aegyptiaca* L.

Thesis: Ahamet (2003)

Some traditional uses in the Gourma district in Mali:

Root bark maceration is drunk to treat constipation and malaria. Fresh leaves crushed with fruits of *Acacia nilotica* (L) Willd. Ex Del are mixed with cow's butter and water and the mixture is used to treat tonsillitis. Applied locally it may be used to treat gum-inflammation. Fruit maceration is used against conjunctivitis. Almonds of crushed fruits are dampened with water and laid on pimples. The almonds are also used to treat wounds and scabies (Diallo et al 1999).

Ahamet (2003)

The authour studied this plant extensively. The plant material was collected in Niger in the Maradi zone where the ground is sandy. The plant was dried in shadow for three weeks before being ground to a powder in a traditional mortar. The stem bark of the plant was analyzed.

Extractions were made with water (decoction, digestion and maceration), ethanol (maceration) and chloroform (maceration).

Tests:

Thin layer chromatography was performed with all the extracts by using one of the following solvent/migration systems:

- Water and ethanol extracts: - Chloroform:acetone / 80:20
- Chloroform: acetone / 60:40
- Chloroform:methanol:water / 65:35:5
Chloroform extract: - Lignoine:ethylacetate / 2:1

The chromatography plates were treated with Godin and Dragendorff reagents and studied using an UV lamp at 245 nm and 366 nm

The antioxidant properties of the extracts were tested using DPPH.

Standard phytochemical tests (A.1.1) were performed at DMT.

- Biological tests: - Test for anti-inflammatory activity
- Test for analgesic activity
- Test for antispasmodic activity

Results:

From the phytochemical tests the following substances were found:

Alkaloids (0,13 %), leucanthocyanines, tannins, saponins (abundant), cardiac glycosides, sterols and/or triterpenes, coumarins, carotenoids, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 4,86 and 6 %. Ashes insoluble in HCl was 1,94 %, total ash content was 7,53 % and sulphur containing ash was 11,18 % (Table 3.2).

Thin layer chromatography:

Saponines and triterpenes gave a violet coloration with Godin's reagent which corresponds well with the results from the phytochemical tests.

In addition to this orange fluorescence at 366 nm and intense yellow coloration with Godin's reagent indicates the presence of flavonoids, despite their absence in the phytochemical tests.

Table 3.1.8.1.a Test for anti-inflammatory activity

Treatment	Dose mg/ml/kg	M $\pm$ SD			
		M is mean volume of the mouse feet at different times			
		60 min	120 min	180 min	240 min
Negative control	10	1,49 $\pm$ 0,17	1,88 $\pm$ 0,42	2,15 $\pm$ 0,53	2,22 $\pm$ 0,44
Indometacine	10	1,13 $\pm$ 0,12**	1,15 $\pm$ 0,16**	1,18 $\pm$ 0,16**	1,32 $\pm$ 0,18**
Digestion H ₂ O	300	1,17 $\pm$ 0,25*	1,28 $\pm$ 0,30*	1,37 $\pm$ 0,32*	1,48 $\pm$ 0,29**
Digestion H ₂ O	900	1,03 $\pm$ 0,15**	1,20 $\pm$ 0,25*	1,29 $\pm$ 0,25*	1,29 $\pm$ 0,21**
Maceration H ₂ O	300	1,25 $\pm$ 0,15*	1,23 $\pm$ 0,16**	1,25 $\pm$ 0,18*	1,33 $\pm$ 0,19**
Maceration H ₂ O	900	1,15 $\pm$ 0,04*	1,19 $\pm$ 0,11	1,35 $\pm$ 0,13*	1,46 $\pm$ 0,19**
Ethanol	300	1,20 $\pm$ 0,07*	1,39 $\pm$ 0,15	1,55 $\pm$ 0,24*	1,70 $\pm$ 0,30
Ethanol	900	1,32 $\pm$ 0,25	1,33 $\pm$ 0,17	1,51 $\pm$ 0,22*	1,72 $\pm$ 0,28
Dichloromethane	300	2,29 $\pm$ 0,11**	1,34 $\pm$ 0,20	1,40 $\pm$ 0,18*	1,69 $\pm$ 0,20*
Dichloromethane	900	1,46 $\pm$ 0,67	1,33 $\pm$ 0,12	1,43 $\pm$ 0,12*	1,84 $\pm$ 0,08

M = mean volume of 5 rats. SD = standard deviation.

Student t test: *P < 0,05 = significant **P = < 0,01 = very significant

All the extracts except dichloromethane at 300 mg/ml/kg at 60 minutes showed some effect compared to the non-treated reference group. Digestion at a concentration of 900 mg/ml/kg showed the best effect after 60 minutes. The results show no dose dependence. The animals used in this test were rats of race “Wistar” with a weight between 150 and 180 g.

Table 3.1.8.1.b Test for analgesic activity “Writhing test”

Treatment	Dose mg/ml/kg	Number of torsions M ± SD	% Inhibition
Distilled water	25	48,00 ± 6,50	-
Paracetamol	100	32,00 ± 7,00**	33,33
Digestion H ₂ O	100	40,20 ± 10,18	16,25
Digestion H ₂ O	300	39,40 ± 5,54*	17,91
Digestion H ₂ O	900	5,60 ± 5,07**	88,33
Maceration H ₂ O	100	25,20 ± 7,59**	47,50
Maceration H ₂ O	300	25,80 ± 6,76**	46,25
Maceration H ₂ O	900	23,20 ± 4,02**	51,66
Decoction H ₂ O	100	42,00 ± 6,00	12,50
Decoction H ₂ O	300	25,40 ± 7,12**	47,91
Decoction H ₂ O	900	21,40 ± 5,17**	55,41
Ethanol	100	32,40 ± 2,10**	31,66
Ethanol	300	30,80 ± 7,98**	35,83
Ethanol	900	31,60 ± 7,30*	34,16

M = mean volume of 5 mice. Student t test: *P < 0,05 = significant **P = < 0,01 = very significant. SD = standard deviation.

The animals used in this test were female mice of the strain Oncins France Souche1.

Table 3.1.8.1.c Test for antispasmodic activity

Treatment	Injected volume (ml)	Concentration (µg/ml)	% Inhibition
Atropine	0,15	0,0075	53,12 ± 4,7
Decoction H ₂ O	0,2	100	22,22 ± 2,6**
Decoction H ₂ O	0,2	300	44,60 ± 6,9**
Decoction H ₂ O	0,2	900	54,84 ± 5,7**
Maceration H ₂ O	0,2	100	16,66 ± 1,9 **
Maceration H ₂ O	0,2	300	22,08 ± 2,4**
Maceration H ₂ O	0,2	900	30,46 ± 3,4**
Dichloromethane	0,2	100	14,44 ± 1,9**
Dichloromethane	0,2	300	49,87 ± 4,2**
Dichloromethane	0,2	900	64,94 ± 3,68*

M = mean volume of 5 rats. SD = standard deviation.

Student t test: *P < 0,05 = significant **P = < 0,01 = very significant.

The animals used in this test were rats of race “Wistar” with a weight between 150 and 180 g. Most of the tested extracts showed analgesic activity. This activity might be caused by saponins.

Numerous compounds showing antioxidant activity were found in all the extracts. Substances like tannins, coumarins or carotenoids might be responsible for this activity.

The anti-inflammatory effect might be caused by saponins and/or triterpenes. All the tested extracts showed good antispasmodic activity. This might be caused by coumarins or alkaloids.

Reviews of this plant were done by Aasberg (2001).

3.1.19 Bignoniaceae

3.1.9.1 *Stereospermum kunthianum* Cham.

Theses: Kanta (1999) and Samake (2000)

Traditional use:

In Mali, the powder of the dried bark is applied on burns or wounds. The wound is washed with a decoction of fresh leaves. Special indications for sexual wounds (Diallo et al, 2002).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words vaginal discharge and vaginitis. 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and the 10th of December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

The leaves from *Stereospermum kunthianum* were analyzed. An extract was done with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*, but it did not have any effect against these microorganisms.

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analysis.

Extraction:

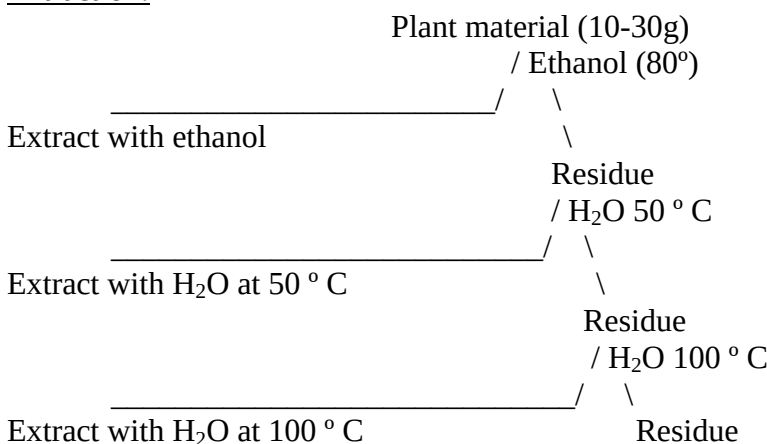


Figure 3.1.9.1.a Extraction with solvents of different polarity

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard substance used was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.9.1.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
S.k. 50°C	Leaves	+	+	+	0	+	+	+	+	0	50
S.k. 100°C	Leaves	+	+	+	0	+	+	+	+	0	25
S.k. 50°C	Stem bark	+	+	+	0	+	+	+	+	0	< 15
S.k. 100°C	Stem bark	+	+	+	0	+	+	+	+	0	< 15

S.k. = *Stereospermum kunthianum*

Gas chromatography:

Table 3.1.9.1.b Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C (leaves)		Extract at 100°C (leaves)	
	Sugar ratio (%)	Test substance ratio (%)	Sugar ratio (%)	Test substance ratio (%)
Arabinose	7	1	7	2
Rhamnose	16	3	14	4
Xylose	2	0,3	2	0,5
Fucose	0	0	0	0
Mannose	5	1	7	2
Galactose	10	2	10	3
Glucose	53	10	38	10
Glucuronic acid	7	1	5	1
Galacturonic acid	0	0	17	4
Total	100	18	100	26
Polysaccharide content (%)	18		26	
Polysaccharide content in stem bark (%)	40		80	

The stem bark showed very good effect on the complement system. This might be caused by the high content of polysaccharides in the stem bark.

For more information about this plant see Aasberg (2001).

3.1.10 Bombacaceae

3.1.10.1 *Bombax costatum* Pellegr. & Vuillet

Thesis: Sanogo (1999)

Traditional uses:

In Senegal, the stem bark and roots are known to have good diuretic properties and the leaves are known to be rich in mucilages. The emollient properties are undisputable and the different plant organs are used either alone or combined with other plants, especially to treat vaginal discharge and diarrhoea (Kerharo and Adam, 1974).

This gum has traditionally been used to treat dental affections (Sanogo, 1999).

Sanogo (1999)

This author did a survey of gums found from different plants in Mali and their commercial and medicinal uses. The collection of plant material took place between November 1997 and February 1998 in Bamako and Banankoro. This specific gum was collected in December 1997 in Banankoro.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances, and with the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was used to confirm the content of monosaccharides.

All gums were tested for possible content of *Escherichia coli* and *Salmonella spp.*

They were also examined for content of starch and starch derivatives.

Results:

From the phytochemical tests performed at DMT the following substances were found:

Coumarins, saponines, tannins, mono- and polysaccharides, mucilages, sterols and triterpenes, leucanthocyanines, carotenoids and cardiac glycosides. The content of water is between 7 and 8,10 %. Ashes insoluble in HCl were 1,95 %, total ash content was 3,30 % and sulphur containing ash was 3,49 % (Table 3.2).

Thin layer chromatography: matching R_f with arabinose.

Gas chromatography:

5 monosaccharides: Arabinose (45,17 %), galactose (40,92 %), glucose (7,60 %), mannose (3,65 %) and rhamnose (2,66 %) Only 1 of these sugars was detected using thin layer chromatography despite the large content.

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of gum.

The test for starch and starch derivatives was also negative.

Field work:

Uses against dermatosis:

Masantola-region, 7.2.04

Boua Fomba uses the gum from this plant against dermatosis. The gum is carbonized and mixed with the oil of *B. parkii* and the mixture is applied twice a day.

Soundjé Coulibaly and N`tiokon Traoré are using the gum from this plant to treat dermatosis. The gum is carbonized, mixed with the oil from *B. parkii* and applied once daily.

A search using www.google.com gave 395 hits while www.PubMed.com gave 0 hits (25.02.2005).

3.1.11 Caesalpiniaceae

3.1.11.1 *Afzelia africana* Sm.

Some traditional uses in Senegal:

A maceration of powdered bark is used against fever and as a stimulating agent for the gastro-intestinal system. It is also used both internally and externally against Hansen's disease (leprosy). The grains are sometimes considered to be toxic, but no specific information on use has been obtained (Kerharo and Adam, 1974)

Field work:

N'Tjobougou 5.2.04

Bourama Traoré uses this recipe to treat black dermatosis; when it itches a lot the bark of *Pterocarpus erinaceus* and *Afzelia africana* is used to make a powder. This powder is mixed with the powder of the bark of *L. velutina*. One part is used for making a decoction that is used to wash the skin, the other part is mixed with oil and applied on the dermatosis once per day until it is completely cured.

A search using www.google.com gave 1570 hits while www.PubMed.com gave 8 hits (25.02.2005).

3.1.11.2 *Burkea africana* Hook.

Theses: Kanta (1999) and Samake (2000)

Some traditional uses:

In Senegal, the plant is used both internally and externally against dizziness and persistent migraines. A decoction from the bark is used as anti-neuralgic remedy (Kerharo and Adam, 1974).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words vaginal discharge and vaginitis. 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and the 10th of December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

The stem bark from *Burkea africana* was analyzed. An extract was done with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*. The extract did not have any effect against *E. coli*, but it showed effect against *C. albicans* at 30 mg/ml. Activity: ++ (maximum activity is marked with +++).

At 10 mg/ml the ethanol extract of the stem bark gave 3 active products using thin layer chromatography plates combined with the microorganism.

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analyzis.

Extractions:

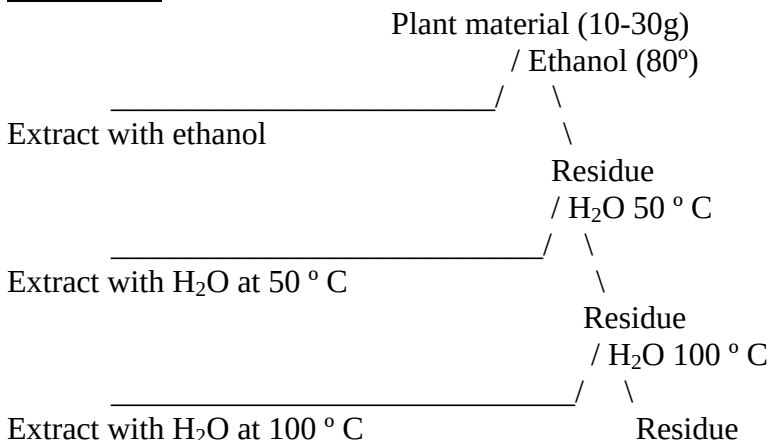


Figure 3.1.11.2.a Extraction with solvents of different polarity

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm. Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard here was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.11.2.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
B.a. 50°C	Stem bark	+	+	+	0	+	+	+	+	0	155
B.t. 100°C	Stem bark	+	+	+	0	+	+	+	+	0	115

B.a. = *Burkea africana*

Gas chromatography:

Table 3.1.11.2.b Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C	Extract at 100°C
	Sugar ratio (%)	Sugar ratio (%)
Arabinose	28	27
Rhamnose	6	15
Xylose	2	5
Mannose	1	1
Galactose	10	21
Glucose	42	18
Glucuronic acid	0	0
Galacturonic acid	10	13
Total	99*	100
Polysaccharides (%)	46	27

*The only information available is a summary table – basic data needs to be checked.

The stem bark showed activity against *C. albicans* as well as activity on the complement system.

Mathisen (Mathisen 1999) discovered a high content of proanthocyanidines with antioxidant and radical-scavenging activities in the bark from *B. africana*.

A search using www.google.com gave 2 hits and www.PubMed.com gave only 1 hit (25.02.2005).

3.1.11.3 *Cassia nigricans* Vahl

Theses: Kanta (1999) and Samake (2000)

Some traditional uses in Senegal:

A decoction of the leaves is used against fever and the roots are used against worms (Kerharo and Adam, 1974).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words vaginal discharge and vaginitis. 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and the 10th of December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

The leaves from *Cassia nigricans* were analyzed. An extract was done with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*. The extract did not have any effect against *E. coli*, but it did show good effect against *C. albicans* at 30 mg/ml. Activity: +++ (maximum activity is marked with +++).

At 10 mg/ml the ethanol extract of the leaves gave 4 active products using thin layer chromatography plates combined with the microorganism.

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analyzing.

Extraction:

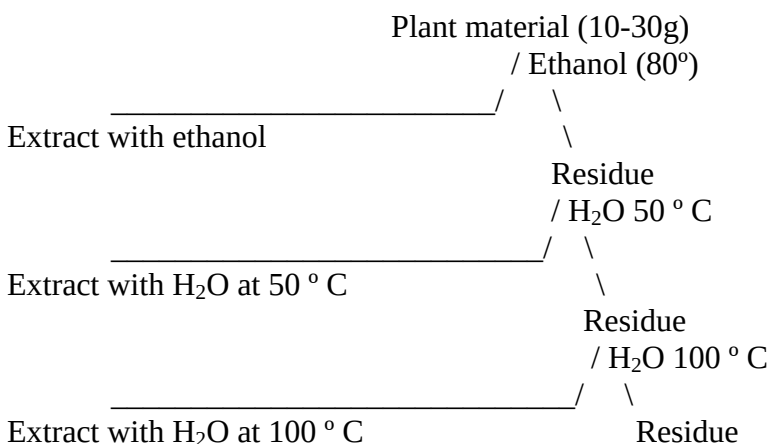


Figure 3.1.11.3.a

A dialysis was performed on all solutions, followed by lyophilization.

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard substance used was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.11.3.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
C.n. 50°C	Leaves	+	+	+	0	+	+	+	0	+	120
C.n. 100°C	Leaves	+	+	+	0	+	+	+	+	+	55

C.n. = *Cassia nigricans*

Gas chromatography:

Table 3.1.11.3.b Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C		Extract at 100°C	
	Sugar ratio (%)	Test substance ratio (%)	Sugar ratio (%)	Test substance ratio (%)
Arabinose	15	4	11	6
Rhamnose	6	2	4	2
Xylose	9	2	4	2
Mannose	5	1	10	5
Galactose	16	4	12	6
Glucose	6	2	6	3
Glucuronic acid			51	25
Galacturonic acid	43	12	2	1
Total	100	7	100	50
Polysaccharide content	27 %		50 %	

The leaves from the plants show very good effect against *C. albicans*. The decoction from the leaves have good effect on the complement system.

For more information about this plant see Aasberg (2001).

3.1.11.4 *Cassia sieberiana* DC.

Theses: Ekoumou (2004), Fane (2002) and Sangare (2003)

Some traditional uses:

In Senegal this plant is known for its purgative and diuretic properties. It is used to treat constipation, urinary infections, intestinal parasites, Hansen's disease (leprosy), oedemas, sexually transmitted diseases, schistosomiasis, weakness, sterility and renal pain. The roots are the most common part used. Twigs with leaves (maceration or decoctions) are used to treat infantile fever and anemia (Kerharo and Adam, 1974).

Ekoumou (2004)

This author identified 5 recipes traditionally used to treat urinary infections and cystitis. Both single plants and combinations of plants were analyzed.

The plants were chosen from several documents on medicinal plants used in West Africa (Kerharo and Adam, 1974 and others).

The leaves from *C. sieberiana* were tested alone and with fruits from *Tamarindus indica* after the following recipes: 90 % *C. sieberiana* + 10 % *T. indica* and 80 % *C. sieberiana* + 20 % *T. indica*.

Extractions:

20 g plant material + water (200 ml)
(15 minutes at 100 °C)

/

Decoction

Figure 3.1.11.4.a Decoction

20 g plant material + water (200 ml x 24 hours)

/

Water maceration

Figure 3.1.11.4.b Maceration with water

20 g plant material + ethanol (200 ml x 24 hours)

/

Ethanol extract

Figure 3.1.11.4.c Maceration with ethanol

20 g plant material was used for all extracts, taking account of the proportions in the recipes. All extracts were concentrated and lyophilized before use.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

The antioxidant properties of the extracts were tested by using thin layer chromatography combined with DPPH.

Thin layer chromatography was performed, using the following solvent system:

Butanol : acetic acid : water (60:15:25) (BAW). The plates were treated with AlCl_3 and FeCl_3 and examined using UV light at 254 and 366 nm.

Antifungal effect:

The ethanol extracts from all plants and recipes were tested for activity against *Candida albicans*. Nystatin was used as reference compound.

Antibacterial test:

The recipe with *C. sieberiana* combined with fruits from *T. indica* was tested for antibacterial activity against *Escherichia coli* and *Klebsiella pneumoniae*.

Results:

From the phytochemical tests the following substances were found:

Leaves from *C. sieberiana* alone:

Flavonoids, leucoanthocyanins, tannins, saponins, mono- and polysaccharides, mucilages, sterols and/or triterpenes, coumarins, anthraquinones, reducing compounds, mucilages and cardiac glycosides. The content of water was found to be 6 % (Table 3.2).

Leaves from *C. sieberiana* combined with fruits from *T. indica*:

Flavonoids, leucoanthocyanins, tannins, saponins, mono- and polysaccharides, mucilages, and cardiac glycosides (traces), coumarins, mucilages and anthraquinones (Table 3.2).

The thin layer chromatography showed the presence of tannins and flavonoids. This corresponds well with the results from the phytochemical tests.

The recipe with *C. sieberiana* combined with fruits from *T. indica* showed some antibacterial activity. Doses of 100 µg gave inhibition zones of 0 mm for *E. coli* and 8 mm for *K. pneumonia* while doses of 300 µg gave inhibition zones of 7 mm and 0 mm respectively.

No antifungal activity was observed from the ethanol extract.

All extracts showed some antioxidant activity with a mean of 2 active compounds detected for each extract.

Fane (2002)

This author interviewed 110 healers in the Bamako district; 50 men and 60 women. Most were between 40-70 years old. They were asked to name known toxic plants, the use of these plants, toxic effects and possible anti-dotes.

Maiga et al (2004) did a literature research of the 19 most cited plants

Phytochemical tests were performed on 5 of these plants and, further biological tests were performed on 3 plants: *Vernonia colorata*, *Afrormosia laxiflora* (3.1.21.1) and *Cassia siberiana* (3.1.12.4). The plants were chosen from both the results from the interviews, but also from the literature about the plants. (See also tables 3.1.7.1.a and 3.1.7.1.b).

Biological material:

- Mice of the strain "Oncins France Souche 1" were used. Their weight was between 20-25 g.

- Refrigerated blood from cattle was collected at the slaughter house in Bamako in March 2002.
- *Anopheles gambiae* larvae (stadium 2) were acquired from the Department de l'épidemiologi des affections parasitaires in Bamako.
- Full grown *Lombricus terrestris* were collected by the river bank in Djoliba in June 2002.
- *Cassia siberiana* roots were collected in Missabougou and in N'tjilla in Sikasso in December 2001.

Extractions:

A decoction was made with 250 g powdered plant material in 2,5 l distilled water for 3 hours.

A maceration was made with 50 g powdered plant material in 500 ml distilled water for 3x24 hours.

A maceration was made with 150 g powdered root, 1,5 l water and 200 ml honey for 24 hours.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Toxicity:

LD₅₀ orally was tested on groups of 6 mice (3 male and 3 female). Dosage of extracts was from 500 to 5000 mg/kg. Mortality was observed up to 3 days after administration.

LD₅₀ intraperitoneal was tested on groups of 6 mice (3 male and 3 female). Dosage of extracts was from 300 to 400 mg/kg. Mortality was observed up to 3 days after administration.

Chronic/prolonged toxicity was tested on groups of 16 mice (6 male and 10 female). Extracts were administration orally at a concentration of 37,5 mg/kg body weight for 4 weeks. After 2 weeks, 2 mice from each group were killed And their organs were examined. After the 4th week, the rest of the mice were killed and their organs examined.

Transaminase test.

Haemolytical tests.

Larvicidal activity.

Test of cytotoxic effect on *Lombricus terrestris*.

Results:

From the phytochemical tests performed at DMT the following substances were found: Alkaloids, flavonoids, tannins, saponins, coumarins, antharquinones, reducing compounds, mono- and polysaccharides, mucilages, carotenoids, sterols and/or triterpenes, leucanthocyanines and cardiac glycosides. The content of water was between 7,27 and 8 %. Ashes insoluble in HCl were 4,44 %, total ash content was 4,66 % and sulphur containing ash was 8,18 %.

Toxicity:

LD₅₀ orally: no deaths observed.

LD₅₀ intraperitoneal: no deaths observed, but the mice were shaking and had diarrhoea.

Chronic/prolonged toxicity: no deaths observed.

The weights of liver and kidneys from treated mice were comparable to the values for mice that were only given water. One of the male mice got an abscess at the right back paw and an enlarged pancreas.

Transaminase:

1. Serum from healthy mice
2. Serum from mice that were given distilled water.
3. Serum from mice (m) that were given *C. siberiana*
4. Serum from mice (f) that were given *C. siberiana*

Table 3.1.11.4.a Results from transaminase test

Serum	SGOT	SGPT
1	34	26
2	65	38
3	101	18
4	139	69

SGOT increased for both groups, while SGPT decrease for male mice and increased for female mice.

Table 3.1.11.4.b Results from larvicidal test (*A. gambiae*)

Extracts (500 µg)	Number of larvae	Time	
		24 hours	
		Number of deaths	% dead
Distilled water	20	0	0
Decoction C.s	20	17	85
Maceration C.s.	20	14	70
Maceration C.s with honey	20	9	45

C.s = *Cassia siberiana*

No deaths were observed after 30 minutes or after 1 hour.

Table 3.1.11.4.c Results from *Lombricus terrestris* (L.t) test:

Extract 90000 pp	Number of L.t.	Mortality			Number of deaths	% dead after 72 hours
		24 hours	48 hours	72 hours		
Distilled water	5	0	0	0	0	0
Decoction C.s	5	0	0	0	0	0
Maceration C.s.	5	1	4	-	5	100
Maceration C.s with honey	5	0	1	0	1	20

Sangare (2003)

This author tested different parts of 8 plants for activity against *Plasmodium falciparum*. The plants were identified after interviews with several healers in Kendié and Finkolo between January and February 2003. 49 healers were interviewed in Kendié and 30 in Finkolo.

Roots from *C. sieberiana* were analyzed.

Tests:

Standard phytochemical tests were performed at DMT by Fane (2002).

Activity against *Plasmodium falciparum* (see A.1.2.1). This was tested using the extracts from Fane; figures 3.1.11.4.a – 3.1.11.4.c

Results:

IC₅₀-concentrations:

Maceration with water:	7,93 µg/ml
Ethanol extract:	12,30 µg/ml
Decoction:	14,93 µg/ml

Chloroquine: 0,05 µg/ml (reference substance)

The maceration with water shows effect against both *A. gambiae* and *P. falciparum*. Although no deaths are observed, the tested extracts have some negative effects on the tested mice.

For more information about this plant see Aasberg (2001) and Maiga et al (2004).

3.1.11.5 *Cordyla pinnata* (A.Rich.) Milne-Redh.**Thesis: Sanogo (1999)**

Some traditional uses:

In Senegal, the stem bark and the roots are considered to be anti-helminthic due to their purgative effects. A decoction of the leaves with salt and chili pepper is used to treat colic. Other uses are against anorexia (weight loss), schistosomiasis, mental troubles, aphrodisiac, diuretic and digestive and abdominal troubles (Kerharo and Adam, 1974). This gum has traditionally been used to treat vaginal discharge (Sanogo, 1999).

Sanogo (1999)

This author did a survey of gums found from different plants in Mali and their commercial and medicinal uses. The collection of plant material took place between November 1997 and February 1998 in Bamako and Banankoro. This specific gum was collected in December 1997 in Banankoro.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances using the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was also performed.

All gums were tested for possible content of *Escherichia coli* and *Salmonella spp.* They were also examined for content of starch and starch derivatives.

Results:

From the phytochemical tests performed at DMT the following substances were found: Coumarins, saponines, mono- and polysaccharides, mucilages, sterols and triterpenes and cardiac glycosides. The content of water was between 8 and 9,26 %. Ashes insoluble in HCl were 0,65 %, total ash content was 2,42 % and sulphur containing ash was 3,35 % (Table 3.2).

Thin layer chromatography:

Matching R_f with galactose, galacturonic acid and glucuronic acid (they all had the same R_f here) rhamnose and arabinose. In addition to this three spots were detected that did not correspond with any of the references sugars.

Gas chromatography:

6 monosaccharides: Galactose (50,18 %), arabinose (24,34 %), glucuronic acid (12,01 %), mannose (6,25 %), xylose (4,13 %) and rhamnose (3,09 %). The two sugars that were only found with gas chromatography might correspond to one or several of the unidentified spots found from the thin layer chromatography.

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of gum.

The test for starch and starch derivatives was also negative.

A search using www.google.com gave 262 hits while www.PubMed.com gave 0 hits (25.02.2005).

3.1.11.6 *Daniellia oliveri* (Rolfe) Hutch. & Dalziel

Thesis: Sanago (1999)

Some traditional uses:

The most important use in Senegal is to treat colic. The resin is used either externally or internally (or both) to treat vaginal discharge, bronchitis, renal pain, sore muscles and so on. The roots are used as aphrodisiac by some ethnical groups, as well as against tuberculosis. "Stipules" 10-15 cm long are used on wounds and ulcers. The roots are also used against mental diseases comined with leaves from *Ficus gnaphalocarpa* (Kerharo

and Adam, 1974). The resin from this plant has traditionally been used to treat dental affections (Sanogo, 1999).

Sanogo (1999)

This author did a survey of gums found from different plants in Mali and their commercial and medicinal uses. The collection of plant material took place between November 1997 and February 1998 in Bamako and Banankoro. The product obtained from *Daniellia oliveri* is not a gum but a “resin” and should not contain sugars but was still tested.

Gum1:

This gum was bought from gum salesmen so place and date of origin could not be identified.

Gum 2:

This gum was collected in December 1997 in Banankoro.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances, and with the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was used to confirm the content of monosaccharides.

All gums were tested for possible content of *Escherichia coli* and *Salmonella spp.*

They were also examined for content of starch and starch derivatives.

Results:

From the phytochemical tests the following substances were found:

Gum 1:

Coumarins, saponines, tannins, mono- and polysaccharides, mucilages, sterols and triterpenes, carotenoids and cardiac glycosides. The content of water was between 7 and 8,11 %. Ashes insoluble in HCl were 1,66 %, total ash content was 1,66 % and sulphur containing ash was 1,99 % (Table 3.2).

Gum 2:

Mono- and polysaccharides, mucilages, sterols and triterpenes, carotenoids and cardiac glycosides. The content of water was between 0,85 and 1 %. Ashes insoluble in HCl were 0,93 %, total ash content was 0,41 % and sulphur containing ash was 0,45 % (Table 3.2).

Thin layer chromatography:

Gum 1:

Matching R_f with arabinose. In addition to this there was detected one spot that did not correspond with any of the references sugars.

Gum 2: No spots detected.

Results from gas chromatography:

Gum 1:

2 monosaccharides: Galactose (76,40 %) and arabinose (23,60 %). Galactose has a very low R_f value with the solvent system used in the thin layer chromatography and might have been detected using another solvent system.

Gum 2: No monosaccharides detected.

The product obtained from *Daniellia oliveri* is not a gum but a “resine” and should not contain sugars. Gum 1 was bought from gum salesmen and has most likely been mixed with other gums. Gum 2 was identified and collected by the author.

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of both gums. The test for starch and starch derivatives was also negative.

For more information about this plant see Aasberg (2001).

3.1.11.7 *Piliostigma thonningii* (Schumach. & Thonn.) Milne-Redh.

Thesis: Ekoumou (2004)

Some traditional uses:

In Senegal, the plant is used against diarrhoea. The bark is used externally against rheumatis as decoction or vapor bath. Leaves moisturized in hot water is rubbed on small pox blisters too prevent scarring (Kerharo and Adam, 1974).

Ekoumou (2004)

This author identified 5 recipes traditionally used to treat urinary infections and cystitis. Both single plants and combinations of plants were analyzed.

The plants were chosen from several documents on medicinal plants used in West Africa (Kerharo and Adam, 1974 and others).

The stem bark from *P. thonningii* was tested alone and with fruits from *Tamarindus indica* after the following recipes: 90 % *P. thonningii* + 10 % *T. indica* and 80 % *P. thonningii* + 20 % *T. indica*.

Extractions:

20 g plant material + water (200 ml)
(15 minutes at 100 °C)

/

Decoction

Figure 3.1.11.7.a Decoction

20 g plant material + water (200 ml x 24 hours)

/

Water maceration

Figure 3.1.11.7.b Maceration with water

20 g plant material + ethanol (200 ml x 24 hours)

/

Ethanol extract

Figure 3.1.11.7.c Maceration with ethanol

20 g plant material was used for all extracts, taking account of the proportions in the recipes.

Tests:

Standard phytochemical tests were performed at DMT.

The antioxidant properties of the extracts were tested by using thin layer chromatography combined with DPPH.

Thin layer chromatography was performed, using the following solvent system: Butanol : acetic acid : water (60:15:25) (BAW). The plates were treated with AlCl_3 and FeCl_3 and examined using UV-light at 254 and 366 nm.

Antifungal effect: The ethanol extracts from all plants and recipes were tested for activity against *Candida albicans*. Nystatin was used as reference.

Antibacterial test: The recipe with *P. thonningii* combined with fruits from *T. indica* was tested for antibacterial activity against *Escherichia coli* and *Klebsiella pneumoniae*.

Results:

From the phytochemical tests the following substances were found:

Stem bark from *P. thonningii* alone:

Flavonoids, leucoanthocyanins, tannins, saponins, mono- and polysaccharides, mucilages, sterols and/or triterpenes, mucilages and cardiac glycosides. The content of water was found to be 6 % (Table 3.2).

Stem bark from *P. thonningii* combined with fruits from *T. indica*:

Flavonoids, leucoanthocyanins, tannins, mono- and polysaccharides, cardiac glycosides (traces), sterols and/or triterpenes and mucilages (Table 3.2).

The thin layer chromatography showed the presence of tannins and sterols and/or triterpenes. This corresponds well with the results from the phytochemical tests.

The recipe with *P. thonningii* combined with fruits from *T. indica* showed some antibacterial activity. Doses of 100 µg gave inhibition zones of 0 mm for *E. coli* and 7 mm for *K. pneumonia* while doses of 300 µg gave inhibition zones of respectively 7 mm and 8 mm. This might explain the use in the treatment of urinary infections.

No antifungal activity was seen in the ethanol extract.

All extracts showed some antioxidant activity with between 1 and 3 active compounds detected for each extract.

A search using www.google.com gave 562 hits and www.PubMed.com gave 2 hits (25.02.2005).

3.1.12 Capparidaceae

3.1.12.1 *Boscia senegalensis* (Pers.) Lam. ex Poir.

Theses: Ba (1998) and Bah (1998)

Some traditional uses:

In Senegal, the root, bark and leaves from this plant are said to be a very good remedy for treating stomach ache. The plant parts are used alone or associated with roots from *Securinga virosa* and/or leaves from *Adansonia digitata*. The plant does not have purgative effects. The leaves are used against schistosomiasis and as a tranquilizer for some mental diseases (Kerharo and Adam, 1974). In the Gourma district in Mali, a decoction of dry roots is used to expel round worms in children. A maceration of fresh leaves is used against cough. The leaves are also used to treat scabies and heart pain (Diallo et al, 1999).

Ba (1998)

This author studied 6 plants traditionally used as “fishing poison” or used as insecticides in cultivation of cereals, to determine the chemical composition and molluscicidal activity of these plants. This was done to find plants that may be used in the prevention of schistosomiasis by killing the molluscs that act as intermediate hosts.

Molluscs were collected in Djikoron Woyowayemko and N’Gomidjirambougou. The species used were *Bulinus truncatus* and *Biomphalaria pfeifferi*. Groups of 6 snails were used in all tests.

The plant material was collected the 4th of June 1997 in Gossi. Only the leaves were tested, and they were dried and pulverized before analysis.

Extracts were made with chloroform, methanol and water. Molluscicidal activity was tested for all extracts at concentrations from 0,025 mg/ml to 0,4 mg/ml.

Standard phytochemical tests were performed at DMT.

Results:

From the phytochemical tests the following substances were found: Alkaloids (0,22 %), tannins, saponines, cardiac glycoside, coumarins, mono- and polysaccharides, reducing compounds, mucilages and sterols and/or triterpenes. The content of water was between 6,6 and 7,4 %. Ashes insoluble in HCl were 14,22 %, total ash content was 6,34 % and sulphur containing ash was 6,35 % (Table 3.2).

No molluscicidal activity was observed.

Bah (1998)

This author studied the larvicidal effects of 10 different plant extracts on *Anopheles gambiae*, one of the intermediate hosts in malaria. As mosquitoes are developing resistance to an increasing number of chemical insecticides, it is important to search for new and possibly less toxic agents from plants to try and control the disease. *Anopheles gambiae* mosquitoes were collected in Mopti. For the tests, larvae were elevated and collected in the laboratory, from full grown females collected at one specific date. Larvae were fed with Whiskas® cat food. The plant material was collected in Rharous in June 1996, and was dried and pulverized before analysis. Only the leaves from *B. senegalensis* were analyzed.

Extractions:

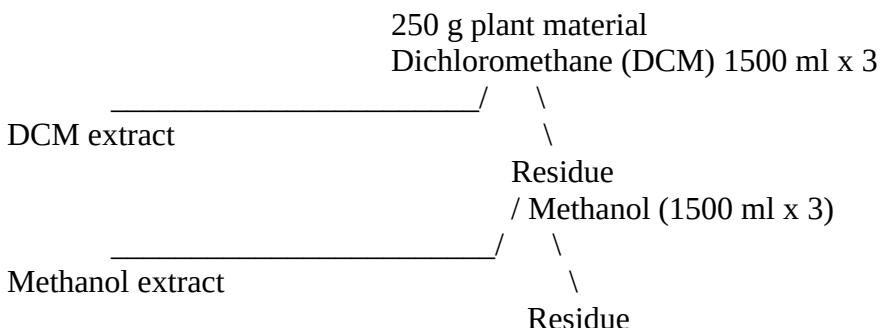


Figure 3.1.12.1.a Extraction with solvents of different polarity

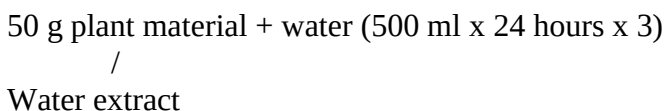


Figure 3.1.12.1.b

Extracts were tested on groups of 8 x 25 larvae. The extracts were tested at concentrations from 0,015 mg/ml to 0,06 mg/ml (preliminary tests) and from 1 mg/ml to 50 mg/ml later. Dead or dying larvae were registered as they floated to the surface of the test container.

Results:

DCM extracts:

0,015 mg/ml and 0,03 mg/ml gave 1 % mortality while 0,06 mg/mg gave 2 % mortality.

Methanol extracts:

Only the extract at 0,06 mg/ml showed activity. It gave 1 % mortality.

Water extracts: no activity.

A review of this plant has been done by Aasberg (2001).

3.1.12.2 *Maerua crassifolia* Forssk.

Thesis: Bah (1998)

Some traditional uses:

In Mali, a maceration of fresh leaves is mixed with butter and used against diarrhoea. A decoction of dry leaves is used against malarial fever, jaundice and constipation. Other uses are to cure abdominal pain, malaria fever, loss of appetite, heart disease and against common cold (Diallo et al, 1999).

Bah (1998)

This author studied the larvicidal effects of 10 different plant extracts on *Anopheles gambiae*, one of the intermediate hosts in malaria. As mosquitoes are developing resistance to an increasing number of chemical insecticides, it is important to search for new and possibly less toxic agents from plants to try and control the disease. *Anopheles gambiae* mosquitoes were collected in Mopti. For the tests, larvae were elevated and collected in the laboratory, from full grown females collected at one specific date. Larvae were fed with Whiskas ® cat food.

The plant material was collected in Rharous in June 1996, and was dried and pulverized before analysis.

Only the leaves from *M. crassifolia* were analyzed. An extract was made with water, 500 ml x 24 hours x 3. The extracts were tested at concentrations from 0,015 mg/ml to 0,06 mg/ml on groups of 8 x 25 larvae and the number of dead larvae registered. No deaths were observed at any of the tested concentrations.

The leaves from this plant do not show any activity in the performed tests. This plant will not be discussed further in this thesis.

A search using www.google.com gave 379 hits and www.PubMed.com gave 2 hits (25.02.2005).

3.1.13 Celastraceae

3.1.13.1 *Maytenus senegalensis* (Lam.) Exell

Thesis: Kanta (1999)

Some traditional uses:

This plant is considered to be one of the most active in the “Pharmacopée sénégalaise”. The main indication is a disease called “diangara Cayor”, in association with other species. The roots are used to treat infantile diarrhoea. It is also used to treat colic, fever and weight loss. The bark is used against fever and as a strength tonic. The leaves are used against ocular diseases, tooth ache and mouth infections (Kerharo and Adam, 1974).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words “vaginal discharge and vaginitis”. 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and the 10th of December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

Leaves and stem bark from *Maytenus senegalensis* were analyzed. Extracts were done with dichloromethane and methanol and tested for activity against *Candida albicans* and *Escherichia coli*. None of the extracts had effect against these microorganisms.

The leaves and the stem bark from this plant do not show any activity in the performed tests. This plant will not be discussed further in this thesis.

A search using www.google.com gave 707 hits and www.PubMed.com gave 7 hits (25.02.2005).

3.1.14 Cochlospermaceae

3.1.14.1 *Cochlospermum tinctorium* A. Rich.

Theses: Kanta (1999) and Samake (2000)

Some traditional uses in Senegal:

The roots are important in the treatment of children, and are used to treat rickets, colic and helminths. The drug consist in most cases of “le tubercule vivace” which constitutes the true medicament specific for all hepatic-biliary affections. This is believed to be because of the yellow colored flower. The plant is also used to treat beriberi, oedemas and tight chest (Kerharo and Adam, 1974).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words vaginal discharge and vaginitis. 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and the 10th of December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

The roots from *Cochlospermum tinctorium* were analyzed. An extract was done with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*, but it did not have any effect against these microorganisms.

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analysis.

Extraction:

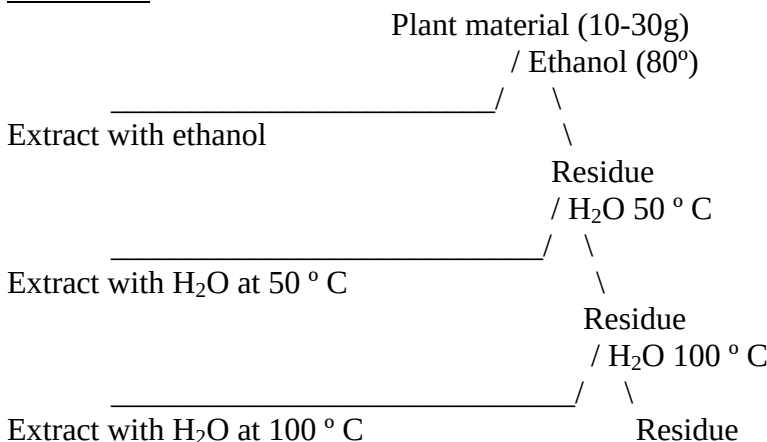


Figure 3.1.14.1.a Extraction with solvents of different polarity

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard substance used was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.14.1.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
C.t. 50°C	Root bark	+	+	+	0	+	+	+	+	+	40
C.t. 100°C	Root bark	+	+	+	0	+	+	+	+	+	45

C.t. = *Cochlospermum tinctorium*

Gas chromatography:

Table 3.1.14.1.b Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C	Extract at 100°C
	Sugar ratio (%)	Sugar ratio (%)
Arabinose	9	3
Rhamnose	19	6
Xylose	1	1
Mannose	2	1
Galactose	39	12
Glucose	13	70
Glucuronic acid	10	4
Galacturonic acid	8	4
Total	101*	101*
Polysaccharides (%)	25	50

*The only information available is a summary table – basic data needs to be checked.

The root bark from this plant shows good activity on the complement system.

Nergård et al (Nergård 2004) studied different medicinal uses of this plant in Mali.

A search using www.google.com gave 190 hits and www.PubMed.com gave 8 hits (25.02.2005).

3.1.15 Combretaceae

3.1.15.1 *Combretum ghasalense* Engl. & Diels

Thesis: Sanogo (1999)

Sanogo (1999)

The gum from this plant has traditionally been used to treat diarrhoea. The author did a survey of gums found from different plants in Mali and their commercial and medicinal uses. The gums tested by this author were bought from people involved in trade/sales of gums in November 1997. Gum number 1 is from the 1997/1998 production while gum number 2 is from the 1996/1997 production. Both were produced in the Kolokani region

Tests:

Standard phytochemical tests (A.1.1.) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances, and with the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was used to confirm the content of monosaccharides.

All gums were tested for possible content of *Escherichia coli* and *Salmonella spp.*

They were also examined for content of starch and starch derivatives.

Results:

From the phytochemical tests the following substances were found:

Gum 1:

Coumarins, mono- and polysaccharides, mucilages, sterols and triterpenes and cardiac glycosides. The content of water was between 8 and 8,59 %. Ashes insoluble in HCl were 0,61 %, total ash content was 2,23 % and sulphur containing ash was 2,85 % (Table 3.2).

Gum 2:

Coumarins, mono- and polysaccharides, mucilages, sterols and triterpenes and cardiac glycosides. The content of water was between 6 and 7,74 %. Ashes insoluble in HCl were 1,26 %, total ash content was 1,91 % and sulphur containing ash was 2,92 % (Table 3.2).

Gum 2:

Thin layer chromatography was performed with known monosaccharides as reference substances and gave the following results:

Matching R_f with galactose, galacturonic acid and glucuronic acid (they all had the same R_f here) rhamnose and arabinose. In addition to this there was detected one spot that did not correspond with any of the references sugars. Solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Results from gas chromatography:

Gum 1:

5 monosaccharides: Arabinose (49,03 %), galactose (31,55 %), rhamnose (11,05 %), galacturonic acid (5,50 %) and glucuronic acid (2,87 %). Only glucuronic acid was undetected by the thin layer chromatography. The R_f value of glucuronic acid was very close to the values of galactose and galacturonic acid.

Gum 2:

5 monosaccharides: Arabinose (53,04 %), galactose (25,63 %), rhamnose (11,08 %), galacturonic acid (6,34 %) and glucuronic acid (2,91 %). This corresponds well with the result from the thin layer chromatography.

The differences in the amount of the sugars found in the gum from two different seasons vary from 5,92 % for galactose and 4,01 % for arabinose to only 0,03 % for rhamnose and glucuronic acid.

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of both gums. The test for starch and starch derivatives was also negative.

For more information about this plant see Aasberg (2001).

3.1.15.2 *Combretum glutinosum* Perr.

Some traditional uses:

In Senegal, this is the most prescribed drug among healers from all ethnic groups. The leaves are used as diuretic remedy, with use in all urinary conditions. They are used to treat hepatic-renal diseases, oedemas, yellow fever, malaria, anemia, weight loss, cough and bronchitis. The peeled greens fruits are used to treat syphilis chancres and other wounds. It is often used in combination with other plants to treat yellow fever, schistosomiasis, Hansen's disease (leprosy), weakness, spasmodic cough and also epilepsy and mental diseases (Kerharo and Adam, 1974).

Field work:

N`Tjobougou, 5.2.04.

Djokin Diarra:

Young leaves are used against internal worms. Pound the leaves into a fine powder, mix with porridge or liquid food like millet. Do not mix with milk. Use this treatment for 15 days.

Bourama Traoré:

Young leaves are used against otitis. Take the leaves and apply the juice directly into the ear. This is first done one day, then investigated the next day and then used only once more if necessary.

Konimba Traoré:

Young leaves are used against diarrhoea.

N`Pankourou Fané:

Dry leaves are pound to a fine powder. One teaspoon is mixed with hot water, filtered and used against stomach ache. Drink as much as possible.

Djenfa Koumaré:

Trunk bark, collected from the east and west side on Thursdays, is dried and ground into a powder. A small part is mixed in water and drunk morning against dizziness. This treatment is only for grown ups.

Didieni- region, 6.2.04

Diotin Traore:

Leaves are chewn against diarrhoea.

Balla Sissoko:

The *Loranthus* sp. is used for diagnosis. Make a decoction, take a bath and then the healer can diagnose the patient.

Konimba Keita:

Young leaves are dried, powdered, mixed with water and drunk to treat dysentery.

Tietin Coulibaly:

Used against internal worms. A decoction of the leaves is drunk. Powdered leaves are applied on external wounds.

Cho Fane:

The *Loranthus* sp. is used against malaria. Make a decoction and drink 3-4 times.

Massantola-region, 7.2.04

Sory Diarra:

A decoction of leaves is drunk against hypertension. One glass is taken per day.

Fah Diarra:

A decoction of leaves and stem bark is drunk as a tonic.

Boua Fomba:

A decoction of leaves is drunk once per day to treat leuchorrea.

Soundje Colibaly:

Decoction of young leaves is drunk against dysentery.

N`tiokon Traore:

The powder of the *Loranthus* sp. is used to wash the patient if the disease is not known. After this a diagnosis may be given.

Soungalo Traore:

Powder of trunk bark is used against wounds.

Against vaginal discharge: the young leaves are mixed with the roots of *Solanum incamon* to a powder, 1 teaspoon is taken with water or porridge.

N`gogna Coulibaly:

A decoction of leaves is drunk to treat constipation.

Mariba Coulibaly:

Young leaves are powdered and used against diarrhoea, the leaves may also be chewed.

Dossere Diarra:

The plant is used to treat stomach ache in small children. Make a maceration of the trunk bark and drink this.

Naoba Diabati:

Against amenorrhoea: flowers are collected, dried and powdered. They are then mixed with water and drunk. This will provoke bleeding.

Baba Diarra:

Against oedema: a decoction of the leaves is drunk morning and evening, and a bath is also taken.

Deese Coulibaly:

A decoction of leaves is used to treat stomach ache. One teaglass or a handful is drunk.

H'toriké Coulibaly:

Powder of rootbark is mixed in the food that is eaten. This is used against internal worms.

N'kodjiri Traoré:

Used as tonic: a decoction is made of the young leaves, a vapour-bath is taken and it is drunk.

6 healers use this plant to treat stomach ache or internal worms, while 5 healers use to treat diarrhoea or dysentery. The leaves are the plant part most commonly used. Only one healer had no use for this plant.

Hansen (2000) studied different aspects of the structure and activity of the polysaccharides from the bark of *C. glutinosum*.

Engdal (2005) and Ringerud (2003) studied different aspects of the structure and activity of the polysaccharides from the leaves, and also in different types of leaves.

For more information about this plant see Aasberg (2001).

3.1.15.3 *Combretum molle* R. Br. ex G. Don

Thesis: Sanogo (1999)

Some traditional uses in Senegal:

Inhalation of the smoke from burnt bark or branches are said to provoke aggressive instincts in subjected persons. For this reason, the wood is never used domestically. The smoke has been used in tribe wars to prepare for battle.

Medicinal uses are as colagogoue and against oedema. A water suspension of powdered bark combined with gum is drunk or gargled to treat throat aches.

Sanogo (1999)

This author did a survey of gums found from different plants in Mali and their commercial and medicinal uses. The collection of plant material took place between November 1997 and February 1998 in Bamako and Banankoro. This specific gum was collected in December 1997 in Banankoro.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances, and with the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was used to confirm the content of monosaccharides.

All gums were tested for possible content of *Escherichia coli* and *Salmonella spp.* They were also examined for content of starch and starch derivatives.

Results:

From the phytochemical tests the following substances were found: Coumarins, mono- and polysaccharides, mucilages and cardiac glycosides. The content of water was between 9 and 9,44 %. Ashes insoluble in HCl were 0,57 %, total ash content was 2,32 % and sulphur containing ash was 2,90 % (Table 3.2).

Thin layer chromatography:

Matching Rf with galactose and galacturonic (they had the same Rf here) rhamnose and arabinose. In addition to this there was detected one spot that did not correspond with any of the references sugars. Solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Results from gas chromatography:

4 monosaccharides: Galactose (39,13 %), arabinose (33,32 %), rhamnose (17,36 %) and galacturonic acid (12,01 %). This corresponds well with the results from the thin layer chromatography.

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of gum. The test for starch and starch derivatives was also negative.

For more information about this plant see Aasberg (2001).

3.1.15.4 *Pteleopsis suberosa* Engl. & Diels

Thesis: Ouologuem (1999)

Some traditional uses:

Kerharo and Adam (1974) found no therapeutic uses of this plant, it is however considered as “the millet medicament” and is planted together with millet if it does not exist naturally in the area.

Ouologuem (1999)

This author tested the larvicidal effects of different extracts of 11 Malian plants. Larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were used. 6 of the plants were tested on both species, while 5 were only tested on *C. quinquefasciatus*.

Larvae from second and third generation *Anopheles gambiae* collected in Mopti were used. Larvae from *Culex quinquefasciatus* were collected in N'Tomikorobougou and Darsalam, in the Bamako district.

Pre-made extracts were used. Water and ethanol extracts from *P. suberosa* twig bark was tested.

Tests:

Tests on larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were done on 5,5 mg extract dissolved in 110 µl of a suitable solvent; water for the water and ethanol extracts and dimethylsulfoxide (DMSO) for the methanol, ether and DCM-extracts. The tests were performed on 5x20 larvae, and larvae that had fallen to the bottom of the tubes or were immobile were considered dead.

Results:

Larvicidal tests:

Table 3.1.15.4.a *Culex quinquefasciatus* - % deaths at 500 ppm

	Plant extract	
Time of exposure	P.s. H ₂ O	P.s. Ethanol
30 minutes	0	0
1 hour	10	0
24 hours	40	45

Table 3.1.15.4.b *Anopheles gambiae* - % deaths at 500 ppm

	Plant extract	
Time of exposure	P.s. H ₂ O	P.s. Ethanol
30 minutes	35	75
1 hour	50	80
24 hours	55	100

P.s. = *Pteleopsis suberosa*

The plant shows a moderate larvicidal effect. The ethanol extract has better effect than the water extract.

A search using www.google.com gave 122 hits and www.PubMed.com gave 4 hits (25.02.2005).

3.1.15.5 *Terminalia avicennoides* Guill et Perr.

Thesis: Sanogo (1999)

Some traditional uses:

A decoction of the roots is used to treat ascite, oedema conditions and “diangara Cayor”.

A water maceration of the roots is given to breast feeding women to treat different diseases affecting the children they are feeding, for example conjunctivitis.

Seven leaves from the plants are used to ensure a good medicinal preparation by one ethnic group. The root bark is used externally to treat ulcers and wounds that are hard to heal. Powdered bark diluted in milk has emetic properties and is used by healers that are not considered to be serious. The mixture provokes a reddish vomisement that might be considered as the departure of the illness (Kerharo and Adam, 1974).

This plant has traditionally been used to treat haemorrhoids (Sanogo, 1999).

Sanogo (1999)

This author did a survey of gums found from different plants in Mali and their commercial and medicinal uses. The collection of plant material took place between November 1997 and February 1998 in Bamako and Banankoro. This specific gum was collected in December 1997 in Banankoro.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances, and with the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was used to confirm the content of monosaccharides.

All gums were tested for possible content of *Escherichia coli* and *Salmonella spp.*

They were also examined for content of starch and starch derivatives.

Results:

From the phytochemical tests the following substances were found:

Coumarins, saponines, mono- and polysaccharides, mucilages, sterols and triterpenes and cardiac glycosides. The content of water was between 7 and 8,99 %. Ashes insoluble in HCl were 0,57 %, total ash content was 2,10 % and sulphur containing ash was 2,61 % (Table 3.2).

Thin layer chromatography:

Matching Rf with galactose, arabinose and glucose (they had the same Rf here) and rhamnose. In addition to this 2 spots were detected that did not correspond with any of the references sugars.

Results from gas chromatography:

5 monosaccharides: Arabinose (54,19 %), galactose (21,33 %), glucuronic acid (15,52 %), mannose (6,65 %) and rhamnose (2,31 %). The gas chromatography did not detect glucose, so the spot found using thin layer chromatography marks arabinose only.

Glucuronic acid and mannose were detected in addition to the sugars found from the thin layer chromatography. These two might correspond to one or several of the unidentified spots found from the thin layer chromatography.

Both the types of sugars and their contents are similar to the contents found in *Terminalia macroptera* (3.1.15.6).

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of gum.

The test for starch and starch derivatives was also negative.

A search using www.google.com gave 69 hits and www.PubMed.com gave 4 hits (25.02.2005).

3.1.15.6 *Terminalia macroptera* Guill. et Perr.

Thesis: Sanogo (1999)

Some traditional uses:

This *Terminalia* species is often confounded with the two other species: *T. avicennioides* and *T. laxiflora*, and the uses are in many cases similar.

T. macroptera is considered an important medicament to reconstitute energy for tired or depressed people. It is also used against fever, icterus (jaundice), syphilis and as an aphrodisiac. The roots are considered to be diuretic and are used to treat excessive vaginal discharge and urinary infections, especially for pregnant women.

The roots are also used to treat sterility. The leaves are used against stomach aches, indigestion and tuberculosis. Roots and root bark is used on wounds and as eye drops against conjunctivitis (Kerharo and Adam, 1974).

This plant has traditionally been used to treat haemorrhoids (Sanogo, 1999).

Sanogo (1999)

This author did a survey of gums found from different plants in Mali and their commercial and medicinal uses. The collection of plant material took place between November 1997 and February 1998 in Bamako and Banankoro. This specific gum was collected in February 1998 in Siby.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances, and with the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was used to confirm the content of monosaccharides.

All gums were tested for possible content of *Escherichia coli* and *Salmonella spp.* They were also examined for content of starch and starch derivatives.

Results:

From the phytochemical tests performed at DMT the following substances were found: Coumarins, saponines, mono- and polysaccharides, mucilages, sterols and triterpenes and cardiac glycosides. The content of water was between 5 and 5,98 %. Ashes insoluble in HCl were 0,72 %, total ash content was 2,10 % and sulphur containing ash was 2,53 % (Table 3.2).

Thin layer chromatography:

Matching R_f with galactose, rhamnose and arabinose. In addition to this 2 spots were detected that did not correspond with any of the references sugars.

Results from gas chromatography:

5 monosaccharides: Arabinose (53,8 %), galactose (25,7 %), glucuronic acid (12,4 %), mannose (5,4 %) and rhamnose (2,7 %). Glucuronic acid and mannose were detected in addition to the sugars found from the thin layer chromatography. These two sugars might correspond to one or several of the unidentified spots found from the thin layer chromatography.

Both the types of sugars and their contents are similar to the contents found in *Terminalia avicennoides*.

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of gum. The test for starch and starch derivatives was also negative.

For more information about this plant see Aasberg (2001).

3.1.16 Convolvulaceae

3.1.16.1 *Ipomoea asarifolia* (Desr.) Roem. Et Schult.

Some traditional uses:

In Senegal, this plant is considered to be toxic for animals, and they do not consume it. Its main medicinal uses are gynecological. It is used to treat albuminuria for pregnant women, bleeding outside of menstrual periods, difficult child birth and *post partum* bleeding. A decoction of twigs with leaves is drunk to treat these conditions.

Other uses are in wound healing, for different eye infections and against pain in the joints (Kerharo and Adam, 1974).

Field work:

Massantola-region, 7.2.04

Mariba Coulibaly is using the leaves and roots from this plant to treat dermatosis. Make a decoction of the leaves and use this as a bath. Make a powder of the roots and apply on the skin.

A search using www.google.com gave 0 hits and www.PubMed.com gave 3 hits (25.02.2005).

3.1.17 Ebenaceae

3.1.17.1 *Diospyros abyssinica* Hochst. ex A. DC.

Some traditional uses:

In Dioïloa in Mali this plant is used to treat stomach diseases, malaria and tooth ache. It is also used in the healing of wounds (Odlo 2003).

Thesis: Ouologuem (1999)

The author tested the larvicidal effects of different extracts of 11 Malian plants. Larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were used. 6 of the plants were tested on both species, while 5 were only tested on *C. quinquefasciatus*.

Larvae from second and third generation *Anopheles gambiae* collected in Mopti were used. Larvae from *Culex quinquefasciatus* were collected in N'Tomikorobougou and Darsalam, in the Bamako district.

Pre-made extracts were used. A methanol extract from *D. abyssinica* leaves was tested.

Tests:

Tests on larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were done on 5,5 mg extract dissolved in 110 µl of a suitable solvent; water for the water and ethanol extracts and dimethylsulfoxide (DMSO) for the methanol, ether and DCM-extracts. The tests were performed on 5x20 larvae, and larvae that had fallen to the bottom of the tubes or were immobile were considered dead.

The DCM extracts from *Lannea velutina* leaves and *Cussonia arborea* roots, methanol extract from *Diospyros abyssinica* leaves and ether extract from *Cissus quadrangularis* twigs were tested at different concentrations. The extended tests were only performed on *Culex quinquefasciatus* larvae, as these are considered to be more resistant than larvae from *Anopheles gambiae*.

Results:

Larvicidal tests:

Table 3.1.17.1.a *Culex quinquefasciatus* - % deaths at 500 ppm

	Plant extract
Time of exposure	D.a. Methanol
30 minutes	30
1 hour	85
24 hours	100

Table 3.1.17.1.b *Anopheles gambiae* - % deaths at 500 ppm

	Plant extract
Time of exposure	D.a. Methanol
30 minutes	45
1 hour	80
24 hours	100

For the results from the extended tests at different concentrations: See tables 3.1.2.2.c - 3.1.2.2.f.

The plant shows good larvicidal effect on both tested species after 24 hours.

Odlo (2003) identified several substances with antioxidant activity from this plant.

Diallo (2000) did a survey and a phytochemical study of this plant.

3.1.18 Euphorbiaceae

3.1.18.1 *Bridelia ferruginea* Benth.

Thesis: Kanta (1999)

The author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words “vaginal discharge and vaginitis”. 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and 10th December 1998 in mount Manding in Siby, 60 km from Bamako. It was dried, pulverized and later analyzed.

Leaves, stem bark and root bark from *Bridelia ferruginea* were analyzed. Extracts were done with dichloromethane and methanol and tested for activity against *Candida albicans* and *Escherichia coli*. The extracts did not have any effect against *E. coli*. The dichloromethane extracts from stem bark and root bark showed good effect against *C. albicans* at 30 mg/ml. Activity: +++ (maximum activity is marked with +++). None of the extracts from the leaves were active.

At 10 mg/ml the dichloromethane extracts of the stem bark and root bark both gave 5 active products using thin layer chromatography plates combined with the microorganism.

The stem bark and root bark both show very good activity against *C. albicans*.

A search using www.google.com gave 415 hits and www.PubMed.com gave 10 hits (25.02.2005).

3.1.18.2 *Euphorbia sudanica* A.Chev.

Field work:

Uses against dermatosis:

N'Tjobougou, 5.2.04

N`Pankourou Fané uses the stem from this plant to treat black dermatosis. The stem of *E. sudanica* is dried in the sun, powdered, applied on the black part of the dermatitis after being mixed with the butter of *Butyrospermum parkii*. This is applied twice per day. Do not eat this plant.

Didieni-region, 6.2.04

Konimba Keita uses *E. sudanica* to treat dermatosis. The plant is carbonized and the powder is applied once daily.

This plant will not be discussed further in this thesis.

A search using www.google.com gave 15 hits while www.PubMed.com gave 0 hits (25.02.2005).

3.1.18.3 *Ricinus communis* L.

Some traditional uses in Senegal:

The seeds contain ricin, which has well known purgative and emetic properties. They are only used to treat mental illness and leprosy.

The leaves are often used externally on wounds and blisters as antiseptic agent.

Ricin is used by one ethnic group to treat schistosomiasis and ascite. The treatment consists of drinking a decoction from the leaves, and a fumigation of the lower stomach (Kerharo and Adam, 1974).

Field work:

Uses against dermatosis:

Didieni-region, 6.2.04

Cho Fané uses the fruit from this plant to treat dermatosis. The fruit is carbonized, the powder is mixed with butter of *B. parkii* and the mixture is applied once per day.

Masantola-region, 7.2.04

Baba Diarre uses the fruit from this plant to treat dermatosis. The fruit is carbonized, the powder is mixed with butter of *B. parkii* and the mixture is applied once per day.

This plant will not be discussed further in this thesis.

A review of this plant was done by Samuelsson (Samuelsson 1992).

3.1.18.4 *Securinega virosa* (Roxb. ex Willd.) Baill.

Thesis: Sangare (2003)

Some traditional uses:

In Senegal, this plant is widely known and used by healers from all ethnic groups. The most common uses are against hepatic-, biliary-, renal-, bladder- and genital trouble. Preparations are often complicated, but are generally based on the roots. More specific indications are: schistosomiasis, sterility, rheumatism, fever associated with liver disease and kidney stones.

The following plants are considered to act synergetically with *S. virosa*: *Capparis tomentosa*, *Combretum glutinosum*, *Combretum micranthum*, *Vernonia colorata*, *Waltheria indica*, *Feretia canthioides*, *Momordica carantia* and more (Kerharo and Adam, 1974).

Sangare (2003)

This author tested different parts of 8 plants for activity against *Plasmodium falciparum*. The plants were identified after interviews with several healers in Kendié and Finkolo between January and February 2003. 49 healers were interviewed in Kendié and 30 in Finkolo.

Leaves and roots from *S. virosa* were collected in Blendi in the Sikasso region in May 2003.

Extractions:

50 g plant material + water (500 ml – 1 hour)
/
Decoction

Figure 3.1.18.4.a Decoction

50 g plant material + water (500 ml x 24 hours x 3)
/
Water maceration

Figure 3.1.18.4.b Maceration with water

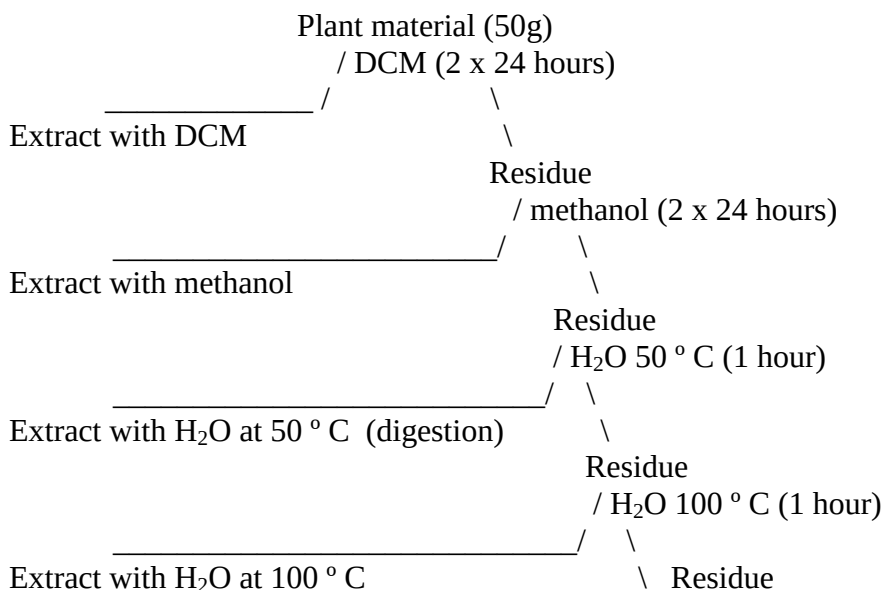


Figure 3.1.18.4.c Extractions with solvents of different polarity.

Tests:

Standard phytochemical tests were performed at DMT.

Activity against *Plasmodium falciparum*.

Thin layer chromatography was performed on some of the decoctions and digestions. Solvent system BAW (60:15:25). The plates were treated with AlCl_3 and Godin's reagent.

Results:

From the phytochemical tests performed at DMT the following substances were found:

Leaves:

Tannins, anthraquinones, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 7 and 8,03 %. Ashes insoluble in HCl were 1,99 %, total ash content was 5,22 % and sulphur containing ash was 7,54 % (Table 3.2).

Bark:

Alkaloids (0,16 %), tannins, cardiac glycosides, sterols and/or triterpenes, coumarins, anthraquinones, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 7 and 7,53 %. Ashes insoluble in HCl were 1,89 %, total ash content was 5,19 % and sulphur containing ash was 4,81 % (Table 3.2).

The thin layer chromatography from the extract of the leaves showed one spot that probably correspond with content of flavonoids.

IC₅₀-concentrations:

Bark:

DCM extract:	12,52 µg/ml
Decoction:	8,69 µg/ml
Maceration with water:	9,68 µg/ml

Leaves:

DCM extract:	2,41 µg/ml
Methanol extract:	7,79 µg/ml
Decoction:	7,81 µg/ml
Maceration with water:	12,97 µg/ml

Chloroquine: 0,05 µg/ml (reference substance)

For more information about this plant see Aasberg (2001).

3.1.19 Fabaceae

3.1.19.1 *Afrormosia laxiflora* (Benth ex Baker) Harms

Theses: Kanta (1999) and Fane (2002)

Some traditional uses:

In Senegal, the main uses for this plant are against pain in the joints and poisoning. Rheumatism is treated with long baths and massages with a decoction made from the leaves. Some forms of paralysis are treated in a similar way.

Poisoning, here in the form of bites or wounds caused by animals such as snakes, dogs and fish, is treated both internally and externally, mostly by preparations made from the bark, often associated with the bark from *Securidaca longepedunculata*.

The roots are used to treat jaundice, fever and stomach ache, and they are also said to increase the energy of the patient (Kerharo and Adam, 1974).

Kanta (1999) studied the root bark and Fane (2002) the leaves of this plant.

Tests:

Standard phytochemical tests were performed at DMT (Appendix A.1.1)

Extracts with dichloromethane and methanol was performed with both root bark and stem bark from *Afrormosia laxiflora*. Thin layer chromatography was performed with n-hexane – Isopropanole as solvent system. Examination of plates was performed after treatment with Godin's reagent and by using a UV spectrophotometer at 254 and 366 nm.

Antifungal effect was tested.

Results:

From the phytochemical tests.

In the leaves:

Alkaloids, flavanoids, leucoanthocyanines, tannins, saponins, cardiac glycosides, sterols and triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages (Table 3.2) (Fane, 2002).

In the root bark:

Alkaloids (0,38 %), leucoanthocyanines, tannins, saponins, cardiac glycosides, sterols and triterpenes, carotenoids, reducing compound, mono- and polysaccharides and mucilages (Table 3.2) (Kanta, 1999).

Antifungal effect:

30 mg/ml dichloromethane extracts of both root bark and stem bark from *Afrormosia laxiflora* were active against *Candida albicans*.

The thin layer chromatography plates were also tested with *Candida albicans* and the root bark from *Afrormosia laxiflora* had 7 “active spots” compared to 5 in the stem bark.

Fane (2002)

This author interviewed 110 healers in the Bamako district; 50 men and 60 women. Most were in the age group between 40-70 years. They were asked to name known toxic plants, the use of these plants, toxic effects and possible anti-dotes.

Maiga et al (2004) did a literature research of the 19 most cited plants

Phytochemical tests were performed on 5 of these plants and, further biological tests were performed on 3 plants: *Vernonia colorata*, *Afrormosia laxiflora* (3.1.21.1) and *Cassia siberiana* (3.1.12.4). The plants were chosen from both the results from the interviews, but also from the literature about the plants. (See also tables 3.1.7.1.a and 3.1.7.1.b).

Biological material:

- Mice of the strain “Oncins France Souche 1” were used. Their weight was between 20-25 g.
- Refrigerated blood from cattle was collected the slaughter house in Bamako in March 2002.
- *Anopheles gambiae* larvae (stadium 2) were acquired from the Department de l'epidemiologi des affections parasitaires in Bamako.
- Full grown *Lombricus terrestris* were collected by the river bank in Djoliba in June 2002.

Extractions:

A decoction was made with 250 g powdered plant material in 2,5 l distilled water for 3 hours.

A maceration was made with 50 g powdered plant material in 500 ml distilled water for 3x24 hours.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT. Results – see above.

Toxicity:

LD₅₀ orally was tested on groups of 6 mice (3 male and 3 female). Dosage of extracts was from 500 to 5000 mg/kg. Mortality was observed up to 3 days after administration.

LD₅₀ intraperitoneal was tested on groups of 6 mice (3 male and 3 female). Dosage of extracts was from 300 to 400 mg/kg. Mortality was observed up to 3 days after administration.

Chronic/prolonged toxicity was tested on groups of 16 mice (6 male and 10 female). Extracts were administered orally at a concentration of 28 mg/kg body weight for 4 weeks. After 2 weeks, 2 mice from each group were killed and their organs were examined. After the 4th week, the rest of the mice were killed and their organs examined.

Transaminase test.

Haemolytical tests.

Larvicidal activity.

Test of cytotoxic effect on *Lombricus terrestris*.

Results:

Toxicity:

LD₅₀ orally: no deaths observed.

LD₅₀ intraperitoneal: no deaths observed, but the mice were shaking and had diarrhoea.

Chronic/prolonged toxicity: no deaths observed, but a decrease in weight for female mice.

The weights of liver and kidneys from treated mice were comparable to the values for mice that were only given water.

Transaminase:

1. Serum from healthy mice
2. Serum from mice that were given distilled water.
3. Serum from mice (m) that were given *Afrormosia laxiflora*.
4. Serum from mice (f) that were given *Afrormosia laxiflora*.

Table 3.1.19.1.a

Results from transaminase test

Serum	SGOT	SGPT
1	34	26
2	65	38
3	18	96
4	186	77

SGOT increased for female mice and decreased for male mice, while SGPT increased for both groups.

Haemostatic tests: negative

Table 3.1.19.1.b Results from larvicidal test on *Anopheles gambiae*

Extracts (500 µg)	Number of larvae	Time	
		24 hours	
		Number of deaths	% dead
Distilled water	20	0	0
Decoction A.l.	20	17	85
Maceration A.l.	20	6	30

A.l. = *Afrormosia laxiflora*

No deaths were observed after 30 minutes or after 1 hour.

Table 3.1.19.1.c Results from *Lombric* test:

Extract 90000 pp	Number of L.t.	Mortality			Number of deaths	% dead after 72 hours
		24 hours	48 hours	72 hours		
Distilled water	5	0	0	0	0	0
Decoction A.l.	5	5	-	-	5	100
Maceration A.l.	5	0	0	0	0	0

Only the decoction displayed effect against *L. terrestris*.

See also Tran (2004) and Maiga et al (2004) for more information about this plant.

3.1.19.2 *Bauhinia thonningii* Schum.

Theses: Kanta (1999) and Samake (2000)

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*, These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words (“vaginal discharge and vaginitis”). 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and 10th December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

Leaves from *Bauhinia thonningii* were analyzed. An extract was done with ethanol, dichloromethane and methanol and tested for activity against *Candida albicans* and *Escherichia coli*. The extract did not have any effect against *E. coli*, but it did show some effect against *C. albicans* at 30 mg/ml. Activity: ++ (maximum activity is marked with +++). At 10 mg/ml the dichloromethane extract of the stem bark gave 2 active products using thin layer chromatography plates combined with the microorganism.

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analyzis.

Extraction:

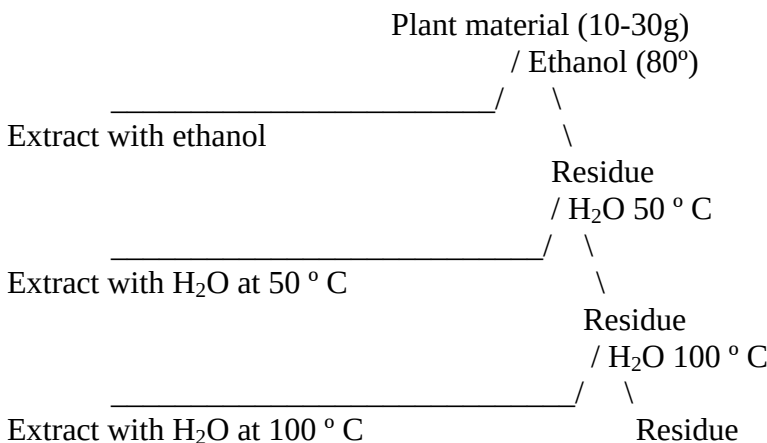


Figure 3.1.19.2.a

A dialysis was performed on all solutions, followed by lyophilization.

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366w nm.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.19.2.a **Extracts tested with known sugars as references and ICH₅₀**

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
B.t. 50°C	Leaves	+	+	+	0	+	+	+	+	0	40
B.t. 100°C	Leaves	+	+	+	0	+	+	+	+	0	110

B.t. = *Bauhinia thoningii*

Gas chromatography:

Table 3.1.19.2.b Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C	Extract at 100°C
	Sugar ratio (%)	Sugar ratio (%)
Arabinose	46	59
Rhamnose	24	5
Xylose	5	6
Mannose	4	2
Galactose	9	8
Glucose	4	17
Glucuronic acid	0	0
Galacturonic acid	12	1
Total	104*	98*
Polysaccharides (%)	52	60

*The only information available is a summary table – basic data needs to be checked.

The leaves from this plant show moderate effects on the complement system. This may be caused by the high content of polysaccharides. It demonstrates also some activity against *C. albicans*.

3.1.19.3 *Ostryderris stuhlmannii* (Taub.) Dunn ex. Harms.

Theses: Kanta (1999) and Samake (2000)

Some traditional uses in Senegal:

The bark is used to treat cough, stomach ache, dysentery and as a purgative substance, often combined with other plants. The roots are known to be emetic, and are rarely used. An exception is the use of a maceration or decoction of the roots against fever and internal worms by one ethnic group, only a small amount of the roots is used in this case (Kerharo and Adam, 1974).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words (“vaginal discharge and vaginitis”). 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and 10th December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

The leaves from *Ostryderris stuhlmannii* were analyzed. An extract was done with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*, but it did not have any effect against these microorganisms.

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analyzis.

Extractions:

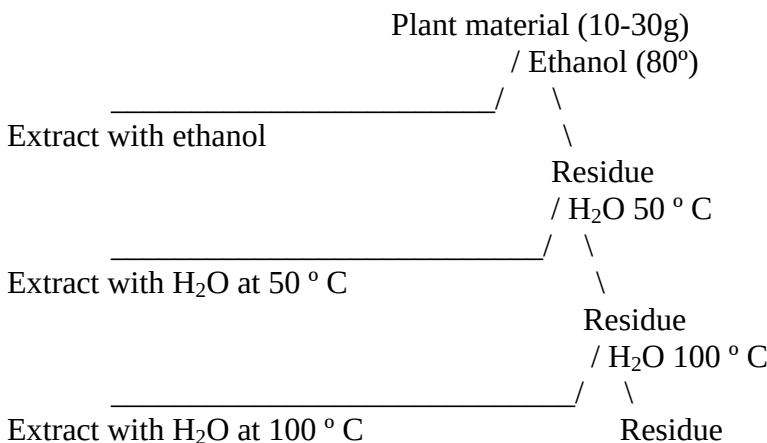


Figure 3.1.19.3.a Extraction with solvents of different polarity

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard here was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.19.3.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
O.s. 50°C	Leaves	+	+	+	0	+	+	+	+	0	80
O.s. 100°C	Leaves	+	+	+	0	+	+	+	+	0	25

O.s. = *Ostryderris sthulmannii*

Gas chromatography:

Table 3.1.19.3.b Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C		Extract at 100°C	
	Sugar ratio (%)	Test substance ratio (%)	Sugar ratio (%)	Test substance ratio (%)
Arabinose	4	1	4	1,5
Rhamnose	58	16	43	16
Xylose	1	0,3	1	0,4
Mannose	1	0,3	2	0,8
Galactose	2	0,6	19	7
Glucose	8	2,2	8	3
Glucuronic acid	26	7,84	23	9
Galacturonic acid				
Total	100	28	100	9
Polysaccharide content (%)	28		38	

The leaves from this plant show moderate effect on the complement system.

A search using www.google.com gave 1 hit while www.PubMed.com gave 0 hits (03.03.2005).

3.1.19.4 *Prosopis africana* (Guill. et Perr.) Taub.

Thesis: Ekoumou (2004)

The author identified 5 recipes traditionally used to treat urinary infections and cystitis.

Both single plants and combinations of plants were analyzed.

The plants were chosen from several documents on medicinal plants used in West Africa (Kerharo and Adam, 1974 and others).

The root bark from *P. africana* was tested alone and with fruits from *Tamarindus indica* after the following recipes: 90 % *P. africana* + 10 % *T. indica* and 80 % *P. africana* + 20 % *T. indica*.

Extractions:

20 g plant material + water (200 ml)
(15 minutes at 100 °C)

/

Decoction

Figure 3.1.19.4.a Decoction

20 g plant material + water (200 ml x 24 hours)

/

Water maceration

Figure 3.1.19.4.b Maceration with water

20 g plant material + ethanol (200 ml x 24 hours)

/

Ethanol extract

Figure 3.1.19.4.c Maceration with ethanol

20 g plant material was used for all extracts, taking account of the proportions in the recipes.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

The antioxidant properties of the extracts were tested by using thin layer chromatography combined with DPPH.

Thin layer chromatography was performed, using the following solvent system:

Butanol : acetic acid : water (60:15:25) (BAW). The plates were treated with AlCl_3 and FeCl_3 and examined using UV light at 254 and 366 nm.

Biological tests:

Antifungal effect:

The ethanol extracts from all plants and recipes were tested for activity against *Candida albicans*. Nystatin was used as reference compound.

Antibacterial test:

The recipe with *P. africana* combined with fruits from *T. indica* was tested for antibacterial activity against *Escherichia coli* and *Klebsiella pneumoniae*.

Results:

From the phytochemical tests performed at DMT the following substances were found:

Root bark from *P. africana* alone:

Alkaloids, flavonoids, anthocyanines, tannins, saponines, cardiac glycosides, mono- and polysaccharides, mucilages, sterols and/or triterpenes, anthraquinones and reducing compounds. The content of water was found to be 8 % (Table 3.2).

Root bark from *P. africana* combined with fruits from *T. indica*:

Alkaloids, anthocyanines, leucoanthocyanins, tannins, saponines, sterols and/or triterpenes, mono- and polysaccharides, mucilages, cardiac glycosides and mucilages (Table 3.2).

The thin layer chromatography showed the presence of sterols and/or triterpenes, flavanoids and alkaloids in *P. africana* alone and the presence of triterpenes, tannins, alkaloids and flavanoids in mixture of *P. africana* and *T. indica*. From the phytochemical tests flavanoids were only detected in the pure extract, but it might be found in smaller amounts that could only be detected by the thin layer chromatography. With this exception the results from the thin layer chromatography corresponds well with the results from the phytochemical tests.

The recipe with *P. africana* combined with fruits from *T. indica* showed some antibacterial activity. Doses of 100 µg gave inhibition zones of 0 mm for *E. coli* and 10 mm for *K. pneumonia* while doses of 300 µg gave an inhibition zone of 7 mm for *E. coli*. No results were observed for *K. pneumoniae*.

No antifungal activity was seen in the ethanol extract.

All extracts showed some antioxidant activity with between 2 and 4 active compounds detected for each extract.

For more information about this plant see Aasberg (2001).

3.1.19.5 *Pterocarpus erinaceus* Poir.

Theses: Kanta (1999) and Samake (2000)

Some traditional uses:

In Senegal, this plant has multiple uses. It is used to treat dysentery either alone or in combination with *Acacia macrostachya*, *Lannea acida* and *Ostryderris stuhlmannii*. Powdered bark or roots are inhaled in the nose, or mixed with pipe tobacco to treat all respiratory affections. A decoction of the leaves is used in inhalation, baths and beverage to treat malaria. It is used in different combinations to treat difficult pregnancies, weakness and yaws, and it is mainly the stem bark or roots that are used in these preparations. The plant is also used in many medico-magical treatments (Kerharo and Adam, 1974).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words vaginal discharge and vaginitis. 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and 10th December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

The stem bark from *Pterocarpus erinaceus* was analyzed. An extract was done with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*. The extract

did not have any effect against *E. coli*, but it showed some effect against *C. albicans* at 30 mg/ml. Activity: +, maximum activity is marked with +++.

At 10 mg/ml the ethanol extract of the stem bark gave 1 active product using thin layer chromatography plates combined with the microorganism.

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analyzis.

Extraction:

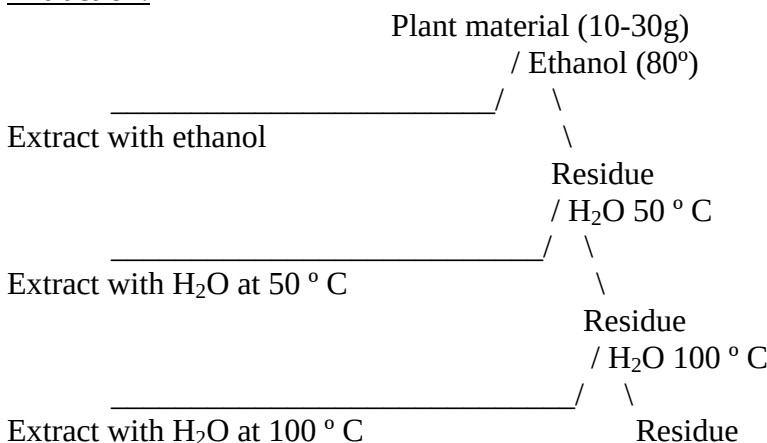


Figure 3.1.19.5.a Extraction with solvents of different polarity

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard here was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.19.5.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
P.e. 50°C	Stem bark	+	+	+	0	+	+	+	+	0	< 15
P.e. 100°C	Stem bark	+	+	+	0	+	+	+	+	0	< 15

P.e. = *Pterocarpus erinaceus*

Gas chromatography:

Table 3.1.19.5.b Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C		Extract at 100°C	
	Sugar ratio (%)	Test substance ratio (%)	Sugar ratio (%)	Test substance ratio (%)
Arabinose	18	1,5	13	2
Rhamnose	9	1	8	1
Xylose	11	1	4	0,5
Fucose	0	0	0	0
Mannose	3	0,2	4	0,5
Galactose	14	1	12	2
Glucose	31	2,1	40	5
Glucuronic acid	0	0	0	0
Galacturonic acid	14	1	19	3
Total	100	7,8	100	14
Polysaccharide content (%)	7		13	

The stem bark from this plant demonstrates very good effect on the complement system. It shows only modest activity against *C. albicans*.

Field work:

N'Tjobougou, 5.2.04

Bourama Toure uses this recipe to treat black dermatosis; when it itches a lot the bark of *Pterocarpus erinaceus* and *Afzelia africana* is used to make a powder. This powder is mixed with the powder of the bark of *L. velutina*. One part is used for making a decoction that is used to wash the skin, the other part is mixed with oil and applied on the dermatosis once per day until it is completely cured.

For a review of this plant see Aasberg (2001).

3.1.19.6 *Pterocarpus lucens* Lepr. Ex Guill. et Perr.

Kerharo and Adam (1974) reported only on use of this plant: a decoction of the roots is said to have effect against diarrhoea.

Field work:

Dosseré Diarra uses the *Loranthus* sp. from this plant together with the *Loranthus* sp. from *Acacia ataxacanth*,. Both plants are carbonized, mixed with the butter from *B. parkii* and applied on affected areas.

This plant will not be discussed further in this thesis.

A search using www.google.com gave 291 hits and www.PubMed.com gave 2 hits (27.02.2005).

3.1.19.7 *Stylosanthes erecta* P. Beauv.

Thesis: Ekoumou (2004)

Some traditional uses:

In Senegal, the plant is not widely used, however a decoction of the leaves is said to be expectorant and a decoction of the roots is said to give energy to the patient (Kerharo and Adam, 1974).

Ekoumou (2004)

This author identified 5 recipes traditionally used to treat urinary infections and cystitis. Both single plants and combinations of plants were analyzed.

The plants were chosen from several documents on medicinal plants used in West Africa (Kerharo and Adam, 1974 and others).

The aerial parts from *S. erecta* were tested alone and with fruits from *Tamarindus indica* after the following recipes: 90 % *S. erecta* + 10 % *T. indica* and 80 % *S. erecta* + 20 % *T. indica* (SET). *S. erecta* was also tested with the “calices” from *Hibiscus sabdariffa* using recipes after the following recipes: 90 % *S. erecta* + 10 % *H. sabdariffa* and 80 % *S. erecta* + 20 % *H. sabdariffa* (SEH).

Extractions:

20 g plant material + water (200 ml)
(15 minutes at 100 °C)

/

Decoction

Figure 3.1.19.7.a Decoction

20 g plant material + water (200 ml x 24 hours)

/

Water maceration

Figure 3.1.19.7.b Maceration with water

20 g plant material + ethanol (200 ml x 24 hours)

/

Ethanol extract

Figure 3.1.19.7.c Maceration with ethanol

20 g plant material was used for all extracts, taking account of the proportions in the recipes.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

The antioxidant properties of the extracts were tested by using thin layer chromatography combined with DPPH.

Thin layer chromatography was performed, using the following solvent system: Buthanol : acetic acid : water (60:15:25) (BAW). The plates were treated with AlCl_3 and FeCl_3 and examined using UV light at 254 and 366 nm.

Analgetic effect:

- “Writhing” test.
- “Hot-plate” test.

Haemostatic effect:

- coagulation time of blood in tests tubes was measured
- haemolytic activity was tested

Antifungal effect: The ethanol extracts from all plants and recipes were tested for activity against *Candida albicans*. Nystatin was used as reference.

Antibacterial test:

The recipe with *S. erecta* combined with fruits from *T. indica* was tested for antibacterial activity against *Escherichia coli* and *Klebsiella pneumoniae*.

Results:

From the phytochemical tests the following substances were found:

Aerial parts from *S. erecta* alone:

Flavanoids, leucoanthocyanins, tannins, saponins, mucilages, sterols and/or triterpenes, coumarins, reducing compounds, mucilages and cardiac glycosides. The content of water was found to be 6 % (Table 3.2).

Aerial parts from *S. erecta* combined with fruits from *T. indica*:
Leucoanthycyans, tannins, sterols and/or triterpenes, saponines, mono- and polysaccharides, mucilages, and cardiac glycosides, coumarins and mucilages (Table 3.2).

Aerial parts from *S. erecta* combined with “calices” from *H. sabdariffa*:
Leucoanthycyans, tannins, saponines, mono- and polysaccharides, mucilages, and cardiac glycosides, coumarins, sterols and/or triterpenes and mucilages (Table 3.2).

The thin layer chromatography of *S. erecta* alone shows the presence of coumarins, flavonoids, tannins and triterpenes. This corresponds well with the results from the phytochemical tests. The same is the situation for the SET and SEH extracts.

Antibacterial tests:

Preliminary tests:

SEH: 100 µg: no inhibition of *E. coli*, but 6,5 mm zone for *K. pneumoniae*.
300 µg: 7 mm inhibition zone of *E. coli* and 10 mm zone for *K. pneumoniae*.
STE: 100 µg: 7 mm inhibition zone of *E. coli* and 9 mm zone for *K. pneumoniae*.
300 µg: 8 mm inhibition zone of *E. coli* and unknown inhibition for *K. pneumoniae*.

Extended tests:

Tested microbes were; *E. coli* (3 different strains), *Staphylococcus aureus* (2 strains), *K. pneumoniae* and *Pseudomonas sp* – giving a total of 8 tested bacteria types.

SEH: The ethyl acetate (400 µg/ml) and methanol (400 µg/ml) fractions were the most active, both with activity on 5 bacteria types and with inhibition zones from 8 to 14 mm.

SET: All tested extracts had good effect against *E. coli* and variable effects against the other tested microbes. The DCM extracts seem to have the strongest antimicrobial activity in total.

The alkaloid fraction was also tested: it showed good effect against *E. coli*, but no effect on *K. pneumoniae*.

No antifungal activity was seen in the ethanol extract.

Antioxidant activity:

SET: All extracts except the water extract showed activity, with a mean of 2 active compounds detected for each extract.

SEH: All extracts except the water extract showed activity, with between 1 and 5 active compounds detected. The methanol extracts showed the strongest activity.

Haemostatic tests: No activity was seen.

Analgetic activity:

“Hot-plate” test: Water extract at 1000 mg/kg did not show any analgetic effect.

“Writhing” test:

Table 3.1.19.7 a Results of tests on analgetic activity

Tested extract/substance	Doses ml or mg/kg	Number of torsions (M + SD)	% Protection
Distilled water	25	56,66 ± 22,01	---
SET 20 %	500	43,33 ± 17,07	23,53
SET 20 %	1000	36,66 ± 6,43*	35,29
SEH 20 %	500	33,16 ± 10,04*	31,85
SEH 20 %	1000	28,66 ± 5,42*	49,41
Paracetamol	100	35,16 ± 9,96*	37,94
Indometacine	25	33,66 ± 3,50*	40,59

*significant results using Student t test.

The tested recipes show good antibacterial activity, especially against *E. coli*. They also show analgetic activity comparable to Paracetamol and Indometacine.

A search using www.google.com gave 122 hits while www.PubMed.com gave 0 hits (27.02.2005).

3.1.20 Flacourtiaceae

3.1.20.1 *Flacourtia flabescens* Forsk.

Thesis: Ouologuem (1999)

This author tested the larvicidal effects of different extracts of 11 Malian plants. Larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were used. 6 of the plants were tested on both species, while 5 were only tested on *C. quinquefasciatus*.

Larvae from second and third generation *Anopheles gambiae* collected in Mopti were used. Larvae from *Culex quinquefasciatus* were collected in N'Tomikorobougou and Darsalam in the Bamako district.

Pre-made extracts were used. Water and ethanol extracts from *F. flabescens* leaves were tested.

Tests:

Tests on larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were done on 5,5 mg extract dissolved in 110 µl of a suitable solvent; water for the water and ethanol extracts and dimethylsulfoxide (DMSO) for the methanol, ether and DCM-extracts. The tests were performed on 5x20 larvae, and larvae that had fallen to the bottom of the tubes or were immobile were considered dead.

Results:

Larvicidal tests:

Table 3.1.20.1.a *Culex quinquefasciatus* - % deaths at 500 ppm

	Plant extract	
Time of exposure	F.f. H ₂ O	F.f. Ethanol
30 minutes	0	15
1 hour	0	20
24 hours	30	80

Table 3.1.20.1.b *Anopheles gambiae* - % deaths at 500 ppm

	Plant extract	
Time of exposure	F.f. H ₂ O	F.f. Ethanol
30 minutes	90	70
1 hour	90	90
24 hours	100	100

F.f. = *Flacourtia flabescens*.

F. flabescens leaves show some activity against both tested larvae species.

A search using www.google.com and www.PubMed.com gave 0 hits (27.02.2005).

3.1.21 Hypericaceae

3.1.21.1 *Psorospermum senegalense* Spach.

- synonym *Psorospermum guineense* (L.) Horch.

Thesis: Ouologuem (1999)

Some traditional uses:

This plant is widely used against dermatosis all over Senegal. Internal and external preparations from the decoction of the bark or roots are used to treat anything from mild skin affections to syphilis, leprosy, herpes and eczema and so on.

The plant is also used to treat colics and vaginal discharge.

A fumigation of the bark is said to be used to chase demons.

The leaves are used as as expectorant, fortifier and against nausea. A decoction of the leaves, bark and roots are used in baths and beverages to treat joint pain (Kerharo and Adam, 1974).

Ouologuem (1999)

This author tested the larvicidal effects of different extracts of 11 Malian plants. Larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were used. 6 of the plants were tested on both species, while 5 were only tested on *C. quinquefasciatus*.

Larvae from second and third generation *Anopheles gambiae* collected in Mopti were used. Larvae from *Culex quinquefasciatus* were collected in N'Tomikorobougou and Darsalam, in the Bamako district.

Pre-made extracts were used. Water and ethanol extracts from the leaves were tested.

Tests:

Tests on larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were done on 5,5 mg extract dissolved in 110 µl of a suitable solvent; water for the water and ethanol extracts and dimethylsulfoxide (DMSO) for the methanol, ether and DCM-extracts. The tests were performed on 5x20 larvae, and larvae that had fallen to the bottom of the tubes or were immobile were considered dead.

Results:

Larvicidal tests:

Table 3.1.21.1.a *Culex quinquefasciatus* - % deaths at 500 ppm

	Plant extract	
Time of exposure	P.g. H ₂ O	P.g. Ethanol
30 minutes	0	5
1 hour	0	5
24 hours	40	70

Table 3.1.21.1.b *Anopheles gambiae* - % deaths at 500 ppm

	Plant extract	
Time of exposure	P.g. H ₂ O	P.g. Ethanol
30 minutes	95	5
1 hour	95	10
24 hours	95	40

P.g. = *Psorospermum guineense*.

P. guineense shows some larvicidal effect on the tested species.

Both names were checked:

Psorospermum senegalense

A search using www.google.com gave 10 hits and www.PubMed.com gave 0 hits (27.02.2005).

Psorospermum guineense

A search using www.google.com gave 9 hits and www.PubMed.com gave 20 hits (27.02.2005).

3.1.22 Liliaceae

3.1.22.1 *Aloe buteneri*

Field work - uses against dermatosis:

N'Tjobougou, 5.2.04

Konimba Traoré uses the clear succus or jelly inside the leaves of this plant directly on dermatosis on the body. He comments that the plant is getting harder to find near his village.

Masantola-region, 7.2.04

Fah Diarra uses the leaves from this plant to treat dermatosis. Cut the fresh leaves, pound them, wash the part infected and apply the juice once per day

This plant will not be discussed further in this thesis.

A search using www.google.com and www.PubMed.com gave 0 hits (27.02.2005).

3.1.23 Lycoperdeae

3.1.23.1 *Podaxon aegyptiacus* Mont.

Thesis: Samake (2000)

The author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analyzis.

Extraction:

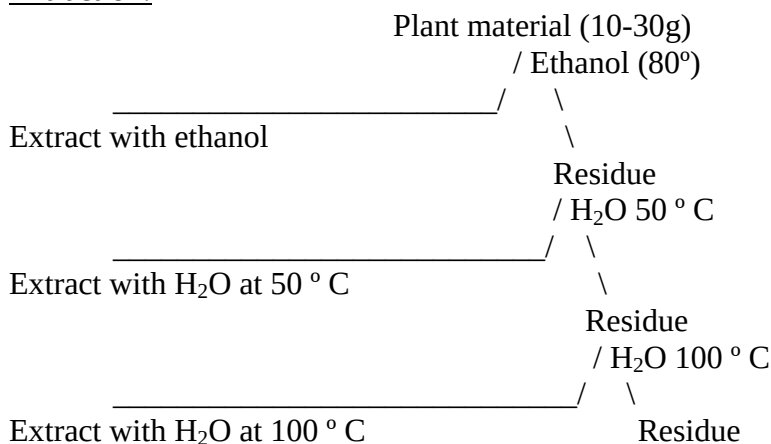


Figure 3.1.23.1.a Extraction with solvents of different polarity

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard substance used was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.23.1.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
P.a. 50°C	Whole plant	+	+	+	0	+	+	+	+	+	< 15
P.a. 100°C	Whole plant	+	+	+	+	+	+	+	+	+	< 15

P.a. = *Podaxon aegyptiacus*

Gas chromatography:

Table 3.1.23.1.b Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C		Extract at 100°C	
	Sugar ratio (%)	Test substance ratio (%)	Sugar ratio (%)	Test substance ratio (%)
Arabinose	1	0,2	0	0
Rhamnose	4	0,8	5	0,75
Xylose	1	0,22	0	0
Fucose	0	0	6	1
Mannose	25	5,5	25	4
Galactose	53	12	40	6
Glucose	12	3	24	3,6
Glucuronic acid	1	0,3	0	0
Galacturonic acid	3	0,6	0	0
Total	100	22	100	15
Polysaccharide content (%)	22		15	

The tested extract demonstrated very good effect on the complement system.

A search using www.google.com gave 2 hits while www.PubMed.com gave 0 hits (27.02.2005). See also Diallo et al (2002).

3.1.24 Lythraceae

3.1.24.1 *Lawsonia inermis* L.

Theses: Ba (1998) and Ouologuem (1999)

Some traditional uses in Senegal:

A decoction of the leaves is used to color feet, hands and head by the women in the Lébout and Wolof tribes. It is also known as henna. The plant is also used against rheumatism, in difficult childbirth and abortion. It is used externally to treat sprained muscles and/or tendons, especially in the fingers (Kerharo and Adam, 1974).

Ba (1998)

This author studied 6 plants traditionally used as “fishing poison” or used as insecticides in cultivation of cereals, to determine the chemical composition and molluscicidal activity of these plants. This was done to find plants that may be used in the prevention of schistosomiasis, by killing the molluscs that act as intermediate hosts.

Molluscs were collected in Djikoroni Woyowayemko and N’Gomidjirambougou. The species used were *Bulinus truncatus* and *Biomphalaria pfeifferi*. Groups of 6 snails were used in all tests.

The plant material was collected in Daoudabougou the 16th of March 1997. Only the leaves were tested, and they were dried and pulverized before analysis.

Extraction:

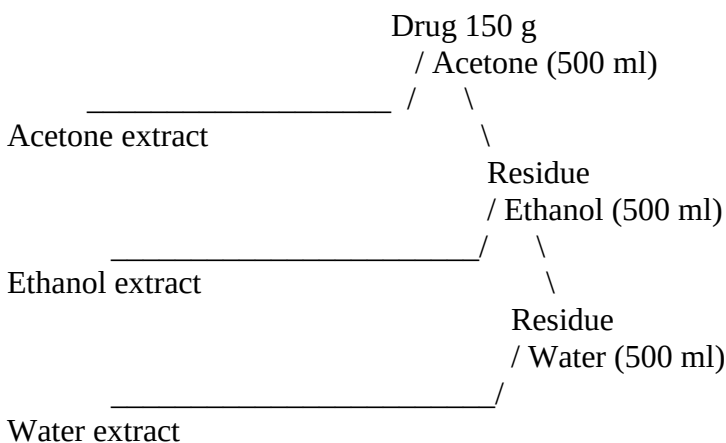


Figure 3.1.24.1.a Extraction with solvents of different polarity

Standard phytochemical tests (A.1.1) were performed at DMT.

Molluscicidal activity was tested for all extracts at concentrations from 0,025 mg/ml to 0,4 mg/ml.

Results:

From the phytochemical tests the following substances were found:

Flavanoids, tannins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 7 and 7,05 %. Ashes insoluble in HCl were 4,32 %, total ash content was 6,62 % and sulphur containing ash was 9,88 % (Table 3.2).

Molluscicidal activity:

Only the acetone extracts showed activity. A concentration of 0,4 mg/ml gave 33,33 % deaths on *Biomphalaria pfeifferi* and 16,66 % deaths on *Bulinus truncatus*.

Ouologuem (1999)

This author tested the larvicidal effects of different extracts of 11 Malian plants. Larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were used. 6 of the plants were tested on both species, while 5 were only tested on *C. quinquefasciatus*.

Larvae from *Culex quinquefasciatus* were collected in N'Tomikorobougou and Darsalam, in the Bamako district.

Pre-made extracts were used. Water, ethanol, acetone and ether extracts from *L. inermis* leaves were tested.

Tests:

Tests on larvae from *Culex quinquefasciatus* were done on 5,5 mg extract dissolved in 110 µl of a suitable solvent; water for the water and ethanol extracts and dimethylsulfoxide (DMSO) for the methanol, ether and DCM-extracts. The tests were performed on 5x20 larvae, and larvae that had fallen to the bottom of the tubes or were immobile were considered dead.

Results:

Larvicidal test:

Table 3.1.24.1.a *Culex quinquefasciatus* - % deaths at 500 ppm

Time of exposure	Plant extract		
	L.i. H ₂ O	L.i. Ethanol	L.i. Acetone
30 minutes	0	5	15
1 hour	0	20	20
24 hours	15	20	55

Leaves from *L. inermis* show only a modest molluscicidal and larvicidal activity.

A search using www.google.com gave 51700 hits and www.PubMed.com gave 57 hits (27.02.2005).

3.1.25 **Meliaceae**

3.1.25.1 ***Khaya senegalensis* (Desr.) A. Juss.**

Thesis: Sanogo (1999)

Some traditional uses:

In Senegal, this plant is used against fever and to treat fatigue. It is also used to treat malaria and as an abortive remedy. Decoctions or macerations of the bark is the most common preparations used in the treatment of syphilis, vaginal discharge, leprosy and small pox, most likely because of its purgative properties. Syphilis and leprosy are also treated externally. This often involves use of the leaves.

The plant is used in combinations with other plants to stop vomiting and against vaginal discharge and stomach aches (Kerharo and Adam, 1974).

The gum from the plant has traditionally been used to treat dysentery, head ache and menstrual pain (Sanogo 1999).

Sanogo (1999)

This author did a survey of gums found from different plants in Mali and their commercial and medicinal uses. The collection of plant material took place between November 1997 and February 1998 in Bamako and Banankoro. This specific gum was collected in December 1997 in Banankoro.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances, and with the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was used to confirm the content of monosaccharides.

All gums were tested for possible content of *Escherichia coli* and *Salmonella spp.*

They were also examined for content of starch and starch derivatives.

From the phytochemical tests the following substances were found:

Coumarins, tannins, mono- and polysaccharides, mucilages and cardiac glycosides. The content of water was between 8 and 8,43 %. Ashes insoluble in HCl were 3,09 %, total ash content was 4,34 % and sulphur containing ash was 6,71 % (Table 3.2).

Thin layer chromatography:

Matching R_f with galactose and galacturonic acid (both had the same R_f), arabinose and rhamnose. In addition to this there was detected one spot that did not correspond with any of the references sugars. Solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Results from gas chromatography:

5 monosaccharides: Galactose (46,62 %), arabinose (26,79 %), galacturonic acid (13,89 %), rhamnose (10,20 %) and mannose (2,5 %). This corresponds well with the results from the thin layer chromatography with the exception of mannose. The small content of this sugar compared to the others might explain this difference.

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of gum. The test for starch and starch derivatives was also negative.

For more information about this plant see Aasberg (2001).

3.1.25.2 *Trichilia emetica* Vahl.

Synonym *Trichilia roka* (Forssk.) Chiov.

Theses: Fane (2002), Kanta (1999) and Samake (2000)

Some traditional uses:

In Senegal, the roots are known for their emetic properties and they are also used to treat cataracts. The bark or sometimes the roots are used in the treatment of syphilis and leprosy, often in combination with other plants. It is also used to treat poisoning, against vaginal discharge and internal worms, as well as to treat different stomach affections; gastritis, hepatitis, internal tumors, dyspepsia, lack of menstrual bleeding and sterility. The plant is also used as strength tonic, stimulator of bronchial secretion and against epilepsy. It is also believed to have magic properties by one ethnic group in Senegal (Kerharo and Adam, 1974).

In Mali, this plant is used in the treatment of rheumatism, malaria, fever and pain. It is also used in the treatment of chronic wounds (Diallo, 2000).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words 1 (“vaginal discharge and vaginitis”). 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and the 10th of December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

The leaves from *Trichilia emetica* were analyzed. An extract was done with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*, but it did not have any effect against these microorganisms.

Fane (2002)

This author interviewed 110 healers in the Bamako district; 50 men and 60 women. Most were in the age group between 40-70 years. They were asked to name known toxic plants, the use of these plants, toxic effects and possible anti-dotes.

Maiga et al (2004) did a literature research of the 19 most cited plants

Phytochemical tests (A.1.1) were performed on 5 of these plants and, further biological tests were performed on 3 plants: *Vernonia colorata*, *Afrormosia laxiflora* (3.1.21.1) and *Cassia siberiana* (3.1.12.4). The plants were chosen from both the results from the interviews, but also from the literature about the plants. (See also tables 3.1.7.1.a and 3.1.7.1.b). The root bark from *Trichilia roka* was bought at the market in Magnambougou in July 2002.

From the phytochemical tests the following substances were found: Flavonoids, leucanthocyans, tannins, saponins, cardiac glycoside, sterol and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages (traces). The content of water was between 7,31 and 8 %. Ashes insoluble in HCl were 5,9 %, total ash content was 8,17 % and sulphur containing ash was 16,2 % (Table 3.2).

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analyzis.

Extractions:

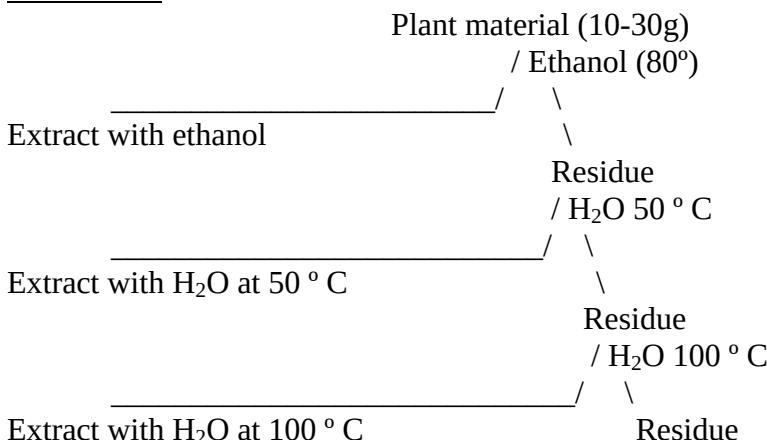


Figure 3.1.25.2.a Extraction with solvents of different polarity

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard substance used was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Leaves from *T. emetica* were chosen for further tests because of their high polysaccharide content (see results):

- Ion exchange chromatography.
- Standard phytochemical tests were performed at DMT (Appendix A.1.1.)

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.25.2.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
T.e. 50°C	Leaves	+	+	+	0	+	+	+	+	+	45
T.e. 100°C	Leaves	+	+	+	0	+	+	+	+	+	35

T.e. = *Trichilia emetica*

Gas chromatography:

Table 3.1.25.2.b Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C (leaves)		Extract at 100°C (leaves)	
	Sugar ratio (%)	Test substance ratio (%)	Sugar ratio (%)	Test substance ratio (%)
Arabinose	38	26	28	22
Rhamnose	12	8	9	8
Xylose	5		1	0,8
Fucose	0	0	0	0
Mannose	1	1	9	8
Galactose	37	26	31	26
Glucose	2	1	7	6
Glucuronic acid	3	2	3	2
Galacturonic acid	2	2	11	9
Total	100	69	99*	82
Polysaccharide content (%)	69		82	

*The only information available is a summary table – basic data needs to be checked.

From the phytochemical tests the following substances were found:

Alkaloids (0,1 %), flavanoids, leucoanthocyanins, tannins, saponins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 8,46 and 9 %. Ashes insoluble in HCl were 6,55 %, total ash content was 5,6 % and sulphur containing ash was 8,645 % (Table 3.2).

Ion exchange chromatography gave a good elution profile for the tested extract and was the background for further separations and examination. The fractions were tested for monosaccharide content and ICH₅₀ in the same way as the rest of the extracts:

Table 3.1.25.2.c Fractions from the extract at 50°C

Fraction	% in sample	Sugar ratios								
		Ara	Rha	Fuc	Xyl	Man	Gal	Glc	GlcA	GalA
FN	17	3	4	0	4	39	4	44	0	2
FI	50	32	10	0	1	0,2	47	0,8	6	2
FII	55	31	22	0	24	1	21	2	9	7
FIII	44	22	17	0	0,5	0,5	40	3	9	8
FIV	19	19	15	0	1	2	36	14	4	8

Table 3.1.25.2.d Fractions from the extract at 100°C

Fraction	% in sample	Sugar ratios								
		Ara	Rha	Fuc	Xyl	Man	Gal	Glc	GlcA	GalA
FN	79	20	7	0	3	28	12	24	3	
FI	96	42	6	0	1	2	42	2	2	3
FII	69	25	18	0	1	1	41	2	6	7
FIII	23	2	29	0	3	2	5	5	41	11
FIV	35	23	26	0	1	2	26	5	15	3
FV	18	17	2	0	2	8	40	21	7	3
FVI	14	16	8	0	7	2	29	22	14	2

The leaves from the plant have good complement activity. ICH_{50} for all the tested fractions in the extended tests was $< 15 \mu\text{g/ml}$. This might explain the use of this plant in wound healing.

Diallo (2000) performed a survey and a phytochemical study of this plant. See also Maiga et al (2004) for a more information about the toxicity of this plant.

3.1.26 Mimosaceae

3.1.26.1 *Acacia ataxacantha* DC.

Some traditional uses:

In Senegal, the powdered leaves are part of a combination of plants used to treat syphilis. It is used in combination with other species to treat hernia, internal worms, wounds and blisters. It is also used to treat gastric ulcer (Kerharo and Adam, 1974).

Field work:

Massantola-region, 7.2.04

Dosseré Diarra uses the *Loranthus* sp. from this plant together with the *Loranthus* sp. from *Pterocarpus lucens*. Both plants are carbonized, mixed with the butter from *B. parkii* and applied on affected areas.

This plant will not be discussed further in this thesis.
A search using www.google.com gave 412 hits while www.PubMed.com gave 0 hits (27.02.2005).

3.1.26.2 *Acacia dudgeoni* Craib

Thesis: Sanogo (1999)

Some traditional uses:

The plant is sometimes used against stomach aches in Senegal (Kerharo and Adam, 1974).

The gum from the plant has traditionally been used to treat ear infections (Sanogo 1999).

Sanogo (1999)

This author did a survey of gums found from different plants in Mali and their commercial and medicinal uses. The collection of plant material took place between November 1997 and February 1998 in Bamako and Banankoro. This specific gum was collected in December 1997 in Banankoro.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances, and with the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was used to confirm the content of monosaccharides.

All gums were tested for possible content of *Escherichia coli* and *Salmonella spp.*

They were also examined for content of starch and starch derivatives.

Results:

The water content in the gum was between 8 and 9,6 %. The small amount of HCl - insoluble ashes (0,64 %) corresponds well with the natural lack of sand and earth in a gum protruding from the tree stem. Total ash content was 3,19 % and sulphur containing ash was 4,35 % (Table 3.2). The amount of gum was too small to perform the rest of the tests.

Thin layer chromatography:

Matching R_f with galactose and galacturonic acid (same R_f), arabinose and rhamnose. In addition to this there was detected two “spots” that did not correspond with any of the references sugars. Solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography:

4 monosaccharides: Rhamnose (16,92 %), Glucuronic acid (19,08 %), arabinose (24,09 %) and galactose (39,91 %). This corresponds well with the results from the thin layer

chromatography, and it corresponds well with the sugars found in the related species *Acacia senegal* and *Acacia seyal*.

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of gum. The test for starch and starch derivatives was also negative.

A search using www.google.com gave 90 hits while www.PubMed.com gave 0 hits (27.02.2005).

3.1.26.3 *Acacia senegal* (L.) Willd.

Thesis: Sanogo (1999)

Some traditional uses:

A decoction of the bark, or powdered gum diluted in water is used as expectorant, to calm stomach ache and colics in both human and veterinary medicine. Gum of bad quality is used by one of the ethnic groups in Senegal both as medicine and food, together with milk, sugar, millet and dates.

The gum from *Acacia senegal* has traditionally been used to treat head aches (Sanongo, 1999).

The gum from this plant is also known as “gum arabic” and is of huge commercial interest in the western world. It is used in different industries and the uses in food and pharmaceutical products are the most common. Some of the uses of this gum are as an emulsifier, tablet coating agent, stabilizer of different products and to prevent crystallization of sugar.

Sanogo (1999) performed a survey of gums found from different plants in Mali and their commercial and medicinal uses. The collection of plant material took place between November 1997 and February 1998 in Bamako and Banankoro. This specific gum was collected in the 1997 season in Kayes.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances, and with the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was used to confirm the content of monosaccharides.

All gums were tested for possible content of *Escherichia coli* and *Salmonella spp*. They were also examined for content of starch and starch derivatives.

Results:

From the phytochemical tests the following substances were found: Coumarins, mono- and polysaccharides, mucilages and cardiac glycosides. The content of water was between 10 and 11,95 %. Ashes insoluble in HCl were 0,74%, total ash content was 3,22 % and sulphur containing ash was 4,42 % (Table 3.2).

Thin layer chromatography:

Matching Rf with galactose and galacturonic acid (same Rf), arabinose and rhamnose. In addition to this there was detected one “spot” that did not correspond with any of the references sugars. Solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Results from gas chromatography:

4 monosaccharides: Rhamnose (14,64 %), Glucuronic acid (16,23 %), arabinose (26,32 %) and galactose (42,81 %). This corresponds well with the results from the thin layer chromatography, and it corresponds well with the sugars found in the related species *Acacia dudgeoni* and *Acacia seyal*.

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of gum. The test for starch and starch derivatives was also negative.

A search using www.google.com gave 14800 hits and www.PubMed.com gave 21 hits (27.02.2005).

3.1.26.4 *Acacia seyal* Del.

Thesis: Sanogo (1999)

Some traditional uses:

In Senegal, the bark is often a part of anti-leprosy treatments. A decoction is used as purgative. The plant is also used in the treatment of jaundice and biliary fever (Kerharo and Adam, 1974). The gum from *Acacia senegal* has traditionally been used to treat headaches (Sanogo, 1999).

Sanogo (1999) did a survey of gums found from different plants in Mali and their commercial and medicinal uses. The collection of plant material took place between November 1997 and February 1998 in Bamako and Banankoro. This specific gum was collected in the 1997-season in Kayes.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed with known monosaccharides as reference substances, and with the following solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Gas chromatography was used to confirm the content of monosaccharides. All gums were tested for possible content of *Escherichia coli* and *Salmonella spp.* They were also examined for content of starch and starch derivatives.

From the phytochemical tests the following substances were found: Coumarins, tannins, mono- and polysaccharides, sterols and triterpenes, mucilages, cardiac glycosides and leucoanthocyanines. The content of water was between 7 and 8,86 %. Ashes insoluble in HCl were 1,88%, total ash content was 3,08 % and sulphur containing ash was 4,62 % (Table 3.2).

Thin layer chromatography was performed with known monosaccharides as reference substances and gave the following results: Matching R_f with galactose and galacturonic acid (same R_f), arabinose and rhamnose. In addition to this there was detected two spots that did not correspond with any of the references sugars. Solvent system: Ethyl acetate: Methanol: Acetic acid: Water (13:3:4:3)

Results from gas chromatography:
4 monosaccharides: Rhamnose (3,99 %), Glucuronic acid (12,68 %), arabinose (39,43 %) and galactose (43,90 %). This corresponds well with the results from the thin layer chromatography, and it corresponds well with the sugars found in the related species *Acacia dudgeoni* and *Acacia senegal*.

The tests for both *Escherichia coli* and *Salmonella spp* were negative for 1 g of gum. The test for starch and starch derivatives was also negative.

A search using www.google.com gave 4650 hits and www.PubMed.com gave 12 hits (27.02.2005).

3.1.26.5 *Entada africana* Guill. et Perr.

Theses: Ba (1998), Bah (1998) and Ouologuem (1999)

Some traditional uses:

This plant is widely used in traditional medicine in different countries in West Africa. In Mali it is used against fever (Bah, 1998), in wound healing and in the treatment of hepatitis (Diallo et al 2000). In Senegal, the plant is used against bronchitis and cough, in wound healing and as a magical remedy (Kerharo and Adam, 1974).

Ba (1998)

This author studied 6 plants traditionally used as “fishing poison” or used as insecticides in cultivation of cereals, to determine the chemical composition and molluscicidal activity of these plants. This was done to find plants that may be used in the prevention of schistosomiasis, by killing the molluscs that act as intermediate hosts.

Molluscs were collected in Djikoroní Woyowayemko and N'Gomidjirambougou. The species used were *Bulinus truncatus* and *Biomphalaria pfeifferi*. Groups of 6 snails were used in all tests.

Only the roots were tested, and they were dried and pulverized before analysis.

Extractions:

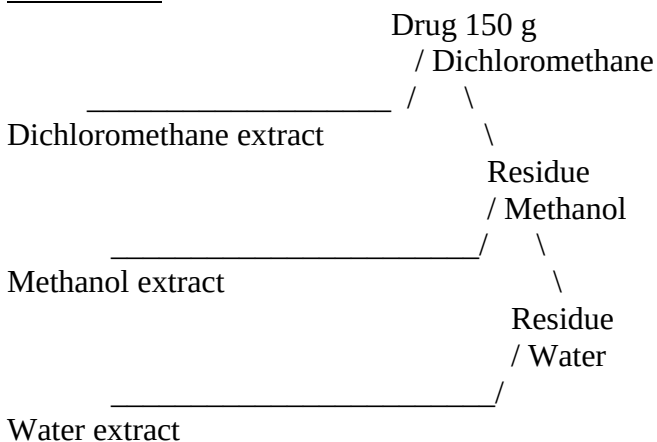


Figure 3.1.26.5.a Extraction with solvents of different polarity

A liquid-liquid extraction was performed with the methanol extract:

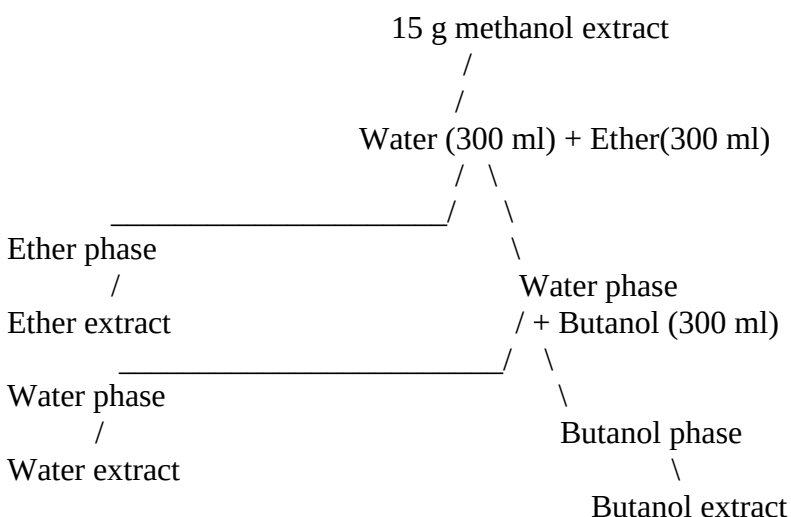


Figure 3.1.26.5.b Liquid-liquid extraction

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Molluscicidal activity was tested for all extracts at concentrations from 0,025 mg/ml to 0,4 mg/ml.

Results:

From the phytochemical tests performed at DMT the following substances were found: Alkaloids (0,27 %), flavanoids, leucoanthocyanins, tannins, saponins, cardiac glycosides, sterols and/or triterpenes, coumarins, carotenoids, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 4,49 and 8 %. Ashes insoluble in HCl were 9,75 %, total ash content was 7,66 % and sulphur containing ash was 7,33 % (Table 3.2).

Molluscicidal activity:

All extracts show some activity. The strongest activity is found for the butanol extract. It gives 100 % deaths at 0,1 mg/ml for both mollusc species.

Bah (1998)

This author studied the larvicidal effects of 10 different plant extracts on *Anopheles gambiae*, one of the intermediate hosts in malaria. As mosquitoes are developing resistance to an increasing number of chemical insecticides, it is important to search for new and possibly less toxic agents from plants to try and control the disease. *Anopheles gambiae* mosquitoes were collected in Mopti. For the tests, larvae were elevated and collected in the laboratory, from full grown females collected at one specific date. Larvae were fed with Whiskas ® cat food. The plant material was collected in Tchinboni in June 1996, and was dried and pulverized before analysis.

Only the roots from *E. africana* were analyzed. An extract was made with water, 500 ml x 24 hours x 3. The extracts were tested at concentrations from 0,015 mg/ml to 0,06 mg/ml on groups of 8 x 25 larvae and the number of dead larvae registered. No deaths were observed at any of the tested concentrations.

Ouologuem (1999)

This author tested the larvicidal effects of different extracts of 11 Malian plants. Larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were used. 6 of the plants were tested on both species, while 5 were only tested on *C. quinquefasciatus*. Larvae from *Culex quinquefasciatus* were collected in N'Tomikorobougou and Darsalam in the Bamako district.

Pre-made extracts were used. Water, methanol and DCM extracts from *E. africana* roots were tested.

Tests:

Tests on larvae from *Culex quinquefasciatus* were done on 5,5 mg extract dissolved in 110 µl of a suitable solvent; water for the water and ethanol extracts and dimethylsulfoxide (DMSO) for the methanol, ether and DCM-extracts. The tests were performed on 5x20 larvae, and larvae that had fallen to the bottom of the tubes or were immobile were considered dead.

Results:

Larvicidal test:

Table 3.1.26.5.a *Culex quinquefasciatus* - % deaths at 500 ppm

Time of exposure	Plant extract		
	E.a. H ₂ O	E.a. Methanol	E.a. DCM
30 minutes	0	5	10
1 hour	0	10	20
24 hours	20	45	55

E.a. = *Entada africana*.

For more information about this plant see Diallo (2000) and Aasberg (2001).

3.1.26.6 *Parkia biglobosa* (Jacq.) R. Br. ex G.Don

Some traditional uses:

In Senegal the bark and roots are used internally, while the leaves are used externally. Internal uses are against sterility, bronchitis, pneumonia, leprosy and sexually transmitted diseases. It is used alone or combined with other plants. Small bits of the bark are kept in the mouth to treat tooth ache and caries. External uses are against dermatosis, skin worms, oedema and bronchitis (Kerharo and Adam, 1974).

Field work:

N'Tjobougou, 5.2.04

Djenfa Koumaré uses this plant on black dermatosis. Trunk bark is divided in two parts. One part is used for making a decoction, the other part is carbonized. The wound is washed with the decoction, the carbonized part is then applied, either directly as a powder or mixed with the butter of *Butyrospermum parkii*. This is done every other day.

This plant will not be discussed further in this thesis.

For more information about this plant see Aasberg (2001).

3.1.27 **Moraceae**

3.1.27.1 *Ficus iteophylla* Miq.

Thesis: Kanta (1999)

Some traditional uses in Senegal:

This plant is used for women to start delivery. A maceration of the bark is used internally against dysentery and externally against rheumatism. A decoction of the roots is used against tuberculosis and mental problems, more specifically against depressions and manic periods (Kerharo and Adam, 1974).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants, and a review of available literature in the period between July and October 1998, using the search words vaginal discharge and vaginitis. 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and 10th December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

Leaves, stem bark and root bark from *Ficus iteophylla* were analyzed. Extracts were done with dichloromethane and methanol and tested for activity against *Candida albicans* and *Escherichia coli*. None of the extracts had effect against *E. coli*. The dichloromethane extracts from the stem bark and the root bark showed effect against *C. albicans* at 30 mg/ml. Activities: +++ and ++ (maximum activity is marked with +++). The extracts from the leaves showed no effect.

At 10 mg/ml the dichloromethane extract of the stem bark and root bark gave 4 and 3 active products using thin layer chromatography plates combined with the microorganism.

The stem bark and root bark show good antifungal activity.

A search using www.google.com gave 90 hits while www.PubMed.com gave 0 hits (27.02.2005).

3.1.28 Moringaceae**3.1.28.1 *Moringa oleifera* Lam.****Thesis: Chetima (2004)**

Some traditional uses:

In Senegal, this plant is widely used, especially in the preparation of food.

The most common medicinal uses are for children with rickets, bronchitis, fever or neural pain. The treatments vary from drinking of the fresh juice from the leaves, nasal administration of powdered roots to beverages and corporal baths with macerations from leaves, bark and roots. For adults it has the following additional indications: oedema, rheumatism, pain in the joints, sprained muscles and so on. The gum has astringent properties and has varied medicinal uses (Kerharo and Adam, 1974).

In Bandiagara in Mali, a decoction of the roots is used to treat pain in the bones, a decoction of branches with leaves and roots are used against respiratory difficulties. It is also used against fever, conjunctivitis, constipation, internal worms, stomach ache and diarrhoea. It is also used in the preparation of food in both Mali and Niger (Chetima, 2004).

Chetima (2004) studied several aspects of this plant, including use in food and medicine. The plant material was collected in the garden of DMT in Bamako in November 2002 and it was dried and pulverized before analysis. The animals used were local rabbits, both male and female. Their average age was 2 years and their weight was between 1,5 and 2 kg.

Extractions:

200 g plant material + water (2500 ml)
(3 hours at 100 °C)

/

Decoction

Figure 3.1.28.1.a Decoction

50 g plant material + water (24 hours x 3)

/

Water maceration

Figure 3.1.28.1.b Maceration with water

50 g plant material + ethanol (24 hours x 3)

/

Ethanol extract

Figure 3.1.28.1.c Maceration with ethanol

200 g plant material + water (2500 ml)
3 hours at 50 °C

/

Digestion

Figure 3.1.28.1.d Water at 50 °C (digestion)

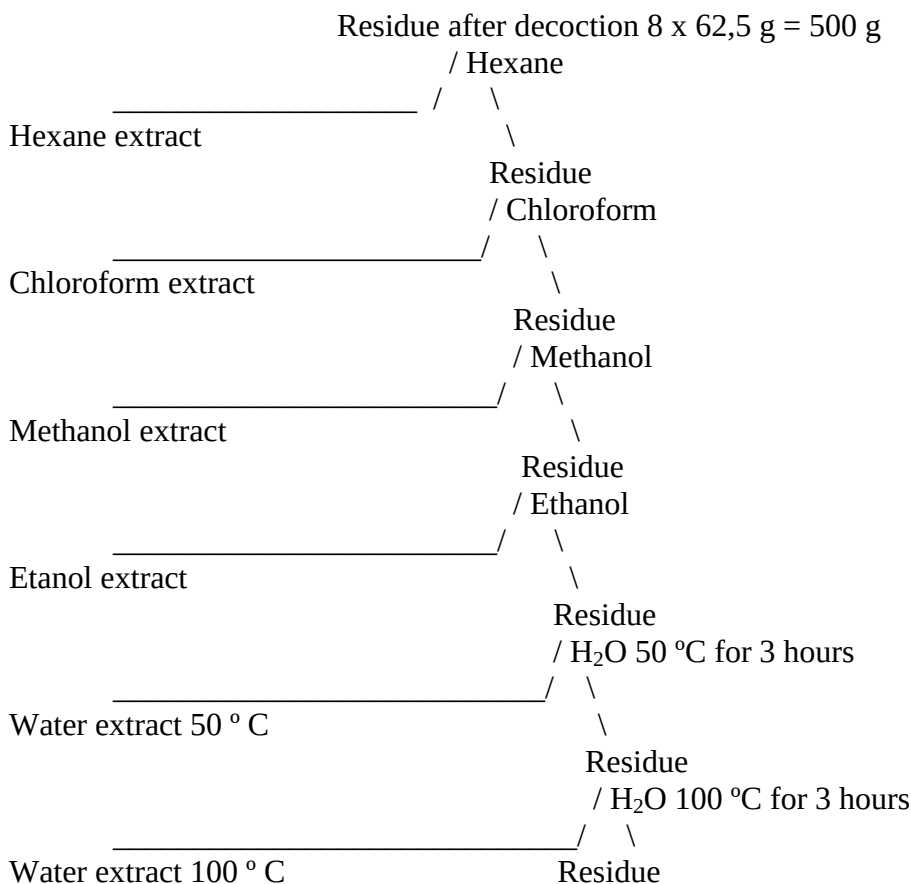


Figure 3.1.28.1.e Extraction using solvents of different polarity

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed, using the following solvent systems:

Chloroform : methanol : water (65:35:5)

Chloroform : methanol (70:30)

Ethyl acetate : methyl ethyl ketone : formic acid : water (50:30:10:10)

Buthanol : acetic acid : water (60:15:25) (BAW)

Ligroine : ethyl acetate (1:1)

Ligroine : ethyl acetate (2:1)

Ligroine : ethyl acetate (3:1)

Hexane : isopropanol (5:1)

Isopropanol : water (85:15)

The thin layer plates were treated with Godins reagent, AlCl_3 , and naphtoresorcinol and examined using UV light at 254 and 366 nm.

They were also tested for antioxidant acitivity using DPPH and they were finally tested with known sugars to test monosaccharide content.

Reference sugars: arabinose, rhamnose, galactose, xylose, mannose, glucose, glucuronic acid and galacturonic acid.

Gas chromatography specifications:
FID with H₂ and O₂ flame.
Vector gas: helium
Speed: 1,8 ml/min
Injection temperatures: 250-260°C
Detection temperatures: 360-370°C
Column temperature: from 140°C to 300°C
Injected volume: 1µl

Biological test:

Antihypercholesterol effect.

The rabbits were fed leaves from the peanut plant (*Arachis hypogea*). Cholesterol was detected in these plants in preliminary tests using thin layer chromatography with cholesterol as reference substance.

Total cholesterol and HDL-cholesterol were measured and atherogenic index (AI) was calculated (total cholesterol:HDL).

5 groups of rabbits were tested, 4 groups for one month, and one group for 45 days.

The groups received the following:

1. distilled water
2. water decoction (from the extractions with solutions of different polarity).
3. clofibrate (100 mg/kg) for a month
4. cholesterol (400 mg/kg) for two weeks, followed by the ethanol extract (80,32 mg/kg) for a month
5. cholesterol (400 mg/kg) for 6 hours, followed by the ethanol extract for one month.

Results:

From the phytochemical tests the following substances were found:

In the leaves:

Flavanoids, leucoanthocyanins, tannins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 6 and 6,46 %. Ashes insoluble in HCl were 0,78 %, total ash content is 7,69 % and sulphur containing ash was 11,97 % (Table 3.2).

In the residue after decoction:

Flavanoids, leucoanthocyanins, tannins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 6 and 6,82 %. Ashes insoluble in HCl were 0,64 %, total ash content is 7,27 % and sulphur containing ash was 12,04 % (Table 3.2).

The results from the thin layer chromatography showed the presence of polyphenols and flavonoids and coumarins. This confirms the results from the phytochemical tests.

Gas chromatography:

Time from injection to observation of peaks: 35 minutes.

Table 3.1.28.1.a Monosaccharide composition in the water digestion (50 °C) and the decoction

	Digestion		Decoction	
	Quantity	Ratio	Quantity	Ratio
Sugar				
Arabinose	91	13,03	93,5	15,41
Rhamnose	110	16	93,33	15,4
Xylose	32,42	4,6	30,81	5,1
Mannose	-	-	9,41	1,2
Galactose	200	28,7	169,56	28
Glucose	62,5	9	60	9,91
Galacturonic acid	200	28,7	150	24,8
Total	695,93	100 %	606,61	100 %

These results correspond well with the results from the thin layer chromatography.

DPPH tested on thin layer chromatography plates: All extracts showed activity except the hexane, chloroforme and digestion extracts from the extraction with solutions of different polarity. The other extracts had between 2 and 8 active spots.

DPPH in solution:

IC₅₀ was calculated to be 47,7 µg/ml for the methanol extract, 113 µg/ml for the ethanol extract, 58,8 µg/ml for the ethanol extract from the extractions with solutions of different polarity.

Cholesterol tests:

Group 1: increase in total cholesterol and AI and a small decrease in HDL.

Group 2: small increase in total cholesterol and a small decrease in HDL.

Group 3: decrease in both total cholesterol and HDL and increased AI.

Group 4: marked increase in total cholesterol, HDL and AI after 2 weeks of cholesterol treatment. All values decrease after 4 weeks of treatment with the ethanol extract.

Group 5. the results are unclear.

The ethanol extract seems to have good antihypercholesterol properties while the water extract does not seem to be very active.

A search using www.google.com gave 15900 hits and www.PubMed.com gave 61 hits (27.02.2005).

3.1.29 Olacaceae

3.1.29.1 *Ximenia americana* L.

Theses: Kanta (1999) and Samake (2000)

Some traditional uses:

In Senegal, this plant is widely used. Internally, the decoction from the fresh leaves is said to be a good non-toxic remedy against fever. Because of this it is often used to treat

children. It is also used against chest pain, intestinal trouble and against internal worms. A maceration of the roots is part of a leprosy-treatment. It is also used to treat weakness and mental illness.

Externally, the plant is used to treat pain in the head, teeth, ears and eyes. Different preparations made from twigs with leaves, bark or roots. Powdered root combined with *Guiera senegalensis* is said to diminish syphilis chancres. The fresh leaves are used as wound dressing and haemostatic agent (Kerharo and Adam, 1974).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words l (“vaginal discharge and vaginitis”). 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and 10th December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

The leaves from *Ximenia americana* were analyzed. An extract was done with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*. The extract did not have any effect against *E. coli*, but it showed some effect against *C. albicans* at 30 mg/ml. Activity: +, maximum activity is marked with +++.

At 10 mg/ml the ethanol extract of the stem bark gave 1 active product using thin layer chromatography plates combined with the microorganism

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analyzis.

Extraction:

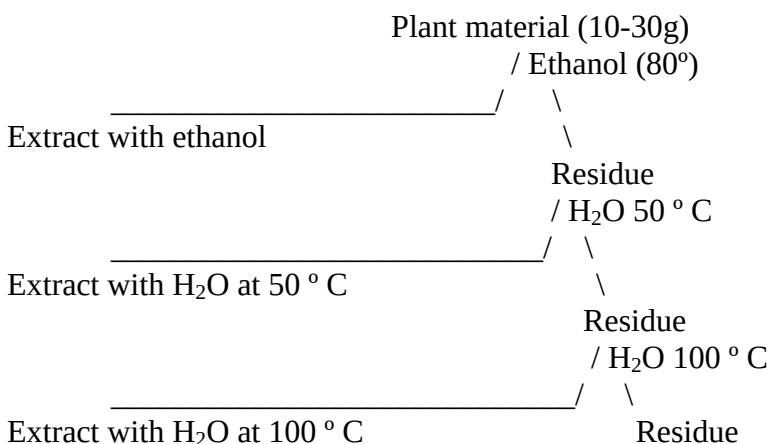


Figure 3.1.29.1.a Extraction with solvents of different polarity

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard here was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.29.1.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
X.a.	Leaves 50°C	+	+	+	0	+	+	+	+	+	40
X.a.	Leaves 100°C	+	+	+	0	+	+	+	+	0	15
X.a.	Root bark 50°C	+	+		0	+	+	+	+	+	< 15
X.a.	Root bark 100°C	+	+	0	0	0	+	+	+	0	45
X.a.	Stem bark 50°C	+	+	+	0	+	+	+	+	+	50
X.a.	Stem bark 100°C	+	+	+	0	+	+	+	+	+	< 15

X.a. = *Ximenia americana*

Table 3.1.29.1.b Amounts of monosaccharides and polysaccharides detected

	Leaves		Root bark		Stem bark	
Monosaccharides	Extract at 50°C	Extract at 100°C	Extract at 50°C	Extract at 100°C	Extract at 50°C	Extract at 100°C
	Sugar ratio (%)	Sugar ratio (%)	Sugar ratio (%)	Sugar ratio (%)	Sugar ratio (%)	Sugar ratio (%)
Arabinose	30	28	54	36	35	27
Rhamnose	11	8	4	2	7	6
Fucose	0	0		0		4
Xylose	2	2	0	0	3	0
Mannose	4	3	0	29	6	2
Galactose	31	15	40	33	26	10
Glucose	6	8	0	0	13	27
Glucuronic acid	1	0	0	0	0	0
Galacturonic acid	15	36	0	0	10	23
Total	100	100	98*	100	100	99*
Polysaccharides content	31 %	48 %	40 %	33 %	5 %	21 %

*The only information available is a summary table – basic data needs to be checked.

All extracts demonstrates good activity on the complement system.

Field work:

N'Tjobougou, 5.2.04

Djokin Diarra:

The eyes are washed with a decoction made from the leaves to treat conjunctivitis.

Bourama Traoré:

The roots are used against inflammation on the chin and knees. Powdered root bark is applied directly on the inflammation. The powder is also applied directly on inflammation of the teeth.

Konimba Traoré:

A decoction of the leaves is used against internal inflammations. The most important case is when the throat is swollen due to throat infection. Breathe in the vapour with a wide open mouth.

N`Pankourou Fané:

Dried and powdered stem bark is dried is mixed with pot ash. This is applied on the inflammation once per day.

Djenfa Koumaré:

The *Loranthus* sp. is used against bad spirit. Crush the *Loranthus* sp. and put it on the fire in the room to remove the bad spirit.

Didieni-region, 6.2.04

Doneke Traore:

Trunk bark powder is mixed with potash and the mixture is used on inflammation.

Diotin Traore:

Power of the roots is mixed with the oil from *B. parkii*. This is used against inflammation.

Balla Sissoko:

Against vaginal discharge: 1 teaspoon of powdered leaves is taken in water

Against asthma: powder made from the root is mixed with water. This is taken once per day.

Konimba Keita:

Make a decoction of the leaves and drink one handful to treat chest pain.

Tietin Coulibaly:

Against inflammation: make a decoction of the leaves, drink a small amount and open the mouth and inhale the vapour while boiling.

Cho Fane:

A decoction of leaves is made and the vapour is inhaled 3 times for men and 4 times for women to treat troath inflammation

Massantola-region, 7.2.04

Sory Diarra:

Powder of the root bark is mixed with hot water and drunk every morning and evening against stomach ache.

Fah Diarra:

Against conjunctivitis: wash the eyes with a decoction of the roots twice a day.

Boua Fomba:

Against dysmenorrhoea; a decoction of roots is drunk morning and evening

Against schistosomiasis: powder of the rootbark is mixed with porridge, coffee or tea and drunk morning and evening.

Soundje Coulibaly:

A decoction of the leaves is drunk against intoxication after snakebite or rabies etc.

N`tiokon Traore:

Powder of the root is mixed with water and drunk, or a decoction can be made. This is used as a tonic.

Soungalo Traore:

Against conjunctivitis: the leaves are macerated and the eyes are washed with the maceration.

N'gogna Coulibaly:

A powder made from the root is mixed with hot water and drunk in the morning before eating to treat stomach ache.

Mariba Coulibaly:

A decoction of leaves is made and one handful is drunk and a bath is taken against convulsions.

Dossere Diarra and Naoba Diabati:

A decoction of the leaves is used for washing the eyes to treat conjunctivitis.

Baba Diarra:

Take powder of the trunk bark and apply it on the inflammation or wound.

Deese Coulibaly:

Against schistosomiasis: a decoction is made of the trunk bark and the fruits of *Tamarindus indica*. This is drunk in the morning and in the evening before going to bed.

H'toriké Coulibaly:

Against conjunctivitis: a decoction of leaves is used for washing the eyes.

Against vaginal discharge: the rootbark is drunk (no method of preparation available here).

N'kodjiri Traoré:

Delirium: a decoction of leaves is drunk and used for a bath.

6 healers use this plant against conjunctivitis while 5 use it against different forms for inflammation. Drissa Diallo believes this plant contains alkaloids. The leaves are the most common plant part used, followed by the stem bark.

For more information about this plant see Aasberg (2001).

3.1.30 Opiliaceae

3.1.30.1 *Opilia celtidifolia* (Guill. et Perr.) Endl. ex Walp.

Thesis: Sangare (2003)

Some traditional uses in Senegal:

The roots are said to have diuretic and purgative properties. They are used to treat leprosy. A 12 hour maceration of branches with leaves, with added salt, is used against

internal worms. A decoction of the branches with leaves is recommended for tooth problems and as a stimulating agent (Kerharo and Adam, 1974). In Dioïla and Dogonland in Mali, the most important uses of this plant are to improve appetite, against internal worms and malaria (Rangjord, 2003).

Sangare (2003)

This author tested different parts of totally 8 plants for activity against *Plasmodium falciparum*. The plants were identified after interviews with several healers in Kendié and Finkolo between January and February 2003. 49 healers were interviewed in Kendié and 30 in Finkolo.

Leaves and bark from *O. celtidifolia* was collected in Blendi in the Sikasso region in May 2003.

Extractions:

50 g plant material + water (500 ml – 1 hour)

/
Decoction

Figure 3.1.30.1.a Decoction

50 g plant material + water or ethanol (80%) (500 ml x 24 hours x 2)

/
Maceration

Figure 3.1.30.1.b Maceration with water or ethanol

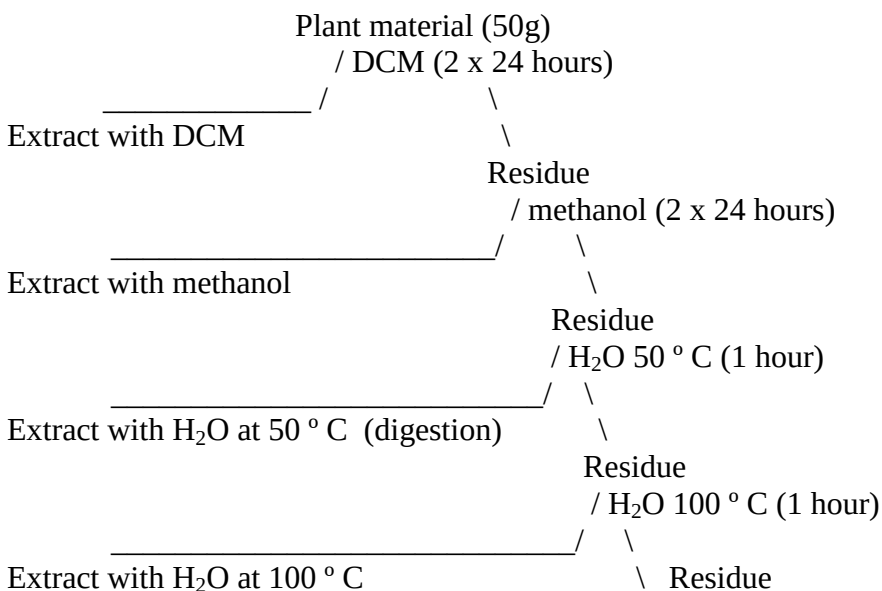


Figure 3.1.30.1.c Extractions with solvents of different polarity.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Activity against *Plasmodium falciparum* (see A.1.2.1).

Thin layer chromatography was performed on some of the decoctions and digestions. Solvent system BAW (60:15:25). The plates were treated with AlCl_3 and Godin's reagent.

Results:

From the phytochemical tests the following substances were found:

Leaves:

Saponins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 6 and 7,02 %. Ashes insoluble in HCl were 4,19 %, total ash content was 11,8 % and sulphur containing ash was 15,56 % (Table 3.2).

Bark:

Anthocyanins, tannins, saponins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 8 and 8,97 %. Ashes insoluble in HCl were 1,74 %, total ash content was 8,03 % and sulphur containing ash was 9,5 % (Table 3.2).

The thin layer chromatography: no results were commented

IC₅₀-concentrations:

Bark:

DCM extract:	6,60 µg/ml
Maceration with water:	7,64 µg/ml
Decoction after digestion:	9,07 µg/ml
Ethanol extract (maceration):	11,16 µg/ml
Decoction:	12,53 µg/ml
Methanol:	13,38 µg/ml
Digestion:	13,46 µg/ml

Leaves:

DCM extract:	4,01 µg/ml
Decoction:	10,92 µg/ml
Ethanol extract (maceration):	10,92 µg/ml
Maceration with water:	11,01 µg/ml
Digestion:	12,28 µg/ml
Methanol:	14,23 µg/ml
Decoction after digestion:	15,09 µg/ml

Chloroquine: 0,05 µg/ml (reference substance)

Field work:**N`Tjobougou, 5.2.04.**

Djokin Diarra:

Leaves and roots are used against malaria. A decoction is made of the leaves. This is drunk and also used for taking a bath. Both dry and fresh leaves are used. If dizziness occurs in connection with malaria, use the leaves of *Tamarindus indica* in the same decoction. The roots are also used to make a decoction. This is drunk and used as a bath. About 400 ml is drunk every day. If the patient has been ill for more than a week, divide the portion to be taken twice per day. The treatment lasts one week.

Bourama Traoré:

The leaves are used against malaria. Make a decoction and mix it with the powder of millet, then drink it. The roots are used in a decoction against internal worms, especially teniasis, the 5-6-meter long worm that people can get if they eat pork.

Konimba Traoré:

A decoction is made of the leaves and is used against “Calia” (a type of inflammation). Drink it once per day.

N`Pankourou Fané:

The leaves are used against malaria. A decoction is made, and is both drunk and used for a bath. This is done twice per day. The same preparation is used against stomach ache.

Didieni-district, 6.2.04

Doneke Traore:

A decoction of stem and leaves is used against fever. Take one bath per day and drink about 75 ml in the morning and the evening.

Diotin Traore:

A decoction of stem and leaves is drunk and used for a bath against stomach ache.

Balla Sissoko:

Against stomach ache: a decoction of the leaves is mixed with powder of millet and drunk.

Konimba Keita:

Against stomach ache: make a decoction of the leaves and drink this once.

Tietin Coulibaly:

Against malaria: a decoction of the stem and leaves is used for a bath and is also drunk.

Cho Fane:

Powder of the leaves is mixed with water and this is drunk in the morning and the evening to treat stomach ache.

Massantola-region, 7.2.04

Sory Diarra:

Used against internal worms. Powder of leaves and stem is mix with milk and drunk in the morning. This is said to be especially effective against teniasis.

Fah Diarra:

Against constipation: a decoction of leaves and stem is drunk.

Boua Fomba:

A decoction of the leaves is drunk to treat ishias and neurological pain.

Soundje Coulibaly:

A decoction of the leaves is drunk against heart failure.

N`tiokon Traore:

Against teniasis: a decoction of leaves and stem bark is drunk.

Soungalo Traore:

Against vaginal discharge: a decoction of fresh leaves is drunk.

Against haemorrhoids: macerate fresh leaves and drink the macerate.

N`gogna Coulibaly:

A decoction is made of the leaves and the stem. This is drunk a little at the time against internal worms

Dossere Diarra:

Against inflammation: a decoction of stem and leaves is used. Take a vapour bath and drink the decoction.

Naoba Diabati:

Against schistosomiasis: fresh leaves are pound, mixed with porridge and drunk.

Baba Diarra:

A tea glass of a decoction of the leaves is drunk in the morning and the evening to treat stomach ache.

Deese Coulibaly:

Againts pain in the nerves: a decoction is made of the leaves and the stem bark and mixed with butter of *B.parkii*. The mixture is applied on the nerves.

H`toriké Coulibaly:

Used as a tonic: a decoction of the leaves is drunk.

N`kodjiri Traoré:

A decoction of trunk bark or roots is used to treat anxiety. One teaglass is drunk 3 times a day, and the decoction is also used as a bath.

The most common part of the plant used is the leaves, followed by the stem bark. 5 healers use this plant against malaria or fever, while 8 healers use it against stomach ache or internal worms. 2 healers do not use this plant.

Rangjord (2003) studied the structure and activity of polysaccharides from the leaves of *O. celtidifolia*.

For more information about this plant see Aasberg (2001).

3.1.31 Oxalidaceae

3.1.31.1 *Biophytum petersianum* Klotzsch

Theses: Kanta (1999) and Samake (2000)

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*, These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words “vaginal discharge and vaginitis”. 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and 10th December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

Leaves from *Biophytum petersianum* were analyzed. An extract was done with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*. The extract did not have any effect against *E. coli*, but it did show some effect against *C. albicans* at 30 mg/ml. Activity: ++, maximum activity is marked with +++.

At 10 mg/ml the ethanol extract of the leaves gave 3 active products using thin layer chromatography plates combined with the microorganism.

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analysis.

Extraction:

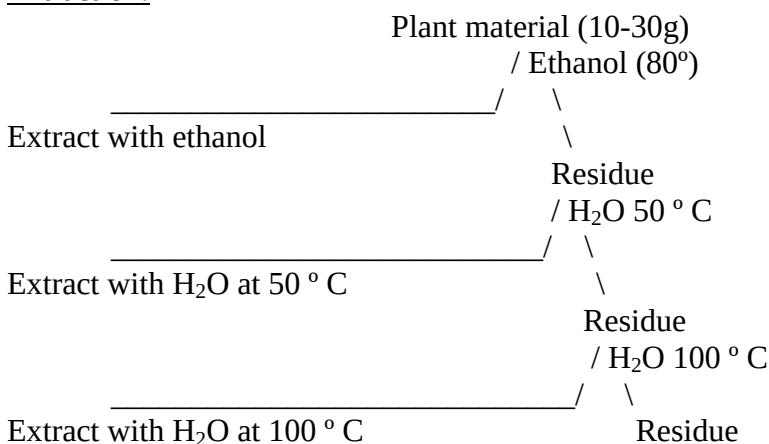


Figure 3.1.31.1.a Extraction with solvents of different polarity

A dialysis was performed on all solutions, followed by lyophilization.

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard here was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.31.1.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
B.p. 50°C	Aerial parts	+	?	+	0	0	+	+	+	0	< 15
B.p. 100°C	Aerial parts	+	+	+	0	+	+	+	+	0	< 15

B.p. = *Biophytum petersianum*

Gas chromatography:

Table 3.1.31.1.b Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C		Extract at 100°C	
	Sugar ratio (%)	Test substance ratio (%)	Sugar ratio (%)	Test substance ratio (%)
Arabinose	30	8	26	12
Rhamnose	8	2	10	5
Xylose			9	4
Mannose			2	1
Galactose	29	7	17	8
Glucose	9	2	9	4
Galacturonic acid	24	5	27	12
Total	100	4	100	46
Polysaccharide content	25 %		46%	

Field work:

N`Tjobougou, 5.2.04.

Djenfa Koumaré:

A decoction of the aerial part is used against stomach ache in children. This stomach ache may be caused by internal wounds OR WORMS???

The aerial part and salt are used for preparation of a decoction. 1 teaspoon is given morning and evening against cough.

Didieni-region, 6.2.04

Tietin Coulibaly:

Against malaria: a decoction of the aerial part is drunk and used to take a bath. This is said to be used especially for children

Massantola-region, 7.2.04

Sory Diarra:

Against bad spirit, mainly fever. Powder of the aerial part is mixed with water, drunk and used for a bath. This is done once per day and is said to be used especially for children.

Fah Diarra:

Against malaria: fresh leaves are mixed with water. Wash the body with this and drink it once a day. This is said to be used especially for babies.

N`tiokon Traore:

Against fever: powder of the aerial part is mixed with water and the body is washed with this.

Soungalo Traore:

Against malaria: powder of the aerial part is mixed with water and drunk. Another part is mixed with the oil of *B. parkii* and applied on the body.

N'gogna Coulibaly:

Against stomach ache: a decoction of the aerial part is drunk.

Baba Diarra:

Against malaria. 2 fingers of powder is mixed with hot water and drunk.

N'kodjiri Traoré:

Against stomach ache: a decoction of the aerial part is drunk in the morning and the evening.

3 healers use the aerial parts of the plant against stomach ache, especially for children.

4 healers use this plant to treat malaria, and two use it to treat fever.

One of the healers uses this plant against cough.

16 of the interviewed healers did not use this plant.

A search using www.google.com gave 81 hits while www.PubMed.com gave 0 hits (03.04.2005).

3.1.32 Papaveraceae

3.1.32.1 *Argemone mexicana* L.

Thesis: Sangare (2003)

Some traditional uses:

In Senegal, this plant is known for its calming, diuretic, cholagogue and wound healing properties. A decoction from the leaves is drunk to treat stomach aches and used in baths to treat muscular pain. The latex is considered a good wound dressing and is also used against dermatitis. A maceration of the roots is used to treat vaginal discharge and hepato-biliary problems.

The plant is known to be toxic for animals, and it might cause death due to intestinal bleeding. This is thought to be caused by the latex and the seeds. Because of this, the plant is only used by healers (Kerharo and Adam, 1974).

Sangare (2003)

This author tested different parts of totally 8 plants for activity against *Plasmodium falciparum*. The plants were identified after interviews with several healers in Kendié and Finkolo between January and February 2003. 49 healers were interviewed in Kendié and 30 in Finkolo.

Leaves from *A. mexicana* were collected in Blendi in the Sikasso region in May 2003.

Extractions:

50 g plant material + water (500 ml – 1 hour)

/
Decoction

Figure 3.1.32.1.a Decoction

50 g plant material + water (500 ml x 24 hours x 3)

/
Water maceration

Figure 3.1.32.1.b Maceration with water

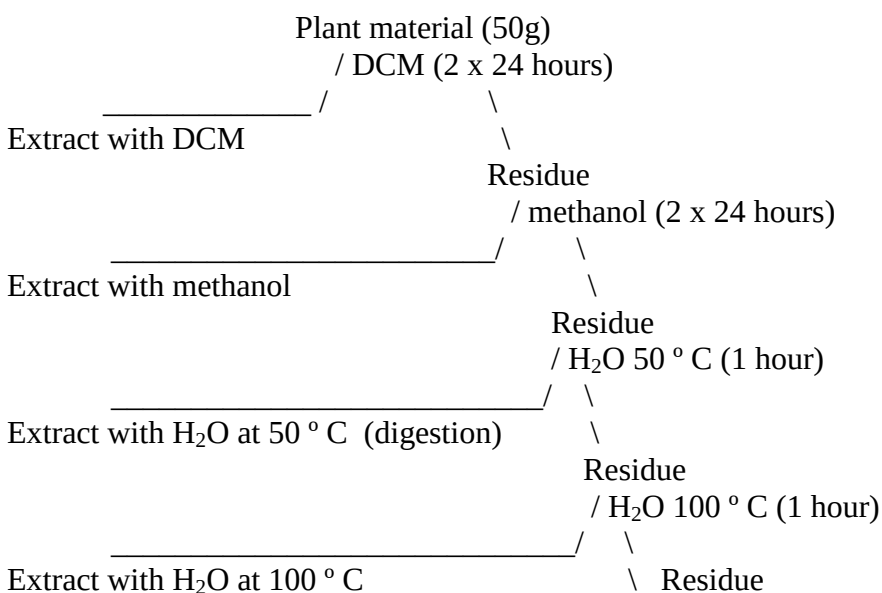


Figure 3.1.32.1.c Extraction with solvents of different polarity.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Activity against *Plasmodium falciparum*.

Thin layer chromatography was performed on some of the decoctions and digestions. Solvent system BAW (60:15:25). The plates were treated with AlCl₃ and Godin's reagent.

Results:

From the phytochemical tests the following substances were found:

Flavanoids, alkaloids (2,7 %), tannins, cardiac glycosides, sterols and/or triterpenes, anthraquinones, coumarins, benzoquinones, reducing compounds, mono- and

polysaccharides and mucilages. The content of water was between 7 and 7,78 %. Ashes insoluble in HCl were 2,98 %, total ash content was 12,98 % and sulphur containing ash was 12,98 % (Table 3.2).

Several spots were detected by the thin layer chromatography showed two spots, but no conclusions are drawn.

IC₅₀-concentrations:

Methanol extract:	1,00 µg/ml	
DCM extract:	1,22 µg/ml	
Decoction:	5,89 µg/ml	
Maceration with water:	6,22 µg/ml	
Chloroquine:	0,05 µg/ml	(reference substance)

A search using www.google.com gave 10500 hits and www.PubMed.com gave 51 hits (27.02.2005).

3.1.33 Papilionaceae

3.1.33.1 *Swartzia madagascariensis* Desv

Thesis: Fane (2002)

The author interviewed 110 healers in the Bamako district; 50 men and 60 women. Most were in the age group between 40-70 years. They were asked to name known toxic plants, the use of these plants, toxic effects and possible anti-dotes.

Maiga et al (2004) did a literature research of the 19 most cited plants.

Phytochemical tests (A.1.1) were performed on 5 of these plants and, further biological tests were performed on 3 plants: *Vernonia colorata*, *Afrormosia laxiflora* (3.1.21.1) and *Cassia siberiana* (3.1.12.4). The plants were chosen from both the results from the interviews, but also from the literature about the plants. (See also tables 3.1.7.1.a and 3.1.7.1.b).

Root bark from *Swartzia madagascariensis* was bought at the market in Magnambougou in July 2002.

Results:

From the phytochemical tests the following substances were found:

Alkaloids (0,14 %), flavonoids, leucanthocyans, tannins, saponins, cardiac glycoside, sterol and/or triterpenes, coumarins, anthraquinones, carotenoids, reducing compounds, mono- and polysaccharides, mucilages and tetrahydrocannabinols.

The content of water was between 7,02 and 8 %. Ashes insoluble in HCl were 5,87 %, total ash content was 2,897 % and sulphur containing ash was 4,79 % (Table 3.2).

A search using www.google.com gave 487 hits and www.PubMed.com gave 8 hits (27.02.2005). This plant will not be discussed further in this thesis.

For more information about this plant see Maiga et al (2004).

3.1.34 Poaceae

3.1.34.1 *Zea mays* L.

Some traditional uses:

In Senegal, this plant is most known for its use in preparation of food.

Mays flour mixed with roots from *Securinega virosa* and bark from *Vernonia colorata* is used against schistosomiasis. It is used in other combinations against ascites, vaginal discharge and leprosy (Kerharo and Adam, 1974).

Field work:

N'Tjobougou, 5.2.04

Djenfa Koumarè uses the seeds from this plant to treat black dermatosis. The seeds are carbonized, mixed with the butter of *Butyrospermum parkii* and applied on the dermatosis once per day.

This plant will not be discussed further in this thesis.

A search using www.google.com gave 293000 hits and www.PubMed.com gave 12269 hits (27.02.2005).

3.1.35 Polygalaceae

3.1.35.1 *Securidaca longepedunculata* Fres.

Theses: Sangare (2003) and Tolo (2002)

Some traditional uses in Senegal:

The roots are used both internally and externally to treat snake bites. The roots have a characteristic smell that is believed to repel snakes. The roots are also used against intestinal parasites, and the powdered root is taken in the nose to treat migraine and diluted in water to start child delivery. A decoction is used internally and externally to treat bronchitis, stomach ache, leprosy, sexually transmitted diseases and fever. The leaves are sometimes used in the same ways.

The plant is used externally to treat rheumatism, wounds and skin worms.

As this plant is known to have emetic properties, internal preparations are carefully prepared and sometimes filtrated before administration.

The bark is used in combination with *Calotropis procera* as arrow poison (Kerharo and Adam, 1974).

Sangare (2003):

This author tested different parts of 8 plants for activity against *Plasmodium falciparum*. The plants were identified after interviews with several healers in Kendié and Finkolo between January and February 2003. 49 healers were interviewed in Kendié and 30 in Finkolo. Roots from *S. longepedunculata* were analyzed.

Extractions:

These were made by Bagayoko (2002). The following extracts were identified from the results in Sangares thesis:

- Petrol ether extract
- DCM extract
- Maceration I
- Decoction I
- Methanol extract
- Ethyl acetate
- Decoction II
- Maceration II
- Buthanol

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT by Bagayoko (2001). Results are not available.

Activity against *Plasmodium falciparum*.

Results:

IC₅₀-concentrations:

Petrol ether extract:	7,34 µg/ml
DCM extract:	8,26 µg/ml
Maceration I (water):	10,75 µg/ml
Decoction I:	11,05 µg/ml
Methanol extract:	11,37 µg/ml
Ethyl acetate:	12,07 µg/ml
Decoction II:	15,15 µg/ml
Maceration II:	16,30 µg/ml
Buthanol:	18,28 µg/ml

Chloroquine: 0,05 µg/ml (reference substance)

Tolo (2002):

Root bark from this plant has traditionally been used to treat different tooth and mouth diseases, in an ITM in combination with *Fagara zanthoxyloides* and *Mangifera indica*. Roots were collected in Tienfala in November 2001, they were peeled and the bark was dried and pulverized before analyzis.

Extractions:

250 g plant material + water (2500 ml – 1 hour)

/

Decoction

The decoction was added a few drops of octanol to reduce the amount of foam coming from the saponines.

Figure 3.1.35.1.a Decoction

50 g plant material + water (500 ml x 24 hours x 3)

/

Water maceration

Figure 3.1.35.1.b Maceration

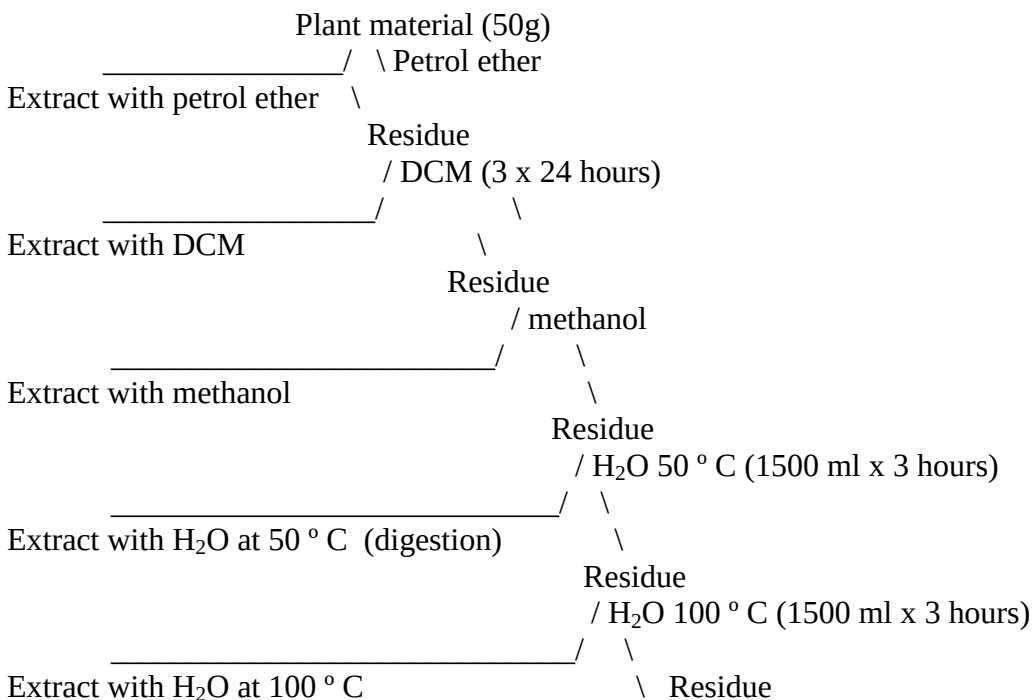


Figure 3.1.35.1.c Extractions with solvents of different polarity.

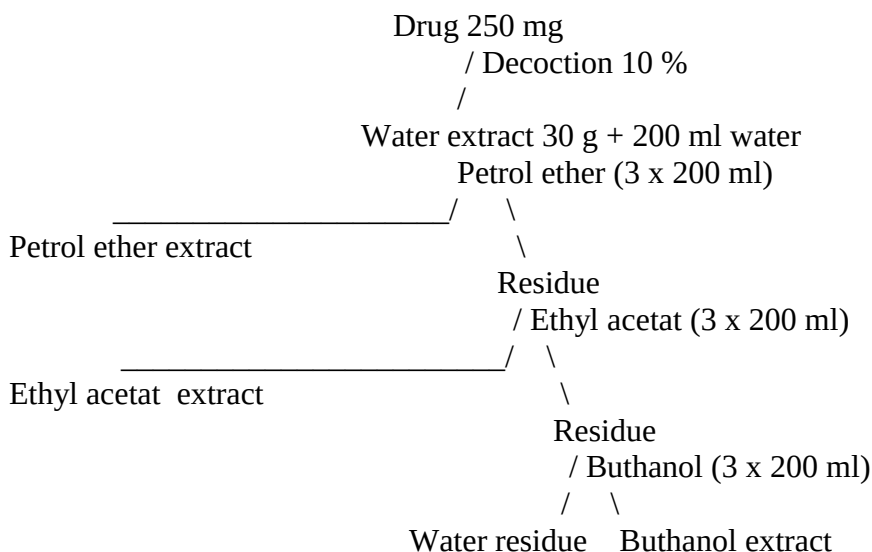


Figure 3.1.35.1.d Liquid-liquid extraction

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography was performed using the following solvent systems:

For the polar extracts: Butanol – acetic acid – water (60:15:25)

For the organic extracts: Ligroin – ethyl acetate (2:1)

The plates were treated with Godin's reagents and examined using UV light at 254 and 366 nm.

Antioxidant activity using DPPH combined with the thin layer plates.

Biological test (see A.1.2.1):

Antifungal activity.

Different tests on haemolytic activity (see results).

Analgetic activity – “Hot plate” and “Writhing test”

Acute anti-inflammatory activity.

Acute toxicity of both oral and intraperitoneal administration.

LD₅₀ was found using Trevan's curve.

Mice of the strain Oncins France Souche 1 were used in all test. They had a body weight between 19 and 25 g.

Results:

From the phytochemical tests the following substances were found:

Alkaloids (0,2 %), flavanoids, leucoanthocyan, tannins, saponins (abundant), cardiac glycosides, sterols and/or triterpenes, coumarins, carotenoids, reducing compounds, mono- and polysaccharides, mucilages.

The content of water was between 5,45 and 6 %. Ashes insoluble in HCl were 4,8 %, total ash content is 4,86 % and sulphur containing ash was 5,26 % (Table 3.2).

Thin layer chromatography showed the presence of coumarins, flavonoids and saponines. This corresponds well with the results from the phytochemical tests.

The organic extracts showed best antioxidant activity with a maximum of 4 spots in the ethyl acetate extract, followed by 3 spots in the methanol and butanol extracts.

Antifungal activity: one spot was detected in the water maceration and one in the petrol ether extract.

Haemolytic test: no clear results were found from the polar extracts. From both petrol ether extract and the DCM extract, one spot was observed. This spot seems to correspond with the saponine spot detected from the thin layer chromatography.

Haemostatic tests:

Figure 3.1.35.1.a Results from haemostatic tests

Extracts	Coagulation time for blood (minutes)							
	Tube	Drop	Tube	Drop	Tube	Drop	Tube	Drop
Tested amount	10 µl		25 µl		50 µl		100 µl	
Negative control	10,45	17	10,45	17	10,45	17	10,45	17
Decoction	7 (33%)	9 (47%)	11	14 (17%)	12	18	13	---
Petrol ether (from liquid-liquid separation)	7,30 (30%)	10,35 (39%)	7 (33%)	---	15	---	---	---
Ethyl acetate	7 (33%)	10,20	7,35 (29%)	---	10	---	13	---
Butanol	10,7	12 (29%)	11,5	16 (5%)	11,30	---	20,5	---

Test on coagulation time of milk:

The decoction gave a positive reaction. This might be caused by the presence of tannins.

Toxicity:

Table 3.1.35.1.b Results from oral administration

Dose (mg/kg)	Number of animals	Number of dead animals	% dead animals
750	6	0	0
1500	6	2	33,33
3000	6	5	83,33
4500	6	4	66,67
6750	6	6	100

LD₅₀ = 538 ± 164 mg/kg. This corresponds to 2,00 ± 0,61 g/kg of the dried plant material.

Table 3.1.35.1.c Results from peritoneal administration

Dose (mg/kg)	Number of animals	Number of dead animals	% dead animals
16,65	6	0	0
25	6	1	16,67
37,5	6	2	33,33
56,25	6	3	50
70,31	6	6	100

LD₅₀ = 56,25 ± 5,47 mg/kg. This corresponds to 209 ± 0,02 g/kg of the dried plant material.

Tests on analgetic activity:

Table 3.1.35.1.d Results from Hot-plate tests

Tested substance	Dose (ml or mg/kg)	Before administration	After administration. Reaksjonstid i sekunder og % vis økning i reaksjonstid			
			30 min	60 min	90 min	120 min
Vann	25	7,35 ± 1,63	3,24±1,20	5,17±0,06	7,55±3,20	3,78±1,89
<i>Securidaca longepedunculata</i>	1000	3,45 ± 0,61	2,61±1,47	2,77±1,16	2,89±1,35	2,11±1,04
Tramadol	5	4,17 ± 0,81	18,3±4,2 338,84 %	24,67±4,70 491,6 %	22,18±6,49 431,89 %	9,88±3,79 136,93 %

The tested extracts showed no analgetic activity compared to Tramadol. On the contrary it seems to have worse analgetic activity then the negative control (water). The author thinks this might be caused by the content of saponins.

Table 3.1.35.1.e Results from “Writhing” tests

Tested substance	Dose ml or mg/kg	Number of torsions – mean and sd.	% protection
Distilled water	25	71,17 ± 6,49	---
S.l. extract	250	32,00 ± 8,03	55,04
S.l. extract	500	45,00 ± 6,96	36,77
S.l. extract	1000	35,00 ± 8,62	50,80
Indometacin 25 mg	5	33,67 ± 3,50	52,69
Tramadol	5	30,50 ± 6,71	57,14

S.l. = *Securidaca lonepedunculata*

Anti-inflammatory tests:

Table 3.1.35.1.f Immediate anti-inflammatory activity

Tested substance	Dose ml or mg/kg	Right foot – left foot (mean and sd)	% inhibition
Distilled water	25	0,111 ± 0,012	---
S.l. extract	250	0,092 ± 0,012**	16,84
S.l. extract	500	0,087 ± 0,025**	21,35
S.l. extract	1000	0,091 ± 0,011**	18,35
ASA	100	0,074 ± 0,010**	33,53
Indometacin	5	0,089 ± 0,013**	19,40

** P < 0,01 – Student t test.

Table 3.1.35.1.f Prolonged anti-inflammatory activity

Tested substance	Dose ml or mg/kg	1 hour after injection	3 hours after injection	5 hours after injection
Distilled water	25	0,093 ± 0,134	0,111 ± 0,012	0,091 ± 0,007
S.l.	1000	0,066 ± 0,010 (28,42 %)	0,091 ± 0,011 (18,35 %)	0,078 ± 0,011 (14,60 %)

The organic extracts from the roots demonstrate the strongest activity against *Plasmodium falciparum*. They also have the largest number of antioxidant substances.

The tested extracts are toxic for mice.

The anti-inflammatory effects are comparable to indometacin and seem to be dose dependent.

For more information about this plant see Aasberg (2001)

3.1.36 Rhamnaceae

3.1.36.1 *Zizyphus mauritiana* Lam.

Theses: Ouologuem (1999) and Yansambou (2002)

Some traditional uses in Senegal:

The roots are used to treat sexually transmitted diseases, while the bark is used against stomach ache. This plant is often used in combination with other plants to treat syphilis, poisoning and indigestion.

The bark is used alone or combined with other plants to treat stomach ache, rickets, weight loss and powdered to treat *post-partum* bleeding (Kerharo and Adam, 1974).

Ouologuem (1999)

This author tested the larvicidal effects of different extracts of 11 Malian plants. Larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were used. 6 of the plants were tested on both species, while 5 were only tested on *C. quinquefasciatus*.

Larvae from *Culex quinquefasciatus* were collected in N'Tomikorobougou and Darsalam, in the Bamako district.

Pre-made extracts were used. Water, acetone and ether extracts from *Z. mauritiana* roots were tested.

Tests:

Tests on larvae from *Culex quinquefasciatus* were done on 5,5 mg extract dissolved in 110 µl of a suitable solvent; water for the water and ethanol extracts and dimethylsulfoxide (DMSO) for the methanol, ether and DCM-extracts. The tests were performed on 5x20 larvae, and larvae that had fallen to the bottom of the tubes or were immobile were considered dead.

Results:

Larvicidal test:

Table 3.1.36.1.a *Culex quinquefasciatus* - % deaths at 500 ppm

Time of exposure	Plant extract		
	Z.m. H ₂ O	Z.m. Acetone	Z.m. Ether
30 minutes	0	10	0
1 hour	5	10	0
24 hours	15	90	15

Z.m. = *Zizyphus mauritiana*.

Yansambou (2002):

This plant has traditionally been used in the treatment of diabetes

Leaves from *Z. mauritiana* were collected in Blendio in the Sikasso region the 17th November 2001. Root bark was bought from healers in Médine. All plant parts were dried and pulverized before analysis.

Extractions:

250 g plant material + water (2500 ml – 3 hours)

/

Decoction

Figure 3.1.36.1.a Decoction

250 g plant material + water (2500 ml – 3 hours at 50°C)

/

Water digestion

Figure 3.1.36.1.b Digestion

50 g plant material + water (500 ml x 24 hours x 3)

/

Water maceration

Figure 3.1.36.1.b Maceration

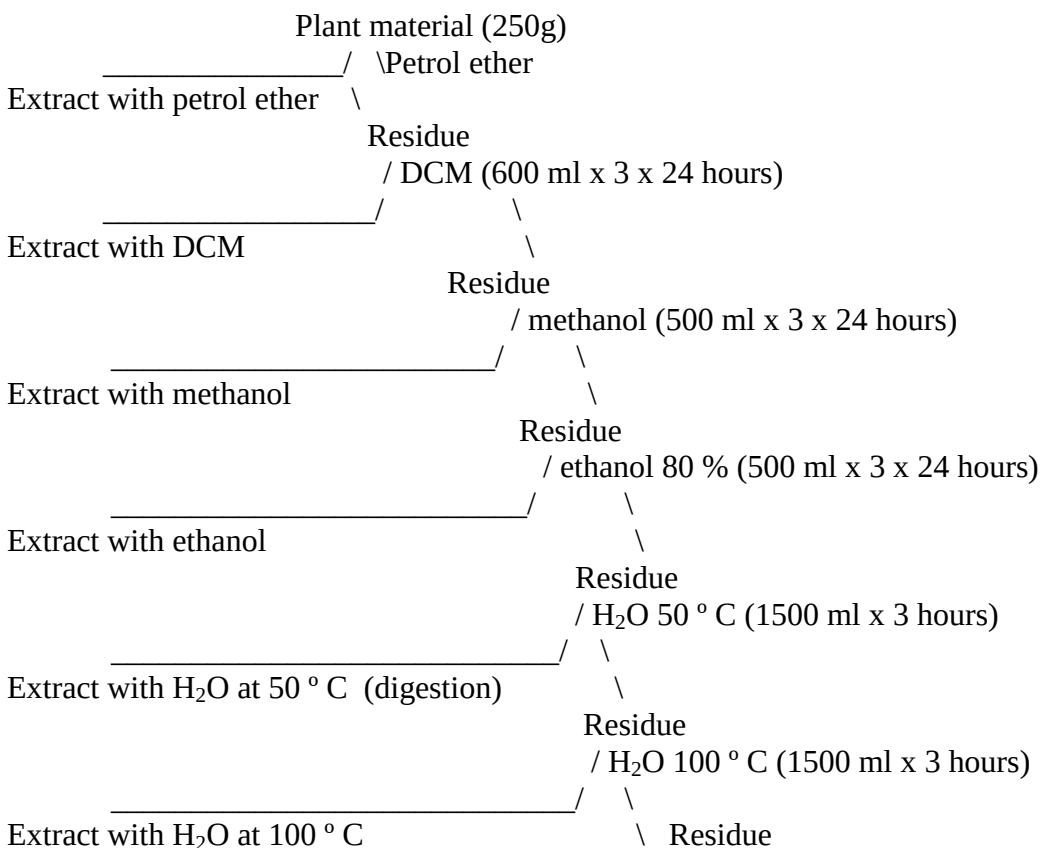


Figure 3.1.36.1.c Extraction with solvents of different polarity.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Thin layer chromatography:

Reagents used were Godin's, AlCl_3 and Dragendorff.

Gas chromatography:

Injected volume - 1 μl .

Carrier gas – helium.

Temperature program: 140 °C – 170 °C – 250 °C – 300 °C

Hypoglycemic activity. Rabbits between 1,5 and 2,250 kg of both sexes were used. Groups of 5 and 5 rabbits were tested.

Results:

From the phytochemical tests the following substances were found:

Leaves:

Flavanoids, leucoanthocyanins, tannins, saponins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 7,28 and 8 %. Ashes insoluble in HCl were 7,62 %, total ash content is 7,53 % and sulphur containing ash was 11,67 % (Table 3.2).

Root bark:

Flavanoids, leucoanthocyanins, tannins, saponins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds and mono- and polysaccharides. The content of water was between 5,87 and 6,66 %. Ashes insoluble in HCl were 6,47 %, total ash content is 11,89 % and sulphur containing ash was 13,04 % (Table 3.2).

Thin layer chromatography shows spots corresponding to flavonoids, sterols and/or triterpenes and polyphenolic compounds. This corresponds well with the results from the phytochemical tests.

Gas chromatography:

The following sugars were detected in the water extracts made from the leaves: arabinose, rhamnose, xylose, mannose, galactose, glucose, glucuronic acid and galacturonic acid.

The decoction from the stem bark contained: arabinose, rhamnose and glucose.

Hypoglycemic activity:

Different extract were tested at different concentrations and times.

Table 3.1.36.1.b % inhibition of decoction (leaves)

	% inhibition			
Dose / Time (minutes)	T ₃₀	T ₉₀	T ₁₂₀	T ₁₈₀
100 mg/kg	12,01	7,6	2,97	5,2
150 mg/kg	22,04	16,36	20,06	22,31
200 mg/kg	28,74	23,75	24,54	27,44
Metformin 22,1 mg/kg	22,64	32,64	16,81	17,43

Table 3.1.36.1.c % inhibition of digestion

	% inhibition			
Dose / Time (minutes)	T ₃₀	T ₉₀	T ₁₂₀	T ₁₈₀
100 mg/kg	10,11	6	-	-
150 mg/kg	17,33	19,83	-	-
Metformin 22,1 mg/kg	22,64	32,64	-	-

Table 3.1.36.1.d % inhibition of decoction (after extraction with other solvents)

	% inhibition			
Dose / Time (minutes)	T ₃₀	T ₉₀	T ₁₂₀	T ₁₈₀
100 mg/kg	26	14,30	1,32	-
150 mg/kg	32,42	19,72	23,60	18,27
200 mg/kg	32,10	34,48	26,10	29,27
Metformin 22,1 mg/kg	22,64	32,64	16,81	17,43

Table 3.1.36.1.e % inhibition of digestion (after extraction with other solvents)

	% inhibition			
Dose / Time (minutes)	T ₃₀	T ₉₀	T ₁₂₀	T ₁₈₀
100 mg/kg	9,8	3,96	1,03	5,24
200 mg/kg	14,28	10,26	2,08	10,66
Metformin 22,1 mg/kg	22,64	32,64	16,81	17,43

Table 3.1.36.1.f % inhibition of maceration

	% inhibition			
Dose / Time (minutes)	T ₃₀	T ₉₀	T ₁₂₀	T ₁₈₀
100 mg/kg	46,71	30,34	33,48	19,12
150 mg/kg	56,02	35,46	38,49	41,96
Metformin 22,1 mg/kg	22,64	32,64	16,81	17,43

Table 3.1.36.1.g % inhibition of methanol extract

	% inhibition			
Dose / Time (minutes)	T ₃₀	T ₉₀	T ₁₂₀	T ₁₈₀
50 mg/kg	9,46	4,5	2,35	5,86
75 mg/kg	13,46	21,23	9,39	10,08
100 mg/kg	30,18	38,56	25,51	24,02
Metformin 22,1 mg/kg	22,64	32,64	16,81	17,43

Table 3.1.36.1.h % inhibition of ethanol extract

	% inhibition			
Dose / Time (minutes)	T ₃₀	T ₉₀	T ₁₂₀	T ₁₈₀
50 mg/kg	1,76	4,73	-	1,85
75 mg/kg	32,10	40,59	28,33	33,50
100 mg/kg	51,20	45,29	34,07	43,30
Metformin 22,1 mg/kg	22,64	32,64	16,81	17,43

Table 3.1.36.1.i % inhibition of decoction (root bark)

	% inhibition			
Dose / Time (minutes)	T ₃₀	T ₉₀	T ₁₂₀	T ₁₈₀
100 mg/kg	-	7,58	13,80	18,68
200 mg/kg	7,9	18,04	10,61	21,32
Metformin 22,1 mg/kg	-	13,23	10,26	18,87

Positive effects on diabetes:

- Flavonoids have antioxidant activity and can prevent atherosclerosis, a common complication in diabetics.
- Tannins are important for wound healing

The water extracts contained large amount of mucliages that made the analysis difficult to perform. These mucilages might have a role similar to *Aloe spp.* in wound healing, but this has to be studied further.

Several of the extract show a good hypoglycemic activity compared to metformin. The activity is prolonged and dose-dependent.

A search using www.google.com gave 919 hits while www.PubMed.com gave 3 hits (27.02.2005).

3.1.36.2 *Zizyphus mucronata* Willd.

Thesis: Ba (1998)

Some traditional uses:

In Senegal this plant is mainly used to treat diseases in the urinary tract system. The fruits and grains are used against enuresis. A maceration done for 48 hours of crushed fruits with grains or just of the grains is used in almost all cases of urinary incontinence. The roots are said to be very diuretic and they are used against hematuries (usually caused by schistosomiasis), gonococcies, oliguria and dysuria. Other rarer indications are against Hansen's disease, syphilis, internal worms and even some mental diseases (Kerharo and Adam, 1974).

Ba (1998)

This author studied 6 plants traditionally used as "fishing poison" or used as insecticides in cultivation of cereals, to determine the chemical composition and molluscicidal activity of these plants. This was done to find plants that may be used in the prevention of schistosomiasis, by killing the molluscs that act as intermediate hosts.

Molluscs were collected in Djikoroni Woyowayemko and N'Gomidjirambougou. The species used were *Bulinus truncatus* and *Biomphalaria pfeifferi*. Groups of 6 snails were used in all tests.

The plant material was found in storage at DMT the 4th of March 1997. The leaves and "tubercules" were tested, and they were dried and pulverized before analysis.

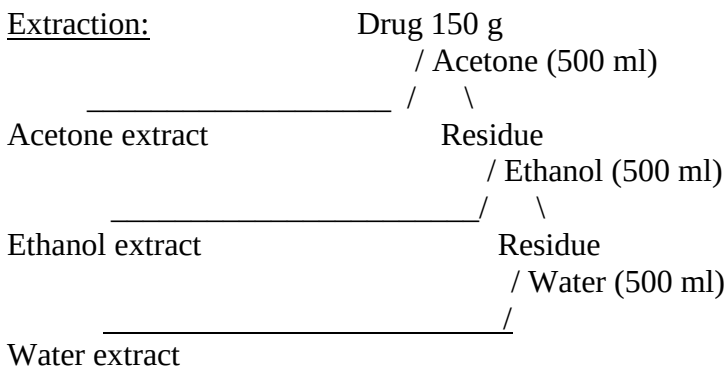


Figure 3.1.36.2.a Extraction with solvents of different polarity

A juice was obtained by pressing 1248 grams of young branches with leaves under a pressure of 200 bars. 148 ml juice was obtained. It was concentrated using a rotvapor at 50 °C.

Tests:

Standard phytochemical tests (A.1.1) were performed on the leaves at DMT.

Molluscicidal activity was tested on extracts from leaves and the juice at concentrations between 0,025 mg/ml to 40 mg/ml.

Results:

From the phytochemical tests performed at DMT the following substances were found: Flavanoids, leucoanthocyanins, tannins, saponins, cyanogenic glycosides, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 6,77 and 7 %. Ashes insoluble in HCl were 6,16 %, total ash content is 10,14 % and sulphur containing ash was 13,05 % (Table 3.2).

Molluscicidal activity:

Only the acetone extract and the juice showed activity. A concentration of 0,05 mg/ml of the acetone extract and 0,1 mg/ml of the juice gave 100 % deaths for *Biomphalaria pfeifferi*, and 0,1 mg/ml of the acetone extract and 0,1 mg/ml of the juice gave 100 % deaths for *Bulinus truncatus*.

A search using www.google.com gave 129 hits and www.PubMed.com gave 4 hits (27.02.2005).

3.1.37 Rubiaceae

3.1.37.1 *Canthium acutiflorum* Hiern.

Thesis: Sangare (2003)

This author tested different parts of 8 plants for activity against *Plasmodium falciparum*. The plants were identified after interviews with several healers in Kendié and Finkolo between January and February 2003. 49 healers were interviewed in Kendié and 30 in Finkolo.

Leaves and bark from *C. acutiflorum* was collected in Blendi in the Sikasso region in May 2003.

Extractions:

50 g plant material + water (500 ml – 1 hour)

/

Decoction

Figure 3.1.37.1.a Decoction

50 g plant material + water (500 ml x 24 hours x 3)

/

Water maceration

Figure 3.1.37.1.b Maceration with water

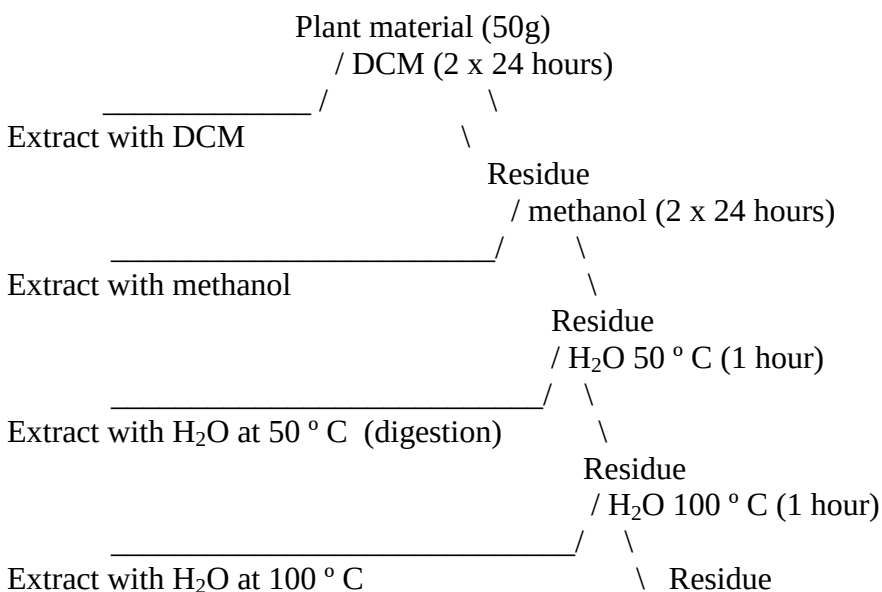


Figure 3.1.37.1.c Extractions with solvents of different polarity.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Activity against *Plasmodium falciparum* (see A.1.2.1).

Thin layer chromatography was performed on some of the decoctions and digestions. Solvent system BAW (60:15:25). The plates were treated with AlCl₃ and Godin's reagent.

Results:

From the phytochemical tests the following substances were found:

Leaves:

Alkaloids, flavanoids, anthocyanins, tannins, saponins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 4,14 and 5 %. Ashes insoluble in HCl were 0,42 %, total ash content was 3,11 % and sulphur containing ash was 2,51 % (Table 3.2).

Bark:

Flavanoids, saponins, cardiac glycosides, anthraquinones, benzoquinones, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 7 and 8,54 %. Ashes insoluble in HCl were 1,5 %, total ash content was 4,05 % and sulphur containing ash was 4,02 % (Table 3.2).

Both extracts show several spots from the thin layer chromatography. Some of the spots indicates the presence of flavonoids.

IC₅₀-concentrations:

Bark:

DCM extract:	6,92 µg/ml
Decoction:	9,73 µg/ml
Maceration with water:	12,01 µg/ml
Methanol extract:	12,19 µg/ml

Leaves:

DCM extract:	5,27 µg/ml
Maceration with water:	8,09 µg/ml
Decoction:	11,56 µg/ml
Methanol extract:	14,55 µg/ml
Chloroquine:	0,05 µg/ml (reference substance)

A search using www.google.com gave 2 hits while www.PubMed.com gave 0 hits (27.02.2005).

3.1.37.2 *Crossopteryx febrifuga* (Afz. ex G.don) Benth.

Theses: Kanta (1999) and Samake (2000)

Some traditional uses:

In Senegal, a decoction from the bark and leaves is used to relieve all types of chest pain. A maceration of the bark is used against stomach ache and vaginal discharge. The bark and leaves are also used to increase energy and strength, and the leaves are used in the treatment of some mental diseases. All preparations made from stem- or rootbark might be diuretic or emetic as a side effect. This is dose dependent (Kerharo and Adam, 1974).

Kanta (1999)

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words 1 (“vaginal discharge and vaginitis”). 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and 10th December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

The fruit from *Crossopteryx febrifuga* was analyzed. An extract was done with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*, but it did not have any effect against these microorganisms.

Samake (2000)

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analysis.

Extractions:

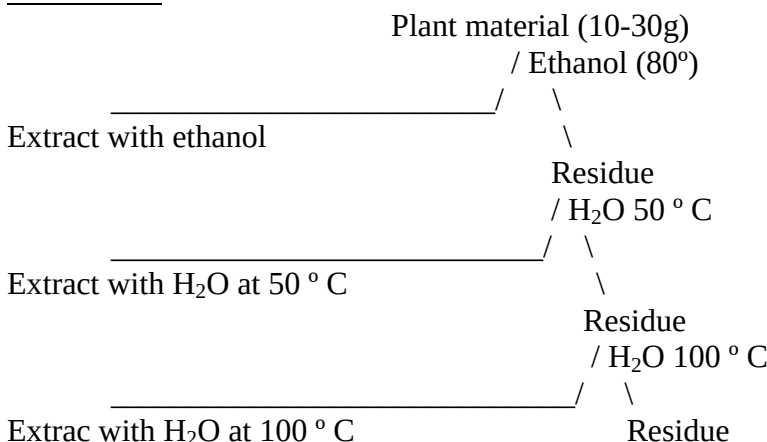


Figure 3.1.37.2.a Extraction with solvents of different polarity

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of anisidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm.

Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard substance used was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.37.2.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
C.f. 50°C	Fruit	+	+	+	0	0	+	+	+	0	150
C.f. 100°C	Fruit	+	+	+	0	+	+	+	+	0	120
C.f. 50°C	Stem bark	+	+	+	0	0	+	+	+	0	135
C.f. 100°C	Stem bark	+	+	0	0	+	+	+	+	0	50

C.f. = *Crossopteryx febrifuga*

Table 3.1.37.2.b Amounts of monosaccharides and polysaccharides detected

	Stem bark		Fruit	
Monosaccharides	Extract at 50°C	Extract at 100°C	Extract at 50°C	Extract at 100°C
	Sugar ratio (%)	Sugar ratio (%)	Sugar ratio (%)	Sugar ratio (%)
Arabinose	16	12	8	10
Rhamnose	9	4	6	5
Xylose	3	0	4	2
Mannose	0	1	0	1
Galactose	16	7	11	7
Glucose	16	39	9	5
Glucuronic acid	0	0	0	0
Galacturonic acid	41	37	61	70
Total	101*	100	99*	100
Polysaccharide content (%)	7	29	11	15

*The only information available is a summary table – basic data needs to be checked.

For more information about this plant see Aasberg (2001).

3.1.37.3 *Feretia apodanthera* Del.

Thesis: Sangare (2003)

Some traditional uses in Senegal:

The plant is used to treat different urinary- and renal affections. It is also used to treat stomach ache, and it is used in preparations in the treatment of nausea and syphilis. It is also used as a calming agent for agitated mental conditions (Kerharo and Adam, 1974).

Sangare (2003)

This author tested different parts of 8 plants for activity against *Plasmodium falciparum*. The plants were identified after interviews with several healers in Kendié and Finkolo between January and February 2003. 49 healers were interviewed in Kendié and 30 in Finkolo. Leaves and bark from *F. apodanthera* were collected in Blendi in the Sikasso region in May 2003.

Extractions:

50 g plant material + water (500 ml – 1 hour)

/

Decoction

Figure 3.1.37.3.a Decoction

50 g plant material + water (500 ml x 24 hours x 3)

/

Water maceration

Figure 3.1.37.3.b Maceration with water

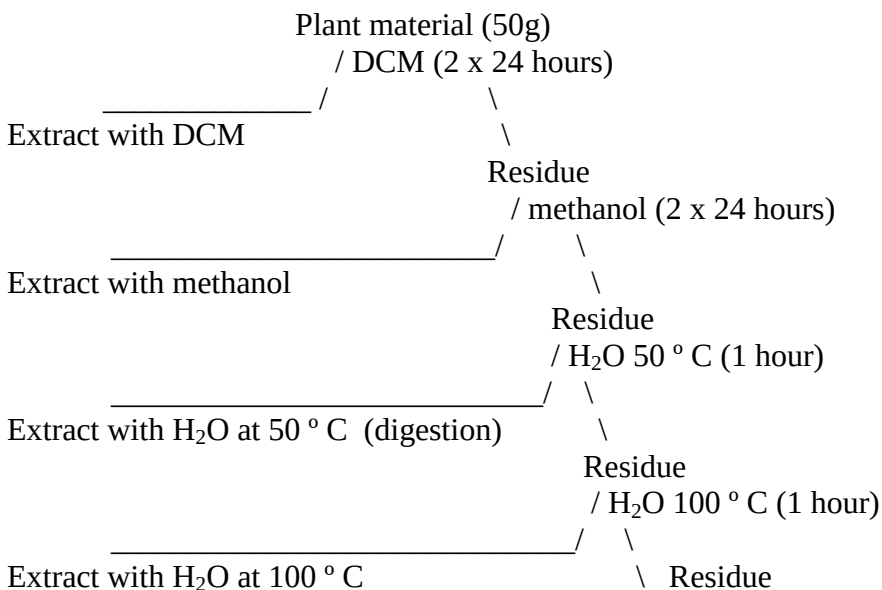


Figure 3.1.37.3.c Extractions with solvents of different polarity.

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Activity against *Plasmodium falciparum* (see A.1.2.1).

Thin layer chromatography was performed on some of the decoctions and digestions. Solvent system BAW (60:15:25). The plates were treated with AlCl₃ and Godin's reagent.

Results:

From the phytochemical tests the following substances were found:

Leaves:

Tannins, saponins, cardiac glycosides, anthraquinones, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 4,4 and 6,94 %. Ashes insoluble in HCl were 1,2 %, total ash content was 4,87 % and sulphur containing ash was 5,17 % (Table 3.2).

Bark:

Flavanoids, tannins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 5,2 and 6,57 %. Ashes insoluble in HCl were 1,5 %, total ash content was 4,17 % and sulphur containing ash was 3,93 % (Table 3.2).

The thin layer chromatography from the extract of the leaves showed several spots that probably correspond with content of flavonoids.

IC₅₀-concentrations:

Bark:

DCM extract:	6,65 µg/ml
Decoction:	9,68 µg/ml
Maceration with water:	11,42 µg/ml
Methanol extract:	13,13 µg/ml

Leaves:

DCM extract:	6,07 µg/ml
Methanol extract:	10,13 µg/ml
Maceration with water:	10,31 µg/ml
Decoction:	11,62 µg/ml
Chloroquine:	0,05 µg/ml (reference substance)

A search using www.google.com gave 100 hits and www.PubMed.com gave 3 hits (27.02.2005).

3.1.37.4 *Mitracarpus scaber* Zucc. ex Schult. et Schult. f

Field work:

N'Tjobougou, 5.2.04

Used against dermatosis:

Djokin Diarra used the aerial parts of this plant against leaking boils. A decoction was used to wash the dermatosis morning and evening.

This plant will not be discussed further in this thesis.

A search using www.google.com gave 388 hits and www.PubMed.com gave 6 hits (27.02.2005).

3.1.37.5 *Mitragyna inermis* (Willd.) Kuntze

Thesis: Bah (1998)

Some traditional uses:

This plant is used by many different ethnic groups in Senegal. The uses vary from treatment of stomach ache, dysentery, schistostomatiosis, fevers and syphilis to healing of large wounds (Kerharo and Adam, 1974).

In Mali, a decoction of leaves is used against malaria. Women use the flowers for cosmetic purposes (Diallo et al, 1999).

Bah (1998)

This author studied the larvicidal effects of 10 different plant extracts on *Anopheles gambiae*, one of the intermediate hosts in malaria. As mosquitoes are developing resistance to an increasing number of chemical insecticides, it is important to search for new and possibly less toxic agents from plants to try and control the disease. *Anopheles gambiae* mosquitoes were collected in Mopti. For the tests, larvae were elevated and collected in the laboratory, from full grown females collected at one specific date. Larvae were fed with Whiskas® cat food. The plant material was collected in Ségou in June 1996, and was dried and pulverized before analysis. The leaves and the bark from *M. inermis* were analyzed.

Extractions:

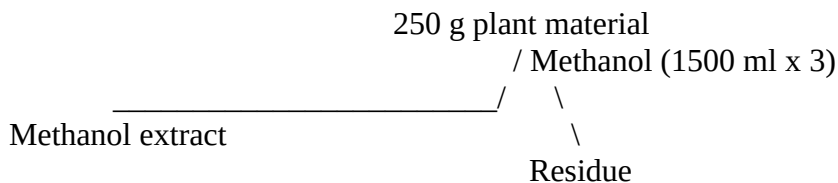


Figure 3.1.37.5.a

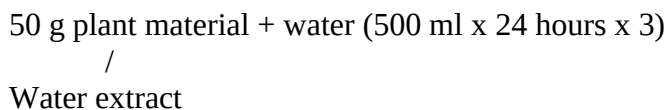


Figure 3.1.37.5.b

All extracts were tested on groups of 8 x 25 larvae. The extracts were tested at concentrations from 0,015 mg/ml to 0,06 mg/ml.

Results:

Methanol extracts:

Only the 0,06 mg/ml extract showed any effect. It gave 1 % deaths.

Water extracts: No activity was observed.

For more information about this plant see Aasberg (2001).

3.1.38 Salvadoraceae

3.1.38.1 *Salvadora persica* L.

Thesis: Bah (1998)

Some traditional uses:

In Mali, a decoction of fresh leaves is drunk as a remedy against influenza. A porridge made from the juice from crushed leaves is used to treat cold and cough. Pieces of thin branches are used as tooth cleaners (Diallo et al, 1999). In Senegal, the plant is especially known for its diuretic properties. The roots are used against rheumatism. Other uses are against Hansen's disease (leprosy), bronchitis, cough and asthma. It is also used to clean teeth and mouth (Kerharo and Adam, 1974).

Bah (1998)

This author studied the larvicidal effects of 10 different plant extracts on *Anopheles gambiae*, one of the intermediate hosts in malaria. As mosquitoes are developing resistance to an increasing number of chemical insecticides, it is important to search for new and possibly less toxic agents from plants to try and control the disease. *Anopheles gambiae* mosquitoes were collected in Mopti. For the tests, larvae were elevated and collected in the laboratory, from full grown females collected at one specific date. Larvae were fed with Whiskas® cat food.

The plant material was collected in Rharous in June 1996, and was dried and pulverized before analysis. Only the leaves from *S. persica* were analyzed.

An extract was made with water, 500 ml x 24 hours x 3. The extracts were tested at concentrations from 0,015 mg/ml to 0,06 mg/ml on groups of 8 x 25 larvae and the number of dead larvae registered. No deaths were observed at any of the tested concentrations.

The leaves from this plant do not show any activity in the performed tests. This plant will not be discussed further in this thesis.

A review of the plant has been done by Samuelsson et al (Samuelsson 1993).

3.1.39 Sapotaceae

3.1.39.1 *Butyrospermum parkii* (G. Don) Kotschy

Some traditional uses:

In Senegal, the "beurre du karité" has its main uses in ointments to treat sprained or stiff muscles and rheumatism. It is also used against migraine (Kerharo and Adam, 1974).

Field work:

Didieni-region, 6.2.04

Tietin Coulibaly uses the stem from this plant combined with the stem from *Combretum molle* to treat dermatosis. The dry stems are carbonized, mixed with the butter from *B. parkii* and is applied on affected areas.

Masantola-region, 7.2.04

Baba Diarra uses *Fomes fomentarius* (English: german tinder, Norwegian: kjuke) that lives on this plant to treat dermatosis. It is made into a powder, mixed with the oil from *B. parkii* and applied on the skin.

The butter or oil from this plant is commonly used in preparations used on the skin. Kjønneøy (2000) studied the structure and activities of polysaccharides from this plant.

This plant will not be discussed further in this thesis.

For more information about this plant see Aasberg (2001).

A search using www.google.com gave 25900 hits and www.PubMed.com gave 6 hits (27.02.2005).

3.1.40 Sterculiaceae

3.1.40.1 *Cola cordifolia* (Cav.) R. Br.

Theses: Kanta (1999) and Samake (2000)

Some traditional uses:

In Senegal, this plant has several medico-magic uses. Besides this, a maceration of the bark is used to treat bronchitis and other pulmonary affections. A maceration of the leaves is used against leprosy. The leaves from the twigs are used in combination with *Khaya senegalensis* to start child birth. The stem bark is used externally as wound dressing (Kerharo and Adam, 1974).

For a list of different traditional uses in Mali, see Næss (Næss 2003).

Kanta (1999):

This author identified 29 plants used in the treatment of infections by *Candida albicans*. These were found after interviews of healers and salesmen of medicinal plants and a review of available literature in the period between July and October 1998, using the search words I (“vaginal discharge and vaginitis”). 18 of these plants were collected the 19th of November 1998 in the Tienfala forest, 30 km from Bamako and 10th December 1998 in mount Manding in Siby, 60 km from Bamako, dried, pulverized and later analyzed.

Stem bark from *Cola cordifolia* was analyzed. An extract was done with ethanol and tested for activity against *Candida albicans* and *Escherichia coli*, but it did not have any effect against these microorganisms.

Samake (2000):

This author identified 13 plants and one mushroom used in wound healing and studied their monosaccharide contents and activities on the complement system. The plants were identified after interviews with local healers. All plants were collected in the forest near Siby in November 1998, dried and pulverized before analyzis.

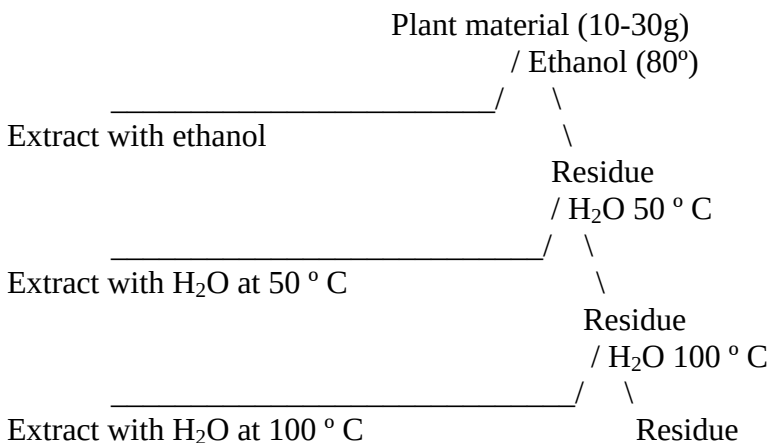
Extraction:

Figure 3.1.40.1.a Extraction with solvents of different polarity

Tests:

Thin layer chromatography was performed with known monosaccharides as references. All solutions were hydrolyzed before testing, to separate polysaccharides into separate monosaccharides. The following solvent system was used: Ethyl acetate – Acetic acid – Water – Methanol (13:3:3:4). The plates were treated with a mixture of ansidine, phthalate and methanol (1,23 : 1,66 : 100 ml) and examined using UV-light at 366 nm. Gas chromatography was also used to determine the monosaccharide content in the different plants. Standard here was mannitol.

Activity on the complement systems was tested on sheep erythrocytes.

Results:

Thin layer chromatography and effect on the complement system:

Table 3.1.40.1.a Extracts tested with known sugars as references and ICH₅₀

Tested substance	Tested part	Ara	Rha	Xyl	Fuc	Man	Gal	Glc	GalA	GlcA	ICH ₅₀ (µg/ml)
C.c. 50°C	Stem bark	+	+	+	0	+	+	+	+	0	95
C.c. 100°C	Stem bark	+	+	+	0	0	+	+	+	+	60

C.c. = *Cola cordifolia*

Gas chromatography:

Table 3.1.40.1.b Amounts of monosaccharides and polysaccharides detected

Monosaccharides	Extract at 50°C	Extract at 100°C
	Sugar ratio (%)	Sugar ratio (%)
Arabinose	16	5
Rhamnose	19	19
Fucose	1	0
Xylose	3	2
Mannose	2	0
Galactose	26	18
Glucose	12	19
Glucuronic acid	0	3
Galacturonic acid	20	33
Total	99*	99*
Polysaccharides (%)	23	35

*The only information available is a summary table – basic data needs to be checked.

Field work:

N`Tjobougou, 5.2.04.

Bourama Traoré:

The bark is used against chronic wounds. Carbonize the bark, make a powder and apply this directly onto the wound. The dressing consists of the leaves of *Combretum micranthum* under the bandage. Renew the dressing every other day.

Djenfa Koumaré:

The bark is used against hypertension. Dry the bark, pound it and mix the powder with water. Drink this morning and evening. Use 1 soup-spoon for 4 dl water.

Didieni-region, 6.2.04

Diotin Traore:

A decoction of the leaves is used as a bath against very serious diseases.

Cho Fane:

Against dysmenorrhoea: a decoction of the trunk bark is drunk 4 times a day.

Massantola-region, 7.2.04

Soundje Coulibaly:

A decoction of the leaves is drunk to treat mental diseases.

N`tiokon Traore

Against head ache: a decoction of the stem bark is made, and a fumigation of the head with the vapours is performed.

Soungalo Traore:

Nose bleeding: a fumigation of the fruitpowder is used.

Mariba Coulibaly:

Decoct of the trunk bark is drunk by women having continuous bleeding.

Dossere Diarra:

Against vascular diseases: a decoction of the trunk bark is used in a bath and is also drunk.

Baba Diarra:

A decoction of leaves or bark is made to treat chest pain. Take a vapour-bath and also a bath.

N’kodjiri Traoré

Against arthritis: a decoction of trunk bark or roots is used for a bath and one teaglass is drunk 3 times per day.

Leaves or trunk bark are used in the different preparations.

14 healers do not use this plant.

Næss (2003) studied the structure and activities from polysaccharides found in the bark of *C. cordifolia*.

A search using www.google.com gave 154 hits while www.PubMed.com gave 0 hits (03.03.2005).

3.1.41 Ulmaceae

3.1.41.1 *Celtis integrifolia* Lam.

Thesis: Bah (1998)

Some traditional uses:

In Senegal the root is used in the treatment of mental diseases and the pulverized leaves are used externally or *per os* after dilution in water to treat oedemas and several wound types. The pulverized root is used internally to treat rheumatism, paralysis, sterility and weakness (Kerharo et Adam, 1974).

Bah (1998):

This author studied the larvicidal effects of 10 different plant extracts on *Anopheles gambiae*, one of the intermediate hosts in malaria. As mosquitoes are developing resistance to an increasing number of chemical insecticides, it is important to search for new and possibly less toxic agents from plants to try and control the disease.

Anopheles gambiae mosquitoes were collected in Mopti. For the tests, larvae were elevated and collected in the laboratory, from full grown females collected at one specific date. Larvae were fed with Whiskas® cat food.

The plant material was collected in Somadougou in June 1996, and was dried and pulverized before analysis.

Only the leaves from *C. integrifolia* were analyzed. An extract was made with water, 500 ml x 24 hours x 3. The extracts were tested at concentrations from 0,015 mg/ml to 0,06 mg/ml on groups of 8 x 25 larvae, and the number of dead larvae registered. No deaths were observed at any of the tested concentrations.

The leaves from this plant do not show any activity in the performed tests. This plant will not be discussed further in this thesis.

A search using www.google.com gave 143 hits while www.PubMed.com gave 0 hits (27.02.2005).

3.1.42 Vitaceae

3.1.42.1 *Cissus quadrangularis* L.

Theses: Ba (1998) and Ouologuem (1999)

Some traditional uses in Senegal:

This plant is considered dangerous or toxic and its rare therapeutic actions are external. Decoction of branches and leaves are used as bath water during fever pains and malaria. The Indian species is used in ayurvedic medicine. (Kerharo and Adam, 1974).

Ba (1998):

This author studied 6 plants traditionally used as “fishing poison” or used as insecticides in cultivation of cereals, to determine the chemical composition and molluscicidal activity of these plants. This was done to find plants that may be used in the prevention of schistosomiasis, by killing the molluscs that act as intermediate hosts.

Molluscs were collected in Djikoron Woyowayemko and N’Gomidjirambougou. The species used were *Bulinus truncatus* and *Biomphalaria pfeifferi*. Groups of 6 snails were used in all tests.

The plant material was collected the 20th June 1997 in Gossi. Only the branches were tested, and they were dried and pulverized before analysis.

Extraction:

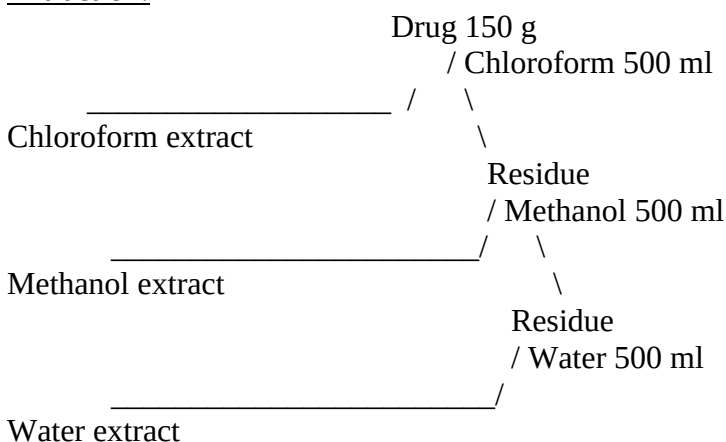


Figure 3.1.42.1.a Extraction with solvents of different polarity

Tests:

Standard phytochemical tests (A.1.1) were performed at DMT.

Molluscicidal activity was tested for all extracts at concentrations from 0,025 mg/ml to 0,4 mg/ml.

Results:

From the phytochemical tests performed at DMT the following substances were found: Alkaloids (0,11 %), tannins, cardiac glycosides, sterols and/or triterpenes, coumarins, reducing compounds, mono- and polysaccharides and mucilages. The content of water was between 9,11 and 10 %. Ashes insoluble in HCl were 3,57 %, total ash content is 16,25 % and sulphur containing ash was 24,07 % (Table 3.2).

Molluscicidal activity:

Only the chloroform extract showed some activity. A concentration of 0,4 mg/ml caused 16,66 % deaths for both mollusc species.

Ouologuem (1999):

This author tested the larvicidal effects of different extracts of 11 Malian plants. Larvae from *Anopheles gambiae* and *Culex quinquefasciatus* were used. 6 of the plants were tested on both species, while 5 were only tested on *C. quinquefasciatus*.

Larvae from *Culex quinquefasciatus* were collected in N'Tomikorobougou and Darsalam, in the Bamako district.

Pre-made extracts were used. Water, methanol and CHCl_3 extracts from *C. quadrangularis* twigs were tested.

Tests:

Tests on larvae from *Culex quinquefasciatus* were done on 5,5 mg extract dissolved in 110 μl of a suitable solvent; water for the water and ethanol extracts and

dimethylsulfoxide (DMSO) for the methanol, ether and DCM-extracts. The tests were performed on 5x20 larvae, and larvae that had fallen to the bottom of the tubes or were immobile were considered dead.

The DCM extracts from *Lannea velutina* leaves and *Cussonia arborea* roots, methanol extract from *Diospyros abyssinica* leaves and ether extract from *Cissus quadrangularis* twigs were tested at different concentrations. The extended tests were only performed on *Culex quinquefasciatus* larvae, as these are considered to be more resistant than larvae from *Anopheles gambiae*.

Results:

Larvicidal test:

Table 3.1.42.1.a *Culex quinquefasciatus* - % deaths at 500 ppm

Time of exposure	Plant extract			
	C.q. H ₂ O	C.q. Methanol	C.q. CHCl ₃	C.q. Ether
30 minutes	0	10	0	95
1 hour	20	0	0	95
24 hours	35	10	30	100

C.q. = *Cissus quadrangularis*.

Extended tests at different concentrations: See tables 3.1.2.2.c - 3.1.2.2.f.

For more information about this plant see Aasberg (2001).

3.2 Table of phytochemical results (with explanations)

All tests are described in the appendix (A.1.1).

Positive results are shown as + to +++++. The scales vary from author to author, some have ++++ (4) as maximum and others use +++++ (5).

Negative results are shown as 0.

Not performed tests are shown either as 0 or an empty box.

Foam index is either shown as the divider (1000/2) or the calculated result (500).

Some chemical groups are tested using multiple tests, ex. tannins and cardiac glycosides.

Some authors does not distinguish between the results from tests and might simply state that; “this plant contains tannins”. This should be considered when the results from the different tests are the same.

4. Discussion and conclusions

Plants that do not show any activity in the performed tests are not included in this discussion. The same is the case for plants that are only mentioned one or two times during the field work, especially if the uses from the field work do not seem related to the uses described by other authors.

A total of 82 plants have been studied. The number of tests performed on each plant and the number of plants tested varies from thesis to thesis. Because of this, a high number of positive tests can either signify a very active plant or that many tests have been performed on a specific plant, see each plant for details.

Table 4.a Tests performed and number of positive reactions

Test type	Number of plants with positive reaction
Activity on the complement system	17
Activity against <i>Anopheles gambiae</i>	13
Activity against <i>Candida albicans</i>	11
Activity against <i>Culex quinquefasciatus</i>	10
Antioxidant activity	9
Activity against <i>Plasmodium falciparum</i>	8
Antibacterial activity (see each plant for specifications)	5
Molluscicidal activity (see each plant for specifications)	5
Activity against <i>Lombricus terrestris</i>	4
Analgesic activity – “Writhing test”	4
Antiinflammatory activity	3
Toxicity	3
Analgesic activity – “Hot-plate test”	1
Antihypercholesterol activity	1
Antihyperglycemic activity	1

In addition to this the monosaccharide content was examined in more than 25 plants or gums and phytochemical tests were performed on over 50 plant parts or recipes (see 3.2).

The main reason for identifying mono- and polysaccharide content and activity on the complement system is the focus on wound healing plants and plants used against dermatosis (Diallo et al, 2002 and others). Other properties that are useful in wound healing are: anti-inflammatory, antimicrobial and analgesic activities.

The other tests are all important in the identification of active plants used against common Malian diseases: malaria, schistosomiasis, sexually transmissible diseases and diabetes.

Table 4.b Plants with activities from 5 of the most common tests performed

Complement	<i>A. gambiae</i>	<i>C. albicans</i>	<i>C. quinqufasciatus</i>	<i>P. falciparum</i>
<i>A. senegalensis</i>	<i>A. laxiflora</i>	<i>A. laxiflora</i>	<i>C. arborea</i>	<i>A. mexicana</i>
<i>B. africana</i>	<i>B. senegalensis</i>	<i>A. senegalensis</i>	<i>C. quadrangularis</i>	<i>C. acutiflorum</i>
<i>B. petersianum</i>	<i>C. arborea</i>	<i>B. africana</i>	<i>D. abyssinica</i>	<i>C. sieberiana (rp)</i>
<i>B. thoningii</i>	<i>C. sieberiana (rp)</i>	<i>B. ferruginea</i>	<i>E. africana</i>	<i>F. apodanthera</i>
<i>C. cordifolia</i>	<i>D. abyssinica</i>	<i>B. petersianum</i>	<i>F. flabescens</i>	<i>O. celtidifolia</i>
<i>C. febrifuga</i>	<i>F. flabescens</i>	<i>B. thoningii</i>	<i>L. inermis</i>	<i>S. longepedunculata</i>
<i>C. nigricans</i>	<i>G. oppositifolius</i>	<i>C. arborea</i>	<i>L. velutina</i>	<i>S. mombin</i>
<i>C. tinctorium</i>	<i>L. pterocarpum</i>	<i>C. nigricans</i>	<i>P. senegalense</i>	<i>S. virosa</i>
<i>D. oliveri</i>	<i>L. velutina</i>	<i>F. iteophylla</i>	<i>P. suberosa</i>	
<i>L. velutina</i>	<i>M. inermis</i>	<i>P. erinaceus</i>	<i>Z. mauritiana</i>	
<i>O. sthulmannii</i>	<i>P. senegalense</i>	<i>X. americana</i>		
<i>P. aegyptiacus</i>	<i>P. suberosa</i>			
<i>P. erinaceus</i>	<i>V. colorata</i>			
<i>S. kunthianum</i>				
<i>S. longepedunculata</i>				
<i>T. roka</i>				
<i>X. americana</i>				

Interesting plants and suggestions for further work:

(These plants are chosen based on the results from the performed tests and the type and amount of available literature).

Limeum pterocarpum

This plant showed very good activity against *A. gambiae* and it is also used to treat malaria. We have not found results from any biological tests performed on this plant.

Lannea velutina

This plant demonstrates good activity against *A. gambiae* and *C. quinqufasciatus*. It has also good effect on the complement system (ICH₅₀ 40 and 50 µg/ml). The digestion has a very high content of polysaccharides (81 %). Identification of active substances might be useful.

Spondias mombin

This plant shows very good activity against *P. falciparum*. We have not identified other studies on this specific activity.

Borassus flabellifer

10 of the 21 interviewed healers use the carbonized flower from this plant to treat dermatosis. An examination of the flowers chemical content and activities might be interesting.

Bombax costatum

The gum from this plant was used by two of the interviewed healers in wound healing. It has traditionally been used to treat dental affections. No biological studies have been found.

Securinega virosa

The leaves from this plant have demonstrates good activity against *Plasmodium falciparum*. We have not found any biological tests on this subject.

Stylosanthes erecta

Two recipes with this plant were tested.

1. *S. erecta* (80 %) with *T. indica* (20 %)
2. *S. erecta* (80 %) with *H. sabdariffa* (20 %)

Both recipes show good antimicrobial activity as well as good antispasmodic activity (Writhing test). They have also a high content of antioxidants. These studies are the only ones we have found on *S. erecta*.

Flacourtia flabescens

This plant show good activity against both *A. gambiae* and *C. quinquefasciatus*. No literature was found on this plant using www.google.com and www.PubMed.com.

Opilia celtidifolia

The traditional use of this plant against malaria and fever is confirmed by the good activity against *P. falciparum*. Further test and identification of active substance could prove useful.

Argemone mexicana

The leaves from this plant show very good activity against *P. falciparum*. Further tests on toxicity are necessary before eventual clinical tests.

Zizyphus mauritiana

The root bark from this plant show very good antidiabetic activity. Further tests on toxicity are necessary before eventual clinical tests.

Zizyphus mucronata

Acetone extract from the leaves and juice made from pressing of young branches show very good molluscicidal activity. Further tests of the juice are recommended.

The studies performed at DMT are extensive. With new laboratory facilities (2005) and better funding the focus of the studies is moving from chemical and *in vitro* tests towards clinical studies and also studies of diagnostic methods used by healers. This is important steps in the development of safe and effective new IMTs.

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A. Appendix

A.1 Phytochemical methods and reagents

The following phytochemical tests are described in Matière Médicale (Paris et al 1976): Alkaloids, quinones, cardiac glycosides, tannins, coumarins, sterols and/or triterpenes, saponins, cyanogenic glycosides and anthracene glycosides.

Tests on ashes are described in Pharmacopée française VIII (1965).

Tests on water content are briefly described by Nordal (Nordal, 1960).

The rest of the tests and the reagents are found and translated from the examined theses. See also Samuelsson (1999).

A.1.1 Methods

A.1.1.1 Alkaloids

Analyzed solution:

10 g plant material (powder) + 50 ml sulphuric acid (concentrated, then diluted 1/10 with distilled water). Stir and keep stirring during 24 hours in the laboratory temperature to obtain a maceration. Filtrate and wash with water until 50 ml of filtrate is obtained.

Characterization:

Reference substance used is strychnine.

Use 4 test tubes and put 1 ml of the filtrate into the first 2 tubes and 1 ml strychnine into the last two tubes. Add 5 drops of Mayer-reagent in tube 1 and 3, and 5 drops of Dragendorff reagent in tube 2 and 4.

The results are registered according to the color intensity or amount of precipitates.

A negative test = absence of alkaloids.

If the test is positive an extraction has to be performed to verify the presence of alkaloids in the tested plant:

25 ml filtrate is put into a decantation container. The solution is made alkaline by adding diluted ammonia (1:1) until it is possible to smell the characteristic smell (pH = 8-9). Add a suitable amount of chloroform: alkaline solution – chloroform (1:1).

Stir without making an emulsion. Take the organic phase and dry it using sodium anhydrous sulphate. Filtrate the solution and divide it between two containers. Evaporate until dry using a water bath.

Add 2 ml diluted HCl (1/10) to the first container. Divide this content between two test tubes and add the two reagents mentioned above (content of general alkaloids – Mayer and Dragendorff).

Tropane alkaloids:

Add 1 ml nitric acid to the second container. Evaporate until dry using a water bath. Cool down, then add 10 ml acetone and then one drop at the time of a 5 % solution of KOH in alcohol (newly prepared: 0,5 g + 10 ml ethanol).

In the presence of tropane alkaloids a violet precipitation will develop.

Quantitative determination of alkaloids:

25 ml filtrate is put into a decantation container.

Make the solution alkaline by using diluted ammonia (1:1) until it is possible to smell the characteristic smell (pH = 8-9). Perform an extraction with 50 ml chloroform. Take the organic phase and dry on sodium anhydrate sulphate, filtrate the chloroform phase to a weighed container. The alkaloid mass is calculated by weighing the capsule before and after extraction.

% alkaloids in the plant material is calculated by the following formula:

$$\% \text{ alkaloides} = \frac{\text{mass of alkaloids}}{\text{mass of test sample}} \times 100$$

A.1.1.2 Polyphenolic substances

Analyzed solution:

Make a 5 % infusion. Put 5 g plant material (powder) in 100 ml boiling water in a 250 ml container. Close the colbe and let it stay for 15 minutes. Filtrate on cotton and wash with hot water to obtain 100 ml filtrate.

Characterizations:

A.1.1.3 Flavonoides

Anthocyanines

5 ml infusion + 5 ml H₂SO₄, then 5 ml NH₄OH.

If the coloration becomes clearer using the acid and then goes towards a blue-violet in alkaline solution, the plant contains anthocyanines.

Cyanidin-reaction:

5 ml infusion + 5 ml chlorohydric alcohol + some pieces of magnesium + 1 ml isoamylic alcohol.

A pink to orange color (flavones), pink to violet (flavonones) or a red color indicates (flavonols, flavanonols) at the layer on top of the the isoamylic alcohol is an indication of free flavonoids.

Reduction with Mg + HCl in alcohol will reduce most aglycones from flavonoid-glycosides to orange or red salt.

Leucoanthocyanines:

Do the same reaction without the magnesium pieces and heat using a water bath for a few minutes. In the presence of leucoanthocyanines a red to dark red or violet coloration is developed.

Cathecols give a brown to red colour.

A.1.1.4 Tannins

5 ml infusion is put into a test tube. Add 1 ml 1 % FeCl₃. A greenish or blue to black coloration is developed in the presence of tannins.

The presence of tannins is shown by adding 1 ml concentrated HCl to 5 ml infusion. Boil for 15 minutes. A red precipitation, soluble in amylic alcohol, is developed. The differentiation between condensed and and gallotannins is obtained from the Stiasny reaction.

30 ml infusion + 15 ml Stiasny-reagent. Varm på vannbad ved 90 °C i 15-30 minutter. Development of a precipitate indicates the presence of condensed tannins. Filtrate the solution and saturate the solution with pulverized sodium acetate. Add 1 ml 1 % FeCl₃. The development of a blue to black color indicates the presence of condensed tannins.

A.1.1.5 Saponines

Analyzed solution:

Decoction: 1 g powder is put in a 250 ml colbe + 100 ml distilled water. Keep boiling for 15 minutes, filtrate and adjust to 100 ml after it has cooled down.

Characterization:

Use 10 test tubes with numbers from 1 to 10. Add 1 ml decoction in tube number 1, 2 ml in tube number 2 and so on. Adjust the volume in each tube to 10 ml with distilled water. Shake each tube during 15 seconds (2 agitations every second). Use the thumb to close the tubes while shaking. Leave for 15 minutes and measure the height of the foam. If it is less than 1 cm in all the tubes the index is less than 100. The dilution where the foam is equal to 1 cm represents the index we look for. If the height of the foam is more than 1 cm in all the tubes it will be necessary to prepare another dilution series from the decoction and restart the process.

$$\text{Foam index} = \frac{1000}{\text{The number of the tube}}$$

A.1.1.6 Cardiac glycosides

Analyzed solution:

1 g powder + 10 ml 60 % alcohol and 5 ml neutral 10 % Pb acetate and heat on a boiling water bath for 10 minutes before filtrating (cotton).

Characterization:

Shake the filtrate gently with 10 ml CHCl_3 without making an emulsion.

Take out the organic phase and divide it between 3 test tubes. Evaporate at a boiling water bath until it is dry. Add 0,4 ml isopropanol to each tube. Then add the following:

Tube 1: 1 ml Baljet-reagent

Tube 2: 1 ml Kedde-reagent

Tube 3: 1 ml Raymond-Marthoud reagent

Add 4 drops of 5 % KOH in alcohol to all three tubes.

If the reaction is positive the following colors will develop:

Tube 1: Orange

Tube 2: Red to violet

Tube 3: Violet

A.1.1.7 Sterols and/or triterpenes

Analyzed solution:

Extraction. 1 g powder is put into a test tube with 20 ml ether. "Sett i kork", shake and leave for 24 hours. Filtrate and add some ether to obtain 20 ml.

Characterization:

Liebermann-Burchards reaction:

Evaporate 10 ml of extract until it is dry and add 1 ml acetic anhydrid + 1 ml CHCl_3 .

Divide the content between two test tubes, one of them will be used as reference.

Use a pipette to add 1-2 ml concentrated H_2SO_4 at the bottom of the test tubes. Do not stir. If there is formation of a "anneau" red to brown or violet in the zone between the two liquids and the top layer is green or violet this indicates the presence of sterols and/or triterpenes.

Carotenoids:

Evaporate 5 ml of extract in a container (capsule) and add 2-3 drops of a saturated solution of SbCl_3 in CHCl_3 or CCl_4 . Positive reaction is shown as the development of a red color that changes to blue.

A.1.1.8 Coumarins

5 ml ether extract (maceration during 24 hours) is evaporated in the air.

Add 2 ml hot water. Divide the solution between 2 test tubes and add 0,5 ml 25 % NH_4OH to one of the tubes. Mix and look for fluorescence using UV at 366 nm. An intense fluorescence in the tube with NH_4OH indicates the presence of coumarins.

A.1.1.9 Anthraquinones and derivatives

Analyzed solutions:

Chloroform extraction. 1 g drogue + 10 ml chloroform and heat for 3 minutes using a water bath at 100 °C. Filtrate while it is still hot and add some chloroform to obtain 10 ml of solution.

Hydrolysate: use the powder left after the chloroform extraction and add 10 ml water and 1 ml concentrated HCl. Keep the test tube in a boiling water bath for 15 minutes. Cool down using cold water and filtrate.

Characterizations:

Free anthracenes:

1 ml chloroform extract + 1 ml diluted NH_4OH and stir. A red or redish color indicates the presence of free anthraquinones.

O-glycosides:

5 ml hydrolysate + 5 ml CHCl_3 is stirred. Take out the organic phase and put it into a test tube, add 1 ml diluted NH_4OH and stir well. The presence of anthraquinones is indicated by a red color of variable intensity. If the reaction is negative or weakly positive look for O-glycosides "a g  nine reduite".

5 ml hydrolysate + 3-4 drops of 10 % FeCl_3 and heat on a water bath for 5 minutes.

Cool down and shake with 5 ml CHCl_3 . Take out the organic phase and put it into a test tube, add 1 ml diluted NH_4OH and stir well. The presence of oxydated products of anthroles and anthrones is indicated by a red color of variable intensity.

C-glycosides:

Use the water phase (preserved with 10 ml water) and add 1 ml 10 % FeCl_3 . Keep the test tube in a boiling water bath for 30 minutes, cool down and shake with 5 ml CHCl_3 . Take out the organic phase and put it into a test tube, add 1 ml diluted NH_4OH and stir well. The presence of C-glycosides is indicated by a red color of variable intensity.

Brissermoret and Combes reaction (differentiation of quinines):

1 g powder is put in a 250 ml ecolbe. Moisturise with 10 % H_2SO_4 . Add 20 ml of a mixture of ether and chloroform (1:1) mix and leave to make a masseration for 24 hours. Filtrate and let evaporate in the air 5 ml of the filtrate. Add a few drops of 95 % alcohol. Add one drop at the time of 5 % nickel acetate. According to the quinine content the following results may be observed:

- benzoquinones: blue color and precipitate
- naphthoquinones: violet color and precipitate
- anthraquinones: red color without precipitate

A.1.1.10 Cyanogenic glycosides

1 g powder + 5 ml mixture of water and toluene (1:1).

Mix well and clean the upper of the tube. A "picrosod  " paper is connected to the upper part of the tube using a closing cap and without the paper touching the solution.

A red coloration of the paper (can appear slowly or fast) indicates the presence of cyanogenic glycosides.

A.1.1.11 Reducing compounds

5 ml 10 % water decoction is put into a suitable container (capsule) and is evaporated until it is dry on a water bath. Add 1 ml Fehlings-reagent. A brick red precipitate is an indication of the presence of reducing compounds.

A.1.1.12 Mono- and polysaccharides

5 ml 10 % water decoction is put into a suitable container (capsule) and is evaporated until it is dry on a water bath. Add 2-3 drops of concentrated H_2SO_4 . Add 3-4 drops of alcohol saturated with thymole after 5 minutes. The development of a red coloration indicates the presence of mono- and polysaccharides.

A.1.1.13 Mucilages

1 ml 10 % water decoction + 5 ml absolute alcohol.

The development of a non-solid precipitate indicates the presence of mucilages.

A.1.1.14 Tetrahydrocannabinols

0,5 g powder + 5 ml petrol ether. Shake for 15 minutes, filtrate into a suitable container (capsule) and evaporate until it is dry using a water bath. Add 3-4 drops of 5 % KOH in alcohol. A violet color indicates the presence of tetrahydrocannabinols.

A.1.1.15 Water extractible substances

This measurement gives an evaluation of how water soluble the drug is in water.

1 g of powdered plant material is put in a colbe with 20 ml of water and boiled for 15 minutes. After it is cooled down (about 20 minutes) the solution is filtrated through cotton wool in a previously weighed container. After drying, the container is measured and the amount of water extractible substances is calculated.

A.1.1.16 Water content

Gravimetrical contents:

Determination of weight loss of a know quantity of powder after dessication in a temperature regulated heating chamber at $100\text{ }^{\circ}\text{C} \pm 3$ during 24 hours.

Practical performance:

5 samples are put into 5 previously weighed suitable containers. The containers are placed in the heating chamber for $100\text{ }^{\circ}\text{C} \pm 3$ during 24 hours.

The samples are cooled down in a dessicator and measured with their containers. The mean weight loss is calculated and converted to loss per 100 g of the tested plant.

Volumetric method:

Measurement of the amount of distilled water collected from distilling a known amount of the tested plant in a non-water miscible solvent (toluene) at a constant temperature.

Practical performance – see one of the theses.

A.1.1.17 Tests involving ashes

These tests are performed to measure the content of foreign elements like sand and earth in the plant tissue.

Total amount of ash:

Measurement of the total amount of ash from a certain plant is found by weighing the amount of white ashes obtained from incinerating the plant material in an oven “moufle” at 800 °C for 4 hours. 5 samples are tested and the mean weight is calculated. This mass is then compared to 100 g of powdered plant.

Determination of sulfur content in ash:

This is a method used to find inorganic substances in plant material. The sample is moistured with sulphuric acid and put in an oven at 110°C for 24 hours, then at 800°C for 4 hours. The ash that is left contains non volatile sulfates. The obtained mass is compared to 100 g of powdered plant.

Determination of amount of ash that is not soluble in hydrochloric acid:

The total amount of ash is boiled in diluted hydrochloric acid. The insoluble matter is collected on a filter paper.

A know amount of ash from a known amount of plant is boiled in 20 ml 10 % hydrochloric acid for 15 minutes, after cooling it down, the solution is filtrated, washed and heated at 110°C for 24 hours. After drying the residue is cooled down and put in an oven at 800°C for 4 hours.

The obtained amount of ash that is not soluble in HCl is compared to 100 g of powdered plant.

This test is used to distinguish between soluble physiological material and insoluble substances like sand and earth.

A.1.1.18 Thin layer chromatography

Migration or solvent systems used are normally described for each plant.

The reagents used to treat the plates were: Dragendorffs reagent, AlCl_3 and Godins reagent.

Some results are as follows:

Dragendorffs reagent is used to indicate the presence of alkaloids.

AlCl_3 is used to indicate the presence of flavonoids.

Godins reagent is used to indicate the presence of sterols, triterpenes, saponines, tannins, cojmarins and chlorophyll.

A.1.1.19 Antioxidant activity

3 μg of each extract was placed on a thin layer chromatography plate. Migration systems are described for each plant. The plates were treated with a solution of 2 mg/ml methanol with DPPH.

Extracts with antioxidant activity will appear as white to yellow spots on a violet background.

A.1.2 Reagents

Baljet's reagent

Picric acid	1 g
Ethanol 50° qsp	100 ml

Dragendorff's reagent

Bismuth nitrate (powder)	20,8 g
Anhydrous sodium iodide	200 g
Iodine	38,10 g
Distilled water	600 ml

Stir for 30 minutes.

DPPH

1-1 difenyl 2 picril hydrazyl	2 mg/ml metanol
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Fehling's reagent

Solution A: CuSO_4	35g
Distilled water	500 ml
H_2SO_4	5 ml

Cool down and complete to 1 liter with distilled water.

Solution B: Seignettes salt	150 g
Distilled water	500 ml

Cool down and add 300 ml non-carbonate washing powder. Complete to 1 liter with distilled water.

Mix equal volumes of the the two solutions before use.

Godin's reagent

Solution A: Vanilline	1 g
Ethanol 95 %	1000 ml
Solution B: HClO ₄	3 ml
Distilled water	100 ml

Mix the two solutions before use.

The thin layer plates are first sprayed with the reagent, then with a 10% solution of H₂SO₄. Coloured compounds appear after heating the plat up to 100 °C.

Guignard's reagent (preparation of "picrosode" paper)

Picric acid	1 g
Sodium carbonate	10 g
Distilled water	100 ml

Kedde's reagent

3,5- dinitro benzoic acid	1 g
Ethanol 95° qsp	100 ml

Raymond Marthoud's reagent

1-3 M dinitrobenzene	1 g
Ethanol 96° qsp	100 ml

Resorcine relevation solution

Resorcine	100 mg
Ethanol	50 ml
Phosphoric acid	50 ml

Valser-Mayer's reagent

Potassium iodate	25 g
Mercuric chloride (HgCl)	6,77 g
Distilled water	250 ml

Plant family	Plant	Author	Year
Aizoaceae	<i>Glinus oppositifolius</i>	Bah	1998
Aizoaceae	<i>Limeum pterocarpum</i>	Bah	1998
Anacardiaceae	<i>Lannea microcarpa</i>	Sanogo	1999
Anacardiaceae	<i>Lannea velutina</i>	Field work	2004
Anacardiaceae	<i>Lannea velutina</i>	Field work	2004
Anacardiaceae	<i>Lannea velutina</i>	Kanta	1999
Anacardiaceae	<i>Lannea velutina</i>	Oulogeum	1999
Anacardiaceae	<i>Lannea velutina</i>	Samake	2000
Anacardiaceae	<i>Mangifera indica</i>	Aouissa	2002
Anacardiaceae	<i>Spondias mombin</i>	Sangare, D.	2003
Annonaceae	<i>Annona senegalensis</i>	Kanta	1999
Annonaceae	<i>Annona senegalensis</i>	Samake	2000
Araliaceae	<i>Cussonia barteri</i>	Bouare	2004
Araliaceae	<i>Cussonia barteri</i>	Oulogeum	1999
Arecaceae	<i>Borassus flabellifer</i>	Field work	2004
Asclepiadaceae	<i>Calotropis procera</i>	Field work	2004
Asclepiadaceae	<i>Leptadenia pyrotechnica</i>	Bah	1998
Asclepiadaceae	<i>Leptadenia hastata</i>	Field work	2004
Asteraceae	<i>Vernonia kotschyana</i>	Ba	1998
Asteraceae	<i>Vernonia kotschyana</i>	Bah	1998
Asteraceae	<i>Vernonia kotschyana</i>	Oulogeum	1999
Asteraceae	<i>Vernonia colorata</i>	Fane	2002
Balanitaceae	<i>Balanites aegyptiaca</i>	Ahamet	2003
Bignoniaceae	<i>Stereospermum kunthianum</i>	Kanta	1999
Bignoniaceae	<i>Stereospermum kunthianum</i>	Samake	2000
Bombacaceae	<i>Bombax costatum</i>	Sanogo	1999
Bombacaceae	<i>Bombax costatum</i>	Field work	2004
Caesalpiniaceae	<i>Afzelia africana</i>	Field work	2004
Caesalpiniaceae	<i>Burkea africana</i>	Kanta	1999
Caesalpiniaceae	<i>Burkea africana</i>	Samake	2000
Caesalpiniaceae	<i>Cassia nigricans</i>	Kanta	1999
Caesalpiniaceae	<i>Cassia nigricans</i>	Samake	2000
Caesalpiniaceae	<i>Cassia sieberiana</i>	Ekoumou	2004
Caesalpiniaceae	<i>Cassia sieberiana</i>	Fane	2002
Caesalpiniaceae	<i>Cassia sieberiana</i> rp.	Ekoumou	2004
Caesalpiniaceae	<i>Cordyla pinnata</i>	Sanogo	1999
Caesalpiniaceae	<i>Daniellia oliveri</i> # 1	Sanogo	1999
Caesalpiniaceae	<i>Daniellia oliveri</i> # 2	Sanogo	1999
Caesalpiniaceae	<i>Piliostigma thonningii</i>	Ekoumou	2004
Caesalpiniaceae	<i>Piliostigma thonningii</i> rp.	Ekoumou	2004

Capparidaceae	<i>Boscia senegalensis</i>	Ba	1998
Capparidaceae	<i>Boscia senegalensis</i>	Bah	1998
Capparidaceae	<i>Maerua crassifolia</i>	Bah	1998
Celastraceae	<i>Maytenus senegalensis</i>	Kanta	1999
Cochlospermaceae	<i>Cochlospermum tinctorium</i>	Kanta	1999
Cochlospermaceae	<i>Cochlospermum tinctorium</i>	Samake	2000
Combretaceae	<i>Combretum ghasalense</i> # 1	Sanogo	1999
Combretaceae	<i>Combretum ghasalense</i> # 2	Sanogo	1999
Combretaceae	<i>Combretum glutinosum</i>	Field work	2004
Combretaceae	<i>Combretum molle</i>	Field work	2004
Combretaceae	<i>Combretum molle</i>	Sanogo	1999
Combretaceae	<i>Pteleopsis suberosa</i>	Oulogeum	1999
Combretaceae	<i>Terminalia avicennoides</i>	Sanogo	1999
Combretaceae	<i>Terminalia macroptera</i>	Sanogo	1999
Convolvulaceae	<i>Ipomoea asarifolia</i>	Field work	2004
Ebenaceae	<i>Diospyros abyssinica</i>	Oulogeum	1999
Euphorbiaceae	<i>Bridelia ferruginea</i>	Kanta	1999
Euphorbiaceae	<i>Euphorbia sudanica</i>	Field work	2004
Euphorbiaceae	<i>Ricinus communis</i>	Field work	2004
Euphorbiaceae	<i>Securinega virosa</i>	Sangare, D.	2003
Euphorbiaceae	<i>Securinega virosa</i>	Sangare, D.	2003
Fabaceae	<i>Afrormosia laxiflora</i>	Fane	2002
Fabaceae	<i>Afrormosia laxiflora</i>	Kanta	1999
Fabaceae	<i>Bauhinia thonningii</i>	Kanta	1999
Fabaceae	<i>Bauhinia thonningii</i>	Samake	2000
Fabaceae	<i>Ostryoderris stuhlmannii</i>	Kanta	1999
Fabaceae	<i>Ostryoderris stuhlmannii</i>	Samake	2000
Fabaceae	<i>Prosopis africana</i>	Ekoumou	2004
Fabaceae	<i>Prosopis africana</i> rp.	Ekoumou	2004
Fabaceae	<i>Pterocarpus erinaceus</i>	Field work	2004
Fabaceae	<i>Pterocarpus erinaceus</i>	Kanta	1999
Fabaceae	<i>Pterocarpus erinaceus</i>	Samake	2000
Fabaceae	<i>Pterocarpus lucens</i>	Field work	2004
Fabaceae	<i>Stylosanthes erecta</i>	Ekoumou	2004
Fabaceae	<i>Stylosanthes erecta</i> (SEH)	Ekoumou	2004
Fabaceae	<i>Stylosanthes erecta</i> (SET)	Ekoumou	2004
Flacourtiaceae	<i>Flacourtia flabescens</i>	Oulogeum	1999
Hypericaceae	<i>Psorospermum guineense</i>	Oulogeum	1999
Liliaceae	<i>Aloe buteneri</i>	Field work	2004
Lycoperdeae	<i>Podaxon aegyptiacus</i>	Samake	2000
Lythraceae	<i>Lawsonia inermis</i>	Ba	1998

Lythraceae	<i>Lawsonia inermis</i>	Oulogeum	1999
Meliaceae	<i>Khaya senegalensis</i>	Sanogo	1999
Meliaceae	<i>Trichilia emetica</i>	Fane	2002
Meliaceae	<i>Trichilia emetica</i>	Kanta	1999
Meliaceae	<i>Trichilia emetica</i>	Samake	2000
Meliaceae	<i>Trichilia emetica</i>	Timbo	2003
Mimosaceae	<i>Acacia ataxacantha</i>	Field work	2004
Mimosaceae	<i>Acacia dudgeoni</i> - G3	Sanogo	1999
Mimosaceae	<i>Acacia senegal</i> - G1	Sanogo	1999
Mimosaceae	<i>Acacia seyal</i> - G2	Sanogo	1999
Mimosaceae	<i>Entada africana</i>	Ba	1998
Mimosaceae	<i>Entada africana</i>	Bah	1998
Mimosaceae	<i>Entada africana</i>	Oulogeum	1999
Mimosaceae	<i>Parkia biglobosa</i>	Field work	2004
Moraceae	<i>Ficus iteophila</i>	Kanta	1999
Moringaceae	<i>Moringa oleifera</i>	Chetima	2004
Olacaceae	<i>Ximenia americana</i>	Field work	2004
Olacaceae	<i>Ximenia americana</i>	Kanta	1999
Opiliaceae	<i>Opilia celtidifolia</i>	Field work	2004
Opiliaceae	<i>Opilia celtidifolia</i>	Sangare, D.	2003
Opiliaceae	<i>Opilia celtidifolia</i>	Sangare, D.	2003
Oxalidaceae	<i>Biophytum petersianum</i>	Field work	2004
Oxalidaceae	<i>Biophytum petersianum</i>	Kanta	1999
Oxalidaceae	<i>Biophytum petersianum</i>	Samake	2000
Papaveraceae	<i>Argemone mexicana</i>	Sangare, D.	2003
Papilionaceae	<i>Swartzia madagascariensis</i>	Fane	2002
Poaceae	<i>Zea mays</i>	Field work	2004
Polygalaceae	<i>Securidaca longepedunculata</i>	Tolo	2002
Rhamnaceae	<i>Ziziphus mauritania</i>	Oulogeum	1999
Rhamnaceae	<i>Ziziphus mauritania</i>	Yansambou	2002
Rhamnaceae	<i>Zizyhpus mucronata</i>	Ba	1998
Rubiaceae	<i>Canthium acutiflorum</i>	Sangare, D.	2003
Rubiaceae	<i>Canthium acutiflorum</i>	Sangare, D.	2003
Rubiaceae	<i>Crossopteryx febrifuga</i>	Kanta	1999
Rubiaceae	<i>Crossopteryx febrifuga</i>	Samake	2000
Rubiaceae	<i>Feretia apodanthera</i>	Sangare, D.	2003
Rubiaceae	<i>Feretia apodanthera</i>	Sangare, D.	2003
Rubiaceae	<i>Mitracarpus scaber</i>	Field work	2004
Rubiaceae	<i>Mitragyna inermis</i>	Bah	1998
Salvadoraceae	<i>Salvadora persica</i>	Bah	1998
Sapotaceae	<i>Butyrospermum parkii</i>	Field work	2004

Sterculiaceae	<i>Cola cordifolia</i>	<i>Field work</i>	2004
Sterculiaceae	<i>Cola cordifolia</i>	Kanta	1999
Sterculiaceae	<i>Cola cordifolia</i>	Samake	2000
Ulmaceae	<i>Celtis integrifolia</i>	Bah	1998
Vitaceae	<i>Cissus quadrangularis</i>	Ba	1998
Vitaceae	<i>Cissus quadrangularis</i>	Oulogeum	1999