



Review

Tamarindus indica L. (Fabaceae): Patterns of use in traditional African medicine

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ABSTRACT

To increase the understanding of the ethnopharmacology of a single species, elaboration of dispersed primary data is required. *Tamarindus indica* L. (Fabaceae), or tamarind, is a common tree, especially in West Africa, with a good potential to contribute to affordable local health care based on traditional medicine (TM). For this single species review, more than 60 references with detailed information on the ethnopharmacology of *Tamarindus indica* in the African context were selected. It showed that most prominently, the fruits are used as laxative or febrifuge throughout the Sahel and Soudan ecological zones. Tamarind bark and leaves are often involved in the treatment of wounds, especially in central West Africa. While the bark is used to treat diarrhoea in West Africa, the leaves are used for this purpose in East Africa. Our findings suggest a difference in the way tamarind is used between East and West Africa and we assess the similarities of its uses within those regions. This review demonstrates the capability of literature research to reveal knowledge by mining and compiling information from the growing body of primary ethnopharmacologic data, much of which is published in this journal. By creating a specific profile of tamarind in the context of traditional medicine throughout Africa, the authors contribute to the collection of current ethnobotanic species accounts on *Tamarindus indica* that tend to be qualitative and more general.

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Abbreviations: DADOBAT, development and domestication of baobab and tamarind; DMT, Département de la Médecine Traditionnelle; RAPD, random amplified polymorphic DNA; TM, traditional medicine.

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1. Introduction

Traditional medicine (TM) is important in tropical countries: contrary to pharmaceuticals, it is often freely and readily available. For example, in Burkina Faso, up to 90% of the population relies entirely on traditional remedies (Guinko, 1984 cited in Kristensen and Balslev, 2003). The Département de la Médecine Traditionnelle (DMT¹) conducted programs to validate and disclose traditional medicine in Mali, eventually leading to a number of affordable and standardised health care products based on traditional remedies (Diallo and Paulsen, 2000). The availability of tamarind (*Tamarindus indica* L.) throughout the drier parts of tropical Africa and the fact that it is widely known, particularly in West Africa, make it an effective and reliable source of home medicine. Tamarind is not identified as a species to provide the secret ingredient in the global search for cures for cancer, AIDS or malaria, but it is a common plant used to treat common illnesses in Africa.

The use of plants in traditional medicine can be explained by physiologically active phytochemical compounds of a species and also by its ascribed meaning in a culture (Etkin, 1986). Medicinal plants with a long history of safe and effective use are likely to have a pharmaceutical effect (Tabuti, 2008). In addition, the likeliness of a medicinal use being based on pharmaceutical properties rather than on a cultural context increases when this use is repeatedly found in different cultures. This is illustrated by the policy of the Malinese DMT program which selects traditional remedies based on the similarity of plant uses among different healers (Diallo and Paulsen, 2000). A comparison of independent studies carried out in different locations will thus improve the ethnopharmacologic understanding of a given use or plant part.

Primary information on the medicinal uses of tamarind is plentiful, but dispersed. Existing species accounts on tamarind often list numerous medicinal uses (e.g. Irvine, 1961; Maydell, 1986; Ross, 2003; Arbonnier, 2004) without characterising the species ethnopharmacologically. The aim of this study is to characterise the way tamarind is used in African TM. Our approach is to compile the primary ethnomedicinal information available (Etkin, 2001) on tamarind in Africa and to highlight and discuss its most common uses. This analysis not only shows the most relevant applications of tamarind in traditional health care, it also supports the understanding of the medicinal capacities of tamarind. A detailed understanding of the way plants are used in TM will facilitate the formulation of relevant research questions on which to make chemical or clinical follow-up studies more valuable (Graz et al., 2007).

1.1. Species biology, distribution and use

Tamarindus is a monospecific genus that was formerly placed in the Caesalpinaceae family, now drawn up in Fabaceae *sensu lato*. *Tamarindus indica* is a pantropical species and is commonly used all over the world (Morton, 1987). For fruit development a dry season is required. Its African range runs along the dryland zone from Senegal in the west through Sudan and Ethiopia in the east, extending southward to Mozambique and Madagascar (World Agroforestry Centre, 2007). In West Africa, it is characteristic of the dry Sahel and northern Soudan² climatic zones, but becomes less common toward the more humid Guinea savanna.

¹ The DMT is one of the five departments of the Malinese 'Institut National de Recherche en Santé Publique' (National Institute for Research on Public Health). Its mission is to stimulate the use of locally available remedies and to improve the integration of traditional and conventional health care.

² 'Soudan' refers to the savanna zone between the Sahel in the north and the Guinea and Congo Forest belts in the south. 'Sudan' refers to the country in Northeast Africa.

Nowadays it is generally assumed that tamarind originated in Africa and was introduced to India by humans in early history or prehistory (Morton, 1958; Busson, 1965; Lefevre, 1971; all cited in Blench, 2003). Burkill (1995) locates the origin of tamarind in central Soudanian West Africa (Mali, Burkina Faso and Niger). A recent study based on Random Amplified Polymorphic DNA (RAPD, a method to estimate genetic diversity) did not succeed in reconstructing the history of the Palearctic population of tamarind, probably because colonisation of either continent took place too long ago while the RAPD method is more suited to qualifying more recent genetic changes (Diallo et al., 2007). A study analysing the population genetics of tamarind based on a gene with a slower mutation rate, like chloroplast DNA, may shed more light on this issue (Diallo et al., 2007). By Soudanian farmers on the ground however, tamarind is considered indigenous, witnessed by the fact that generally they do not take the species into consideration for planting (Lahuec, 1980; Nordeide et al., 1996; El-Siddig et al., 1999). African farmers tend to cultivate exotic trees like *Mangifera indica* or *Azadirachta indica*, but not indigenous species (Sollart, 1986; Gijssbers et al., 1994; Jama et al., 2008), even if these species have high use values. Toward the Guinea zone, tamarind is sometimes found around compounds and villages, suggesting an anthropogenic dispersal (e.g. Burkill, 1995; Tchiegang-Megueni et al., 2001).

Tamarind certainly has a high use value. It is one of the species saved when a piece of the savanna is cleared for agriculture (Boffa, 1999). The tree carries brittle, ligneous pods about the size of a human digit, containing up to 10 shiny seeds surrounded by a sticky, sour pulp that is used in food and drinks. The fruits are commonly consumed and traded in Africa (e.g. Hines and Eckman, 1993; Tchiegang-Megueni et al., 2001; Glew et al., 2005; Jama et al., 2008). In parts of West Africa, this is the case for the leaves as well (e.g. Bergeret, 1986; Nordeide et al., 1996). The semi-deciduous tree bears alternate, paripinnate leaves that are unpalatable to cattle (Le Houérou, 1979) but are used as fodder nevertheless (Verinumbe, 1991; Thoen and Thiam, 1993; Lykke et al., 2004) especially in the early dry season when many other trees have already dropped their leaves (Fandohan, 2008). The hard wood of tamarind serves to make agricultural tools and kitchen equipment (Irvine, 1961; Berhaut, 1975; Fandohan, 2007). Food production is probably the most important commercial use of tamarind, but traditional medicine surely accounts for the highest diversity of uses and virtually every plant part is found in various traditional pharmacopoeias.

2. Methodology of the review

The literature search was performed during March–September 2007 using literature databases, including online catalogues of relevant institutions and e-journal consortia. Databases were chosen according to their topic (e.g. ethnology, agroforestry, ethnobotany and agriculture), geographical covering (Africa) and language (German, English and French). The following keywords were used to search for literature inside the databases: *Tamarindus indica*, tamarinde, tamarind, tamarinier³. In databases with a global covering, the search was constrained by the following keywords: Africa; Afrika; Afrique; Sahel. Libraries in Africa and analogous catalogues were not systematically searched; due to limited time and resources. Abstracts; extracted from the databases; were selected based on topic and geographical covering. Literature was

³ Information about tamarind in literature which documents several species was accessed only if the species name of tamarind was detected by the search engines. Examples are literature focussing on plant use of specific ethnic groups, regional floras or publications about agroforestry, non-timber forest products or useful trees in the Sahel zone.

downloaded as PDF-document from the Internet; borrowed from libraries or obtained directly from authors. Literature comprising information without a clear source; be it primary data or other literature; was rejected. A search for additional literature; found in reference lists of collected publications (snowball principle) continued until October 2008.

In the main, for the scoring of medicinal uses, only primary research was consulted. Secondary information in reviews was not included unless the original publication could be traced back or, in some cases, when the information was cited in sufficient detail. Older sources with primary information often lack a clear description of the conditions under which the information was collected. Some of them, like Kerharo and Bouquet (1950a), Dalziel (1937) and Kokwaro (1976), can nevertheless be regarded as original sources of information and have therefore been included. In many African cultures, human and veterinary medicine is based on the same concepts (McCorkle and Mathias-Mundy, 1992). Ethnoveterinary medicine has therefore been included in this review. In Appendix A, the uses were clustered by disorder categories, according to the Economic Botany Data Collection Standard (Cook, 1995). In the figures and text, these lumping categories were omitted and results are presented directly per selected medical use. For every medicinal use, the plant parts used are listed in Appendix A. For every plant part, one or more recipes are listed. For each recipe, the country of origin and the corresponding ethnic group is listed, followed by the publication in which the information was found.

3. Research effort

Most of the African ethnopharmacologic data on tamarind has been collected in central West Africa, notably Mali and Burkina Faso, and northern Nigeria (Fig. 1, for detailed information see Appendix A). In Mali, much research has been undertaken

on traditional medicine, whereas Burkina Faso has been extensively researched by agroforesters and food scientists, sometimes recording ethnobotanical information as part of their work. Northern Nigeria is the main source of knowledge on ethnoveterinary medicine in which tamarind plays a role, but also more general ethnobotanic and ethnopharmacologic work has been carried out there by, among others, the late Nina Etkin (1982, 1990). Senegal is well discussed in older literature, books and theses, but silently absent in more recent peer reviewed publications. The works by Dalziel (1937) and Kerharo and Bouquet (1950a,b) are among the oldest accounts of the ethnopharmacology of this region and are still often cited in species descriptions (e.g. Irvine, 1961; Burkill, 1995; Lanhers et al., 1996; El-Siddig et al., 2006; De Caluwé et al., 2009).

The second geographical concentration of ethnopharmacologic information on tamarind is in East Africa, notably Uganda, Kenya and Tanzania. The list of publications from this area starts in 1964 with the original work by F. Haerdi, carried out in the Ulanga district of southern Tanzania. The area where *Tamarindus indica* is found, however, extends further south into Mozambique and Madagascar and encompasses the savannas of Chad, Sudan and Ethiopia. In these areas, little or no ethnobotanical information on tamarind is available (Fig. 1). This is unfortunate, especially in the case of Sudan, a vast country with an amazing biocultural diversity in the heart of the tamarind's African distribution.

4. The most common uses of tamarind in Africa

Aligning the available information on the species ethnopharmacology in Africa, we find that tamarind is most commonly used as a laxative and in the treatment of wounds and abdominal pains, followed by diarrhoea, helminth infections, fever, malaria, aphrodisiac, respiratory problems and dysentery (Fig. 2). This list gives



Fig. 1. Locations where tamarind was recorded in ethnobotanic research. The black dots in this map represent the locations of the ethnobotanical surveys consulted for this paper. Tamarind naturally occurs in the savanna belt from Senegal to Ethiopia and south to Mozambique and Madagascar. Note the information gap in Chad and most of Sudan.

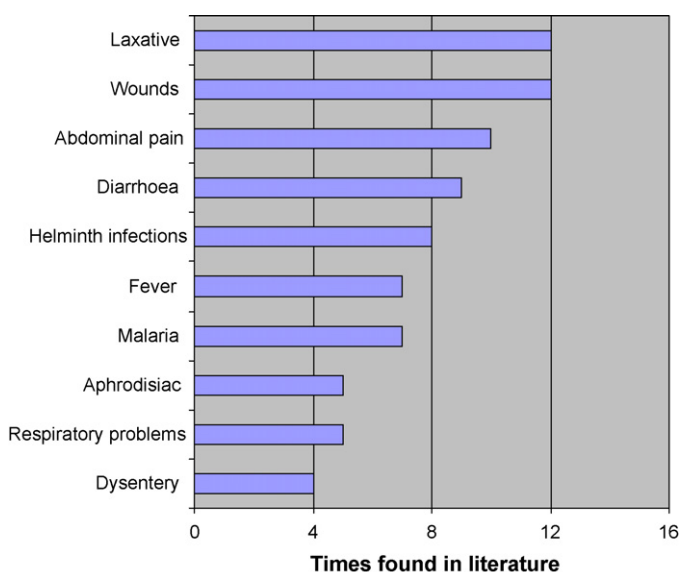


Fig. 2. Main ethnomedical applications of *Tamarindus indica* in Africa. A medical use is counted only once per publication.

only a first glance at the medical uses of tamarind in Africa. For a better understanding of the different uses, each bar in Fig. 2 will be discussed in detail in the following sections of paragraph four.

Many other plants have comparable virtues to those of tamarind, based on common phytochemical compounds like tannins that are similar to or even greater than those of tamarind. Therefore, it is important to note that this article does not discuss the medical applications for which tamarind is the most obvious ingredient. In the markets of Dakar, most medicinal plants sold are used to treat bowel problems and wounds (Tignokpa et al., 1986), showing that these conditions are commonly treated with traditional plant medicine. Therefore, the dominance of these categories among the uses of tamarind is not surprising. However, some studies support a relative importance of tamarind leaves or bark in the treatment of wounds (Fabiya et al., 1993; Inngjerdingen et al., 2004) and explicit reference to the treatment of circumcision cuts has been made for the use of tamarind leaves (Dalziel, 1937; Fandohan, 2007).

4.1. Laxative

With few exceptions, all laxative medicine is prepared from the fruit or fruit pulp. The use of the fruit as a laxative, due to the high amounts of malic and tartaric acids and potassium acid tartrate (Irvine, 1961), is universally recognised and can even be found in the pharmacopoeias of industrialised countries like France, Britain and the United States (Irvine, 1961; Morton, 1987). In Africa, this use is consistently found across the Sahel and Soudan zones from Senegal to Sudan, but also in Madagascar. Some older sources (Dalziel, 1937; Kerharo and Bouquet, 1950a) emphasize the common use of the fruits as a laxative. The laxative can be taken in form of a sweetmeat, called bengal by the Wolof of Senegal, prepared from the unripe fruit and sometimes mixed with lime juice or honey (Dalziel, 1937, p. 200). Kerharo and Adam (1974, p. 307) state that in most cases in Senegal, the fruits are peeled, deseeded and then mashed in a mortar. This fruit mass is then diluted with water or sanglé, a beverage based on milk and millet flour, and drunk with or without salt. The Dogon people of Central Mali macerate the fruit with the leaves of *Combretum micranthum* in water, until the drink develops a sour taste (Keita and Coppo, 1993, p. 84). In Bamako, Mali, drinks prepared from the pulp are used (Diarra,

1977, p. 45) and in Burkina Faso fruits are crushed and soaked for half a day in water with a little salt before consumption (Kerharo and Bouquet, 1950a, p. 114). Soaked fruit are also eaten by rural Fulani in Nigeria, to relieve constipation (Lockett et al., 2000, p. 201). In northern Benin, the fruit pulp is mixed into a water-based drink and sweetened to taste with sugar (Fandohan, 2007, p. 36). In eastern Sudan, people prepare an infusion or decoction (El-Kamali and El-Khalifa, 1999, p. 496), as they do in Togo (Adjanohoun et al., 1986 cited in Anonymous, 1993). Children in Madagascar are given whole tamarind fruits for breakfast to overcome constipation but an anal wash based on tamarind may also be used (Boiteau, 1986 cited in Anonymous, 1993).

Strikingly, there are no clear records of tamarind fruits used as a laxative in East Africa. Mpande and Mpofu (1995) have found tamarind used in the treatment of gastro-intestinal disorders in Zimbabwe, but the plant part is not specified. While almost all accounts of tamarind use as a laxative refer to the use of its fruit, a macerate of its leaves with potash has been reported in northern Nigeria (Bhat et al., 1990) and the pastoral Maasai of Kenya use a decoction of the bark for calves (Ole-Miaron, 2003). In Benin, the fresh bark of young stems is macerated for 24 h and taken orally as a purgative or for abdominal pain (Fandohan, 2007).

4.2. Wound healing

Tamarind is often cited in literature concerning the treatment of cuts, wounds and abscesses. In general, wound healing is an important application of plant based traditional medicine in developing countries (e.g. Tignokpa et al., 1986). In Mali, over 80% of wounds are treated using traditional medicine compared to pharmaceuticals (Diallo et al., 1996 cited in Inngjerdingen et al., 2004). Wounds are first washed with a decoction of a plant, followed by the application of dried powder of the species (Diallo et al., 2002; Inngjerdingen et al., 2004). As for tamarind, bark or leaves are most commonly used (Mali: Diallo et al., 2002; Benin: Fandohan, 2007; Mali: Inngjerdingen et al., 2004; Senegal: Kerharo and Adam, 1974), applied externally on the spot, either as a decoction or as a powder or poultice, alone or in combination with other species. A decoction of the leaves may be used to wash wounds and ulcers (Irvine, 1961; Kerharo and Adam, 1974), lesions or sores in the mouth (Tapsoba and Deschamps, 2006). Applying leaf powder to a wound is rather common (e.g. Inngjerdingen et al., 2004) and may be carried out to dry up open sores (Irvine, 1961). Fresh (Irvine, 1961) or boiled (Dalziel, 1937) leaf pulp can be applied as a poultice. Some studies mention the use of the leaves alone (Nigeria: Fabiya et al., 1993; Burkina Faso: Kerharo and Bouquet, 1950a; Kenya: Simitu and Oginosako, 2005, p. 19). In the medicinal plant market in Dakar, tamarind bark was mostly sold for wound healing purposes (Tignokpa et al., 1986). Occasionally other tamarind plant parts are found in wound healing medicine, like the fruit (Tapsoba and Deschamps, 2006), the pod husks (Kerharo and Adam, 1974) or the gum (Inngjerdingen et al., 2004). At the beginning of the century, leaves were used as a dressing around circumcision cuts in Dagariland, Burkina Faso (Dalziel, 1937). Recently, the use of a leaf decoction to wash circumcision wounds was found in nearby Benin (Fandohan, 2007, p. 35).

The fact that tamarind leaves and bark are often mentioned in connection to wound healing does not automatically prove it is the most appreciated species for this purpose. In the Bamako region of Mali, for instance, tamarind was not among the 15 most important species used for wound healing (Diallo et al., 2002). In Dogonland, on the other hand, tamarind was the second most important ingredient in wound healing medicine. It was found in wound healing in 6 out of 22 villages, only to be surpassed by *Guiera senegalensis* that was found in a total of nine villages (Inngjerdingen et al., 2004). In Bauchi state, Nigeria, a decoction of tamarind leaves was one of the

most important agents to clean wounds caused by Guinea worm infections (Fabiya et al., 1993).

The perceived medicinal effects of tamarind leaves (Fabiya et al., 1993), bark (Kerharo and Adam, 1974; Tignokpa et al., 1986) and pod husks (Fl Congo Belgique iii438 cited in Irvine, 1961) relate to its anti-inflammatory activity and scarification or cicatrization (the formation of scar tissue).

4.3. Abdominal pain

Abdominal pain is not a specific disorder but a complaint, indexed by Cook (1995), which refers to a painful abdomen and which may have a wide variety of causes, including constipation or diarrhoea. Depending on the underlying cause, abdominal pain may be treated with various parts of *Tamarindus indica*. When a plant is recorded in the literature as a remedy to alleviate a painful or distended abdomen, this often implies that the actual problem was not stated. Knowing which plant parts of tamarind are used for which abdominal complaints (see Appendix A under 'digestive system disorders') without knowing their cause, we could turn the argument around and start probing for the disorder that has caused the abdominal pain based on the part of the tamarind used in the treatment. When fruit is used (Etkin and Ross, 1982; Ichikawa, 1987, p. 34; Norscia and Borgognini-Tarli, 2006), constipation may have been the cause, assuming the fruit is given as a laxative. Bark treatments for abdominal pain in Nigeria (Doughari, 2006) could well refer to diarrhoea. When leaves are used, it is more difficult to assess what may have caused the abdominal pain. In East Africa

this could be diarrhoea (Haerdi, 1964; Fleuret, 1986; Chhabra et al., 1987) whereas in West Africa, although atypical, leaves have been recorded as a laxative (Bhat et al., 1990) and macerated fresh bark of the young twigs was used both as a purgative and to relieve abdominal pain (Fandohan, 2007). Roots are repeatedly found in the treatment of stomach ache or painful abdomen, mainly in East Africa, prepared as an extract (Chhabra et al., 1987; Ichikawa, 1987; Geissler et al., 2002), but also in Burkina Faso (Kristensen and Balslev, 2003).

4.4. Diarrhoea and dysentery

Other important disorders treated by tamarind include diarrhoea and dysentery. Dysentery is a kind of diarrhoea containing mucus or blood, usually caused by an infection of the intestine. When diarrhoea is not treated accurately, the patient risks dehydration and death. In tropical countries, diarrhoea is one of the major health problems and frequently occurs during rainy weather (Heinrich, 1998 cited in Gutiérrez et al., 2008). There appears to be a striking dissimilarity between West and East Africa in the treatment of diarrhoea. For West Africa, literature only mentions the use of the bark. It can be applied as a decoction (Dalziel, 1937; Kerharo and Bouquet, 1950a; Traoré, 1983; Keita and Coppo, 1993), pulped with lemon (Kerharo and Bouquet, 1950a) or macerated in milk (Keita and Coppo, 1993). In East Africa, it is not the bark but the leaf that is used (Fig. 3), made into a juice or beverage (Haerdi, 1964; Chhabra et al., 1987) or prepared in a concoction with *Sterculia africana* (Kokwaro, 1976). In Kenya the use of ground seeds

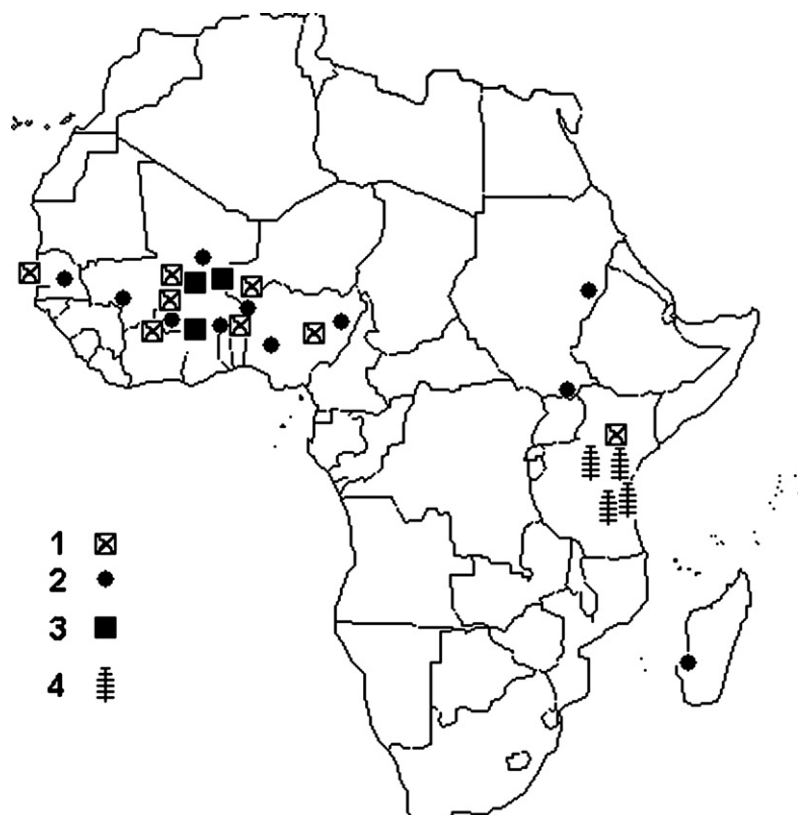


Fig. 3. Distribution of four common applications of tamarind in African traditional medicine. The use of the fruits as a laxative is found from Senegal in the west through Sudan in the east and in the same range, fruits are used to treat fever and malaria (see Section 4.6). Leaves and bark are used everywhere in central West Africa for wound healing, whereas only bark is used to treat diarrhoea. In East Africa, only leaves are found in diarrhoea medicine.

Key:

- 1: Leaves and/or bark used for wound healing.
- 2: Fruits used as a laxative.
- 3: Bark used to treat diarrhoea.
- 4: Leaves used to treat diarrhoea.

has been recorded (Simitu and Oginosako, 2005) and in Tanzania the root is used to treat dysentery (Chhabra et al., 1987).

4.5. Helminth infections (parasitic worms)

The bark is used in Dogon country (Traoré, 1983 cited in Fortin et al., 1990) and the Office du Niger area (Bah et al., 2006), both in Mali, to treat schistosomiasis (bilharzia), a worm infection of the gut or urinary tract. Inngjerdingen et al. (2004) confirm the use of the bark in Dogon country for helminth infections, but ascribe it to the treatment of internal wounds caused by the worms. Among the Guiziga and Moundang of Cameroun, crushed and boiled seeds of tamarind were mentioned most often for the treatment of 'red urine' or urinary schistosomiasis (Hewlett and Cline, 2001). In Zimbabwean traditional medicine, root extracts of two other Fabaceae (*Abrus precatorius* and *Pterocarpus angolensis*) are important agents to treat schistosomiasis and have been shown to be lethal to schistosomes (Ndamba et al., 1994). The authors suggest, based on the doctrine of signatures, a link between the red colour of Fabaceae extracts and the main symptom of schistosomiasis: haematuria (bloody urine). Tamarind leaves are used in the extraction of Guinea worms in Nigeria, and afterwards in the treatment of wounds, left by the parasite (Fabiya et al., 1993). Keita and Coppo (1993) describe another way in which tamarind is used as a vermifuge (literally 'worm-expulsor'), based on its laxative effect: "... Cette préparation peut provoquer diarrhée et évacuation d'éventuels vers par les selles⁴ (Keita and Coppo, 1993)". The preparation, a sour macerate of tamarind fruits and leaves of *Combretum micranthum*, was applied as a laxative and for the expulsion of unwanted 'passengers'. In Ethiopia, a macerate of the seeds is used as vermifuge (Le Floch et al., 1985) and in Niger, it is the fruits that are used for this purpose (Adjanohoun, 1985; Anonymous, 1993). An extract of the leaves and the root is used to treat ankylostomiasis (hookworm) in parts of Tanzania (Haerdi, 1964).

4.6. Fever and malaria

Fruits are known as a febrifuge in Madagascar (Norscia and Borgognini-Tarli, 2006) and throughout the Soudan (Dalziel, 1937). In Benin (Fandohan, 2007) and Sudan (El-Kamali and El-Khalifa, 1999) the fruits are used to treat malaria. Malaria is treated with tamarind leaves in Ghana (Asase et al., 2005), Benin (Fandohan, 2007) and Nigeria (Bhat et al., 1990). The use of the fruit pulp as a febrifuge seems to be connected to its use as a laxative in the Sahel and Soudan regions. Both problems are not only treated with the same ingredient (e.g. Kerharo and Adam, 1974) all across the savanna belt from Senegal to Ethiopia, but also records of identical recipes based on tamarind fruit pulp exist for the treatment of malaria or fever and constipation. This is the case in Senegal (Dalziel, 1937), Benin (Fandohan, 2007) and Sudan (El-Kamali and El-Khalifa, 1999) where the recipe involves preparing a solution of tamarind pulp and water, sometimes involving a boiling step.

4.7. Other consistent uses

Few remaining applications of tamarind show any consistency in the plant part used. Leaves are known as a tonic in Benin (Fandohan, 2007), Burkina Faso (Kerharo and Bouquet, 1950a) and Nigeria (Doughari, 2006). The bark is used to treat asthma or coughs in Mali (Traoré, 1983 cited in Fortin et al., 1990) and East Africa (Kokwaro, 1976) and tamarind leaves have been recorded in two different recipes for coughs in Burkina Faso (de la Pradilla, 1981

⁴ "This preparation can provoke diarrhoea and the expulsion of possible worms from the intestine."

cited in Kerharo and Bouquet, 1950a; Fortin et al., 1990) and one in Kenya (Simitu and Oginosako, 2005). Four publications mention tamarind as an aphrodisiac but all recorded different plant parts: in Mali, the roots (Ahua et al., 2007), flowers or twigs (Gustad et al., 2004) were used whereas in Côte d'Ivoire people use the fruit pulp (Kerharo and Bouquet, 1950b) and in Benin, the bark (Fandohan, 2007).

Traditional medicine in Africa is often composed of more than one ingredient. Bah et al. (2006) conclude that tamarind is part of orally administered Malinese anti-schistosomiasis remedies as an additive to render it more palatable by providing a pleasant sour taste. The recipes are often a combination of either tamarind or otherwise sour citrus fruits. In Burkina Faso, an emetic preparation is made of *Trichilia emetica* combined with lemon (Kerharo and Bouquet, 1950b), and in Senegal, the same recipe was combined with tamarind (Kerharo and Adam, 1974). In combinations like these, the question remains as to the source of the bioactivity and whether tamarind is added to a compound medicine because of medicinal or sensorial properties.

5. Differences between East and West Africa

We have already established that most published ethnopharmacologic information on tamarind refers to the western Sahel zone and East Africa (Fig. 1). However, there is a marked difference between the two regions (Fig. 3). The use of the fruits as a laxative, probably the most common medical application of tamarind, is found in the Sahel from west to east, with an information gap around Chad and Darfur. In the East African 'centre of published knowledge' (Uganda, Kenya, Tanzania) however, records of tamarind fruits used as a laxative or of its bark used in wound healing, are absent. Also the use of leaves in wound healing has been recorded in Kenya only once (Simitu and Oginosako, 2005), whereas tamarind leaves are commonly used to treat wounds in West Africa (e.g. Inngjerdingen et al., 2004). As the fruit is so commonly used as a laxative in West Africa and Sudan, it seems premature to state that in East Africa, tamarind fruit is simply not used as such. In West Africa the fruits are used as a laxative for children and pregnant women (Kerharo and Bouquet, 1950a). Perhaps East African ethnobotanical interviews were predominantly obtained from male traditional healers. Traditional healers possess specialised knowledge rather than general knowledge of common, less serious ailments, such as constipation, that form part of the female domain of home remedies (Geissler et al., 2002, p. 41). Some studies from East Africa are indeed based on interviews with traditional healers (Haerdi, 1964, p. 10). Others focus on a specific illness like malaria or leprosy (Moshi et al., 2005; Makundi et al., 2006; Tabuti, 2008). If tamarind fruit was to be commonly used as a laxative, it would likely have shown up as such in the household or women oriented studies by Tabuti et al. (2003, p. 20) or Geissler et al. (2002, p. 42), or in a general work like 'Medicinal Plants of East Africa' (Kokwaro, 1976, p. 123). It seems that the fruits are used optionally for the treatment of stomach disorders by the Suiei Dorobo hunter-gatherers of northern Kenya (Ichikawa, 1987) and in Kitui, Kenya, to treat scurvy (Simitu and Oginosako, 2005), a symptom of vitamin C deficiency. The other studies conducted in East Africa and consulted for this review do not mention medicinal uses of tamarind fruit at all. Fleuret (1986, p. 66–67) discusses the role of edible fruits used in home remedies prepared by Taita mothers in Kenya but laxatives are not mentioned.

Although the lack of evidence for one thing does not prove the contrary, the use of tamarind as a laxative in East Africa seems to be much less frequent than in the Soudano-sahelian parkland zone or may even be absent. Assuming there is a difference between the ways tamarind is used medicinally in East and West Africa, an alter-

native explanation could be that the use of laxatives in general is much more common in West Africa than it is in East Africa. Surinamese Maroons, a South American people descendent from West Africans, consider constipation or 'cold' a dangerous illness that can be cleared out with a laxative (Fleury, 1991 cited in Odonne et al., 2007, p. 320). The use of laxatives may therefore be related to indigenous health beliefs, rather than to prevalent diseases (van Andel, 2009). Indigenous therapeutic systems in West Africa prescribe expulsive medicine like diuretics, emetics, laxatives etc., to remove a disease from the body (Kerharo and Adam, 1974; Etkin and Ross, 1982). This concept of disease egress could be an explanation for the distinctive use of tamarind as a laxative in West Africa.

Tamarind is a common species in parklands, the prevalent Soudano-sahelian land use system defined by farmland with scattered multipurpose trees in between the fields. This agroforestry system is composed of the same species from the Atlantic side in Senegal to the Red Sea coast in the east (Pélissier, 1980). Similar uses of tamarind across this west to east dryland belt could share the same origin as the parkland system that is found here. More recently, the pastoral Fulani people could have played a role in spreading tamarind and its medical and cultural uses. Another Soudanian fruit species, the baobab (*Adansonia digitata*), is known to have dispersed along Fulani migration routes and established from discarded seeds (Blench, 2001). The Fulani expansion from central Mali since the late Middle Ages has left pockets of Fulani populations across the savanna from Senegal to Chad and Sudan (Gajdos, 1995). In the middle and south of Benin, tamarind is traditionally regarded as the tree of the Fulani, suggesting that it was they who brought it from the north. Nowadays, Fulani people in Benin still tend to appropriate the harvest from any tamarind tree in the area, even if it does not grow on their own land (Fandohan, 2008). Finally, local abundance may have influenced the differences in uses between the two regions. Whereas tamarind is common in the Soudanian parklands of West Africa (e.g. Pélissier, 1980), it is said to be rare in most of Kenya (Ichikawa, 1987; Muok, 2005). For the treatment of common medical complications, people are likely to pick an alternative that is more readily available.

6. Bark or leaves?

Where Tanzanians use tamarind leaves to treat diarrhoea, West Africans use the bark. Throughout West Africa, both plant parts are used to treat wounds. In the Caatinga drylands of Brazil, anti-inflammatory and wound healing uses of a plant have shown to be related to a high tannin content (de Sousa Araújo et al., 2008), which suggests that tannins are the bioactive compounds in those treatments. Indeed, both the bark and the leaves of tamarind are known to contain tannins (De Caluwé et al., 2009). Although tamarind parts were recorded by several researchers focussing on traditional methods for wound healing (Fabiya et al., 1993; Diallo et al., 2002; Inngjerdingen et al., 2004), we did not come across tamarind in publications on anti-diarrhoea plants. This implies tamarind is not on the short list of important anti-diarrhoeal plants in Africa, in spite of the apparent anti-diarrhoeal effect of its bark and leaves.

Now the question remains as to what determines the choice between bark and leaves. The geographic separation within Africa in the use of the two plant parts for diarrhoea might argue for an 'ethnobotanic drift': the plant part used was initially selected by chance, and then continued to be used without further investigation of other plant parts' effectiveness. The way a species was used by past generations often predicts the present use of the plant (Ganaba et al., 1998; Kristensen and Balslev, 2003). Tanzania and the southern parts of Uganda and Kenya were colonised during

the second Bantu-expansion (1st millennium BC), bringing people and cultural habits from the Congolian rainforests rather than from the dry savannas further north (Collins and Burns, 2007) where tamarind grows. These newcomers were probably unfamiliar with a lot of plants they encountered in the East African hills, including tamarind, and had to improvise with the new resources around them. Perhaps they were familiar with the use of leaves, not of bark, of other species in the treatment of diarrhoea. Groups of the Nilotic Luo and Maasai peoples on the other hand, percolated into the area from Sudan and Ethiopia roughly between 1000 and 1600 AD (Collins and Burns, 2007) and could have brought along knowledge on the tamarind's uses from their heartland. In publications discussing their ethnobotany however (Geissler et al., 2002; Ole-Miaron, 2003), we could not find any of the common uses, shown in Fig. 3.

In West Africa where both bark and leaves are used in wound healing, often by the same people (Diallo et al., 2002; Inngjerdingen et al., 2004; Fandohan, 2007), the choice between using bark or leaves may be correlated with different concentrations of active compounds. As tamarind bark contains up to 70% tannins (De Caluwé et al., 2009) this could be a much stronger and more toxic agent than the leaves. This may explain why only preparations made of the leaves, not the bark, have been recorded for the treatment of sensitive wounds such as circumcision cuts (Dalziel, 1937; Fandohan, 2007). Leaf and bark of tamarind have also been recorded for the treatment of coughs and as a skin cleanser (see Appendix A). Epidermal and gastro-intestinal tissues – the gut, lungs, skin and eyes for example – are all derived of the embryonic endoderm. Afflictions of all of these body parts are treated with astringent tannin containing bark or leaves of tamarind (this review, Appendix A). The use of astringents for the treatment of these tissues is supported by other research. Leaves of *Psidium guajava* are used as an astringent for problems related to the skin and gut, including wounds, diarrhoea, coughs and abdominal pain (Gutiérrez et al., 2008) and the Popoluca people of Mexico almost always use astringent plant parts, most commonly bark and roots, as a remedy for diarrhoea and dysentery (Leonti et al., 2002). It would be interesting to see whether in ethnopharmacology worldwide, a correlation exists between the use of tannin-containing astringent plant parts and the treatment of epidermal and gastro-intestinal tissues.

7. Conclusion

Ethnopharmacological information on tamarind has been recorded mainly in central West Africa and East Africa. More research needs to be carried out in Chad and Sudan, where documentation of medicinal plant use is scant or missing. Given the fact that tamarind is a common species in this region, the absence of data is probably due to an overall lack of ethnobotanic research. The difference in medicinal uses of tamarind between West and East Africa correlates with the cultural division of the two regions. East Africa is colonised from the rainforest by Bantu people, probably unfamiliar with tamarind upon arrival in the East African drylands, whereas West Africa and the Soudan and Sahel zones have been connected through the course of history by human movements and trade. One of the main applications of tamarind is the use of its fruit as a laxative. This use, however, is confined to the Sahel and Soudan regions, and seems to be absent in East Africa. The reason could be a relative importance of purgatives as a culture-bound remedy, specific for that region. To increase the understanding of the use of purgatives in West African cultures, including those of the diaspora in the New World, a review or focussed ethnobotanic field study on that issue is necessary. Leaves and bark of tamarind are used in wound healing and to soothe or cure ailments of other tissues derived of the embryonic endoderm. This supports the hypothesis

that the choice of plant species and plant parts used to treat tissues derived of the embryonic endoderm can be predicted by their tannin composition. As one of the most important economic trees in the Sahel, tamarind is a reliable source of affordable medicaments for rural people.

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Appendix A. Medicinal uses of tamarind in Africa

	Disorder category ^a	Medicinal use ^b	Plant part	Preparation	Country	Ethnicity	Reference
1	Unspecified	Fortifiant	Bark and leaf	Decoction of fresh plant parts with potash used as blood tonic	Nigeria	–	Doughari (2006)
2			Fruit pulp	The fruit has the reputation to be a fortifiant for children, old people and travellers	Senegal	–	Giffard (1974)
3			Leaf	Decoction of the leaves use for bathing children and given to drink to get strong	Burkina Faso	–	Kerharo and Bouquet (1950a)
4			Leaf, fruit	Add decoction of the leaves and fruits to millet porridge and drink	Benin	Dendi, Fulani, Gourmantché, Haussa	Fandohan (2007)
5		Jaundice ^c	Bark and leaf	Decoction of fresh plant parts with potash	Nigeria	–	Doughari (2006)
6			Fruit	A handful of fruits is macerated with powdered <i>Cassia siberiana</i> bark and the extract drunk	Niger	Hausa	Adam et al. (1972) cited in Neuwinger (1996)
7	Circulatory	Chest complaints	Root	Not specified	Eastern Soudan zone	–	Dalziel (1937)
8		Heart disease	Fruit (unripe)	Chew with onion and swallow to treat palpitations	Benin	Dendi, Fulani, Gourmantché, Haussa	Fandohan (2007)
9			Leaf; unknown	Decoction of the leaves of tamarind, <i>Combretum micranthum</i> and <i>Guiera senegalensis</i> ; 'Tamarind' combined with <i>Azelia africana</i> and iron fillings	Burkina Faso	–	Kerharo and Bouquet (1950a)
10			Root/ leaf	Drink root extract and leaf juice against pains of heart	Tanzania	Several tribes involved	Haerdi (1964)
11		Hypotension	Leaf	Infusion taken 3 times a day	Madagascar	Veso-Sakalava Malagasy	Norscia and Borgognini-Tarli (2006)
12	Digestive System	Abdominal pain	Bark	Well the fresh bark of young twigs in water for 24 h and drink as purgative and to treat abdominal pain	Benin	Dendi, Fulani, Gourmantché, Haussa	Fandohan (2007)
13				Powdered bark given to calves with intestinal problems due to over eating	Senegal	Fulani	Kerharo and Adam (1964) cited in Burkill (1995)
14			Bark and leaf	Decoction of fresh plant parts with potash against stomach disorders	Nigeria	–	Doughari (2006)
15			Fruit	Beverage	Madagascar	Veso-Sakalava Malagasy	Norscia and Borgognini-Tarli (2006)
16			Fruit or root and bark	Fruit or root and bark soaked in water for stomach disorders	Kenya	Suiei Dorobo	Ichikawa (1987)
17			Fruit/ leaf	Not specified	Nigeria	Hausa	Etkin and Ross (1982)
18			Root	Root decoction drunk for distended painful abdomen	Tanzania	–	Chhabra et al. (1987)
19				Decoction drunk for stomach ache	Kenya	Luo	Geissler et al. (2002)
20				Treatment for stomach ache not specified	Burkina Faso	Gourounsi	Kristensen and Balslev (2003)
21			Unknown	"tamarind liquid" used for gastro-intestinal disorders	Zimbabwe	Tonga	Mpande and Mpofu (1995)
22		Chew sticks	Wood	Not specified	West Africa	–	Dalziel (1937)
23		Diarrhoea	Bark	Decoction, used as astringent	West Africa	–	Dalziel (1937)

Appendix A (Continued)

Disorder category ^a	Medicinal use ^b	Plant part	Preparation	Country	Ethnicity	Reference
24			Ground stem bark is mixed into fresh milk. This suspension is drunk by the diseased person. A decoction may also be used	Mali	Dogon	Keita and Coppo (1993)
25			Pounded bark with lemon or prepared as decoction	Burkina Faso	–	Kerharo and Bouquet (1950a)
26			Decoction of stem bark with <i>Acacia nilotica</i> var. <i>adansonii</i> and <i>Raphia pubescens</i> to treat nausea in combination with diarrhoea	Mali	–	Traoré (1983) cited in Fortin et al. (1990)
27		Leaf	Juice of crushed leaves drunk against bloody diarrhoea	Tanzania	–	Chhabra et al. (1987)
28			Not specified	Kenya	Taita	Fleuret (1986)
29			Drink leaf juice	Tanzania	Several tribes involved	Haerdi (1964)
30			Decoction of leaves of tamarind and twigs of <i>Sterculia africana</i> , drink cupful after it has cooled down, for treatment of diarrhoea and dysentery	East Africa	–	Kokwaro (1976)
31		Seed	Powdered seeds administered orally	Kenya	–	Simitu and Oginosako (2005)
32	Dysentery	Green stem bark	Absorption of filtrated fresh milk with green bark to treat amoebic dysentery	Mali	–	Traoré (1983) cited in Fortin et al. (1990)
33		Leaf	Decoction of leaves of tamarind and twigs of <i>Sterculia africana</i> , drink cupful after it has cooled down, for treatment of diarrhoea and dysentery	East Africa	–	Kokwaro (1976)
34		Root	Root decoction drunk	Tanzania	–	Chhabra et al. (1987)
35		Seed	Powdered seeds administered orally	Kenya	–	Simitu and Oginosako (2005)
36	Laxative	Bark	The fresh bark of young twigs is soaked in water for 24 h and drunk as purgative and to treat abdominal pain	Benin	Dendi, Fulani, Gourmantché, Haussa	Fandohan (2007)
37			Decoction used as laxative for calves	Kenya	Maasai	Ole-Miaron (2003)
38		Fruit	Decoction of the fruit, administered orally	Togo	–	Adjanohoun et al. (1986) cited in Anonymous (1993)
39			Eaten raw or prepared as 'lavement' for constipation	Madagascar	–	Boiteau (1986) cited in Anonymous (1993)
40			Processed into laxative beverage	Mali	–	Diarra (1977)
41			Infusion or decoction of the fruit	Sudan	Several tribes involved	El-Kamali and El-Khalifa (1999)
42			Drink macerate of fruits in water, for constipation	Nigeria	Fulani	Lockett et al. (2000)
43			Sweetmeat called bengal prepared of the fruit pulp by Wolof of Senegal. Used as laxative mixed with honey or lime juice	West Africa	–	Dalziel (1937)
44			Mix fruit pulp with water and add sugar for taste, then drink as laxative, purgative or for constipation	Benin	Dendi, Fulani, Gourmantché, Haussa	Fandohan (2007)
45			The fruits are welled with leaves of <i>Combretum micranthum</i> until the water has taken an acid taste, then drink. Also used to treat nausea	Mali	Dogon	Keita and Coppo (1993)
46			Crushed and soaked for half a day in water with a little salt before administration	Côte d'Ivoire and Burkina Faso	not specific	Kerharo and Bouquet (1950a)
47			Mashed fruit pulp is mixed with water or <i>sanglé</i> , a beverage based on milk, and given to drink with or without salt	Senegal	–	Kerharo and Adam (1974)

Appendix A (Continued)

	Disorder category ^a	Medicinal use ^b	Plant part	Preparation	Country	Ethnicity	Reference
48			Leaf	Macerate of leaves with potash in water	Nigeria	–	Bhat et al. (1990)
49		Vomiting	Fruit	In leprosy treatment to enhance the emetico-cathartic properties of <i>Trichilia emetica</i> ; A mixture of Cantharides-powder and tamarind pulp is taken by the patient before the syphilis treatment starts	Senegal	Wolof	Kerharo and Adam (1974)
50		Vomiting: stop	Leaf; unknown	Hyperemesis: decoction of the leaves of tamarind, <i>Combretum micranthum</i> and <i>Guiera senegalensis</i> ; 'Tamarind' combined with <i>Afzelia africana</i> and iron fillings	Côte d'Ivoire	–	Kerharo and Bouquet (1950a)
51			Root/ leaf	Drink root decoction or use leaf juice as a basis for a thin porridge to stop vomiting	Tanzania	–	Hedberg et al. (1982)
52			Stem bark	Decoction with <i>Acacia nilotica</i> var. <i>adansonii</i> and <i>Raphia pubescens</i> to treat nausea in combination with diarrhoea	Mali	–	Traoré (1983) cited in Fortin et al. (1990)
53	Endocrine System	Diabetes	Leaf	Not specified	Guinea	–	Baldé et al. (2006)
54	Genitourinary System	Aphrodisiac	Bark	Mash and add to porridge to treat impotence	Benin	Dendi, Fulani, Gourmantché, Haussa	Fandohan (2007)
55			Flower/ twigs	Not specified	Mali	Bambara, Fulani, Marka	Gustad et al. (2004)
56			Fruit pulp		Côte d'Ivoire	–	Kerharo and Bouquet (1950b)
57			Not specified	Preparation method not specified. To treat impotence and sterility	Senegal	–	Kerharo and Adam (1974)
58			Root	Powder to treat sexual asthenia	Mali	–	Ahua et al. (2007)
59		Contraceptive	Not specified	Large quantity of 'tamarind' infusion drunk by the woman before sexual intercourse; Mixture of 'tamarind' with pepper and honey in water, called Konkori Badji	Mali	–	Laplante and Soumaoro (1973)
60		Diurethic	Unspecified/ bark	In the treatment of gonorrhoea: food prepared of millet with 'tamarind' and ground seeds of <i>Jatropha curcas</i> or with <i>Trichilia emetica</i> (Wolof); Medicine prepared bark of tamarind and that of <i>Prosopis africana</i> (Toucouleur)	Senegal	Wolof; Toucouleur	Kerharo and Adam (1974)
61		Infertility	All arial parts	Crush all parts and soak in water; give 10cl of the solution orally to the cattle two or three times a day	Nigeria	Fulani	Alawa et al. (2002)
62	Infections/ Infestations	Cold	Fruit pulp	Mix with water and add sugar for taste, then drink	Benin	Dendi, Fulani, Gourmantché, Haussa	Fandohan (2007)
63		Fever	Fruit	Fruit pulp used in the treatment of fever for refreshment and to quench thirst. Often followed by rubbing the roughly dehusked pods with some vinegar on to the body of the feverish patient	Senegal	–	Kerharo and Adam (1974)
64				Beverage	Madagascar	Veso-Sakalava Malagasy	Norscia and Borgognini-Tarli (2006)
65			Fruit pulp/ bark	Drink boiled, evaporated pulp that is partly dissolved in water	All over Soudan	–	Dalziel (1937)
66			Leaf	Leaves ground with those of <i>Prosopis africana</i> , taken orally with water to treat malaria fever	Nigeria	–	Bhat et al. (1990)

Appendix A (Continued)

	Disorder category ^a	Medicinal use ^b	Plant part	Preparation	Country	Ethnicity	Reference
67				Herbal bath	Benin	Dendi, Fulani, Gourmantché, Hausa	Fandohan (2007)
68				Decoction	Kenya	–	Simitu and Oginosako (2005)
69	Malaria		Root	Drink root decoction	East Africa	–	Kokwaro (1976)
70			Bark	Decoction with <i>Mangifera indica</i> (part used of the latter species unclear)	Uganda	–	Tabuti (2008)
71			Fruit	Infusion or decoction of the fruit	Sudan	Several tribes involved	El-Kamali and El-Khalifa (1999)
72				Fruit juice drunk for malaria	Sudan	–	Imbabi et al. (1992)
73			Leaf	Leaves ground with those of <i>Prosopis africana</i> , taken orally with water to treat malaria fever	Nigeria	–	Bhat et al. (1990)
74			Leaf/ bark	Decoction of leaves and stem bark to drink	Ghana	Brefo, Wale	Asase et al. (2005)
75			Leaf/ fruit pulp	Mix fruit with water and add sugar for taste, then drink	Benin	Dendi, Fulani, Gourmantché, Hausa	Fandohan (2007)
76			Unknown	Ground and possibly boiled, administered hot or cold, treatments ranging from three to five days	Tanzania	Sagara, Kaguru, Vidunda, Zigue	Makundi et al. (2006)
77	Helminth infections (parasitic worms)		Bark	Macerate used in the treatment of vesical schistosomiasis	Mali	–	Traoré (1983) cited in Fortin et al. (1990)
78			Bark/ leaf/ fruit	In decoction or macerate with other plants, drink for schistosomiasis	Mali	Bambara, Minianka, Mossy, Fulani	Bah et al. (2006)
79			Bark/ leaf	Dried leaves or stem bark applied for internal wounds caused by worms	Mali	Dogon	Inngjerdingen et al. (2004)
80			Fruit	Vermifuge not specified	Niger	–	Adjanohoun (1985) cited in Anonymous (1993)
81			Leaf	Decoction with anti-inflammatory and cicatrisating properties used in the external treatment of dracunculiasis	Nigeria	–	Fabiyyi et al. (1993)
82			Root/ leaves	Drink leaf juice and root extract together with root abstract of <i>Mimosa pigra</i> and soil from Chikula (kind of termite nest) for ankylostomiasis (hookworm)	Tanzania	Several tribes involved	Haerdi (1964)
83			Seed	Crushed and boiled seeds used to treat urinary schistosomiasis, mode of administration not given	Cameroun	Guizinga, Moundang	Hewlett and Cline (2001)
84				Seeds are welled in water for an entire night. The macerate is used as vermifuge	Ethiopia	Afar	Le Floc'h et al. (1985)
85	Hepatitis A		Leaf	Not specified	Guinea-Bissau	–	Lima (1984)
86		Leprosy	Bark/ root	Drink root and bark extract together with root and bark extract of <i>Stereospermum kunthianum</i>	Tanzania	Several tribes involved	Haerdi (1964)
87			Root/ bark/ pod husks	Decoction of bark and pod husks and bark and leaves of <i>Diospyros mespiliformis</i> added to porridge made of <i>Sorghum bicolor</i>	Nigeria	–	Dalziel (1937)
88			Unknown	In combination with 30 other species	Burkina Faso	–	Kerharo and Bouquet (1950a)
89	Measles		Pods/ leaves	Burnt to symbolise the disease egress through the skin	Nigeria	Hausa	Etkin et al. (1990)
90	Microbial infections		Fruit	Soaked fruit, oral administration to treat infectious diseases including STD's	Guinea	Malinké or Sousou	Magassouba et al. (2007)

Appendix A (Continued)

	Disorder category ^a	Medicinal use ^b	Plant part	Preparation	Country	Ethnicity	Reference
91		Blackleg	Root/ stem bark	Application not specified, plant parts used in the treatment of blackleg in ruminants	Nigeria	Fulani	Abdu et al. (2000) cited in Useh et al. (2006)
92		Mumps	Leaf	Pounded leaves with water applied to the cheeks	Benin	Dendi, Fulani, Gourmantché, Haussa	Fandohan (2007)
93		Newcastle disease	Bark	Bark extract added to poultry food to treat Newcastle disease	Malawi	–	Clements, Herb. Oxf., cited in Irvine (1961)
94		Sleeping sickness	Leaf, fruit	Boil leaves and give to animals to drink; grind fruits with raw beans and give animals to feed	Nigeria	Hausa, Fulani	Atawodi et al. (2002)
95			Root/ leaf	Leaf and root of tamarind, <i>Azelia africana</i> and <i>Ficus</i> given in decoction to drink, bath and vapor bath	Burkina Faso	Kong	Kerharo and Bouquet (1950a)
96			Unknown	Not specified	Nigeria	–	Ahua et al. (2007)
97			Unknown	"tamarind liquid" added to the drinking water of the animals	Zimbabwe	Tonga	Mpande and Mpofu (1995)
98		Syphilis	Root	Drink decoction	Uganda	–	Tabuti et al. (2003)
99		Yellow fever	Bark and leaf	Decoction of fresh plant parts with potash	Nigeria	–	Doughari (2006)
100	Inflammation	Bronchitis	Leaf	Leaf juice with ginger in the treatment of bronchitis	Burkina Faso	–	Kerharo and Bouquet (1950a)
101		Inflammation	Bark	Dried and pounded and added to water for the treatment of eye inflammation	West Africa	–	Lynn, cited in Irvine (1961)
102				Rubbing on the skin	Madagascar	Veso-Sakalava Malagasy	Norscia and Borgognini-Tarli (2006)
103			Leaf	Decoction used to treat inflammation of the wound left by the Guinea worm	Nigeria	–	Fabiya et al. (1993)
104	Injuries	Wounds	Bark	Not specified	Senegal	–	Tignokpa et al. (1986)
105			Leaf	Not specified, fresh leaves used to treat breast abscess	Niger	–	Adjanohoun (1985) cited in Anonymous (1993)
106				Applied externally on open sores and other wounds; decoction used as a wash; dried and pulverised as dressing; fresh and pounded as poultice; boiled and pulped as poultice	West Africa	–	Dalziel (1937)
107				Decoction used in cicatrisation	Nigeria	–	Fabiya et al. (1993)
108				Pounded leaves used as dressing around circumcision cuts	Burkina Faso	Dagari	Kerharo and Bouquet (1950a)
109				Fresh young leaves applied or prepared as poultice on wounds, ulcers and abscesses	Kenya	–	Simitu and Oginosako (2005)
110			Leaf/ bark	Dry pulverised bark to heal incurable wounds. Leaf decoction used to wash circumcision cuts. Fresh leaves with water are brought to the boiling point and left to cool down. The circumcised child is placed on the lukewarm decoction and its wounds are washed	Benin	Dendi, Fulani, Gourmantché, Haussa	Fandohan (2007)
111				Powdered or mashed, applied to foul sores	Mali	–	Traoré (1983) cited in Fortin et al. (1990)
112				Not specified	Mali	–	Diallo et al. (2002)
113				Decoction of the leaves is used as wash; Leaf powder is applied; Bark powder mixed with powder of fruit from <i>Hibiscus sabdariffa</i> is applied; Gum powder is applied for odontitis	Mali	Dogon	Inngjerdigen et al. (2004)

Appendix A (Continued)

	Disorder category ^a	Medicinal use ^b	Plant part	Preparation	Country	Ethnicity	Reference
114			Leaf/ bark/ pod husks	Haemostatic and cicatrising properties attributed to a mixture of ground bark of tamarind and <i>Ptilostigma reticulatum</i> with fruits of <i>Acacia nilotica</i> ; tropical ulcers treated with a leaf decoction or with finely ground powder of the bark or fruits	Senegal	–	Kerharo and Adam (1974)
115			Leaf/ fruit	Leaf decoction used as mouthwash for lesions and sores	Burkina Faso	Mossi	Tapsoba and Deschamps (2006)
116	Mental	Mental	Not specified	Not specified	Senegal	–	Kerharo and Adam (1974)
117		Sleep	Fruit pulp	Mix with water and add pepper, then drink	Benin	Dendi, Fulani, Gourmantché, Hausa	Fandohan (2007)
118			Unknown	Preparation of medicine used to sedate livestock	Kenya	Maasai	Ole-Miaron (2003)
119		Sorcery	Leaf/ bark	Several preparations in the domain of sorcery, fear and talismans	Benin	Dendi, Fulani, Gourmantché, Hausa	Fandohan (2007)
120	Nervous System	Epilepsy	Root	One cup of root decoction taken twice a day	Tanzania	Zigua	Moshi et al. (2005)
121	Nutritional	Appetite	Leaf	Cooled down decoction, to drink for appetite	Benin	Dendi, Fulani, Gourmantché, Hausa	Fandohan (2007)
122		Scurvy	Fruit pulp	Not specified	Kenya	–	Simitu and Oginosako (2005)
123	Pain	Dysuria	Bark	Add to the soup a tablespoon of a sugared decoction of ground tamarind stem bark and <i>Capsicum frutescens</i> fruit pericarps	Benin	–	Adjanohoun et al. (1989) cited in Neuwinger (1996)
124		Pain	Bark and leaf	Decoction of fresh plant parts with potash used to treat body pains	Nigeria	–	Doughari (2006)
125	Poisoning	Antidote	Leaf	Decoction of the leaves is used as wash on snake and insect bites	Mali	Dogon	Inngjerdingen et al. (2004)
126			Root/ leaf	Leaf and root of tamarind, <i>Azelia africana</i> and <i>Ficus</i> given in decoction to drink, bath and vapor bath as antidote for poisons	Côte d'Ivoire	–	Kerharo and Bouquet (1950a)
127	Pregnancy, birth, puerperium	Birth	Leaf	Cooled down decoction is given to drink to sheep and goats to treat complications with delivery	Benin	Dendi, Fulani, Gourmantché, Hausa	Fandohan (2007)
128		Lactation	Fruit	To increase lactation, eat <i>Kunu</i> (a kind of porridge) prepared with fruit of tamarind and <i>Ximenia americana</i> or drink a macerate of tamarind fruits in water	Nigeria	Fulani	Lockett and Grivetti (2000)
129		Pregnancy	Fruit	Drink macerate of fruits in water to relieve pain upon labour	Nigeria	Fulani	Lockett et al. (2000)
130			Pods	Bitter infusion of the pods is taken after delivery	Ghana	Nankani (Gur)	Lynn, cited in Dalziel (1937)
131	Respiratory System	Respiratory	Bark	Macerate of the bark taken for coughs	Mali	–	Traoré (1983) cited in Fortin et al. (1990)
132			Leaf	Decoction of the leaf is taken to treat coughs and sore throat	Kenya	–	Simitu and Oginosako (2005)
133				Decoction of leafy twigs used as vapour bath against coughs	Burkina Faso	–	Kerharo and Bouquet (1950a)
134				To treat coughs: dried leaves with dried parts of the following species: <i>Calotropis procera</i> (calcinated twigs), <i>Guiera senegalensis</i> (leaves), <i>Adansonia digitata</i> (leaves). Mode of administration not stated	Burkina Faso	–	de la Pradilla (1981) cited in Fortin et al. (1990)

Appendix A (Continued)

	Disorder category ^a	Medicinal use ^b	Plant part	Preparation	Country	Ethnicity	Reference
135			Root/ bark	Drink root decoction for cough; use bark decoction as gargle for a soar throat	East Africa	–	Kokwaro (1976)
136	Sensory System	Ear ache	Leaf	Pounded, applied to ear	Kenya	Luo	Geissler et al. (2002)
137		Eye	Leaf/ bud	Decoction used as wash	Burkina Faso	–	Kerharo and Bouquet (1950a)
138		Vertigo	Fruit pulp	Mix with water and add sugar for taste, then drink	Benin	Dendi, Fulani, Gourmantché, Hausa	Fandohan (2007)
139	Skin	Skin	Bark and leaf	Decoction of fresh plant parts with potash used as skin cleanser	Nigeria	–	Doughari (2006)

^a Disorder categories follow the Economic Botany Data Collection Standard of the Royal Botanic Gardens, Kew (Cook, 1995).

^b Subordinate medicinal uses and treated body parts follow the Economic Botany Data Collection Standard (Cook, 1995) as well. The wide range of denominations for illnesses made it necessary in some cases to translate them into a single denomination found in Cook (1995). In those cases, the original denomination is included in the text in the column 'Preparation'. E.g. 'tonic' is classified as 'fortifiant' and 'pains of heart' is classified as 'heart disease'.

^c Jaundice is not indexed in the latest version of the Economic Botany Data Collection Standard (Cook, 1995). The term may be interpreted in different ways by different users (Cook, 2008). Although most commonly associated with hepatitis, the symptoms, that effectively are a kind of blood poisoning, can have widely different physiological backgrounds such as the liver, gallbladder, kidneys or the blood itself.

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