ETHNOMEDICAL STUDY AND IRON CONTENT OF SOME MEDICINAL HERBS USED IN TRADITIONAL MEDICINE IN COTE D'IVOIRE FOR THE TREATMENT OF ANAEMIA

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Abstract

Medicinal plants have been a source of succour in the control of many diseases in developing countries and anaemia is no exception. In this study, ethnomedical survey was carried out for recording medicinal plants used in Northern and South-Eastern Côte d'Ivoire against anaemia. Also iron content was determined for some of the recorded plants using phenanthroline method. Thirty (30) medicinal plants, covering 28 genera and 22 families were recorded. These plants were used to prepare 30 receipts for the treatment of anaemia and aggravating factors such as malaria and gastro-intestinal helminthes. Eleven (11) of these medicinal plants showed presence of iron in various quantities. The most promising were *Tectona grandis*, *Amaranthus spinosus* and *Stylosanthes erecta* which contained the highest iron contents viz; 266.6, 236.6 and 206.6 mg/100 g respectively. They were followed by *Hoslundia opposita*, *Imperata cylindrica*, *Cajanus cajan*, *Thalia geniculata* and *Milicia excelsa*. These results lend credence to the traditional use of these plants in Cote d'Ivoire's ethnomedicine for the treatment of anaemia.

Key words: Anaemia, Côte d'Ivoire, Ethnomedicine, Iron, Medicinal plants

Introduction

Anaemia is one of the most widespread disorders of blood which affect the populations of all ages throughout the world. It is a public health problem that affects populations in both rich and poor countries (de Benoist et al., 2008). However, the incidence of this disorder is higher in the developing countries than in the developed countries (Ogbe et al., 2010) due to poverty and lack of hygiene. The situation is aggravated by factors such as nutritional deficiencies and high prevalence of parasitic gastrointestinal infections which cause heavy loss of blood. Other conditions, such as malaria and haemoglobinopathies are also responsible (Crawley, 2004; de Benoist et al., 2008). In the tropics, due to endemicity of malaria, between 10 to 20% of the population presents less than 10 g/dl of haemoglobin (Diallo et al., 2008) against reference values of 12 g/dl in women and children, 13 g/dl in men (WHO, 1968).

At the nutritional level, the most current and primary cause of anaemia is the iron deficiency. Approximately 30% of the world population are affected by iron deficiency, making iron by far the most widespread nutrient deficiency worldwide (Staubli Asobayire, 2005). About half of the iron deficient people suffer from the more severe form of iron deficiency anaemia (IDA) (Staubli Asobayire, 2000). In Cote d'Ivoire, the prevalence of anaemia is high and varies according to the strata of the population. A high prevalence of iron deficiency with or without anaemia was noted in 3 rural food zones (Bouake, Kolia, Guitry) of Cote d'Ivoire, in addition to Abidjan. The values were 50-62% in the children from 2 to 5 years, 33-45% in the children from 6 to 15 years and 27-37% among women (Staubli Asobayire, 2000). Anaemia has economic implications for the country because it can have profound effects on work performance and productivity (Basta et al., 1979; Edgerton et al., 1979). The people at the risk are the old persons, the young women in reproductive age and children (Ogbe et al., 2010). IDA can cause adverse pregnancy outcome (Scholl et al. 1992), decrease immune function and has been recognized as an important cause of cognitive deficit in infants and young children (Lozoff et al. 1982).

Iron deficiency (ID) control programs have not been successful in reducing the number of iron deficient people in developing countries due to unsuccessful supplementation programs, the low absorption of some fortification iron compounds, and to the presence of other complicating health factors such as vitamin A deficiency (Staubli Asobayire, 2000). Although various drugs are available for the treatment of anaemia, they are not often affordable to resource-poor people from Cote d'Ivoire. Moreover as in many remote areas of Nigeria (Akah et al., 2009), the populations always do not have access to quality drugs, and as such largely depend on traditional medicine for the treatment of the diseases including anaemia.

This present paper concentrates on ethnomedical survey of plants traditionally used in Northern and South-eastern Cote d'Ivoire for the treatment of anaemia and, laboratory determination of the iron content of 11 among the most used plant species.

Material and methods

Study area

The ethnobotanical surveys were conducted in Ferkessedougou and Tiassale. The town of Ferkessedougou is located in the Northern Cote d'Ivoire, about 585 km from Abidjan, in the savannah region. This area is characterized by a

sub-Sudanese climate (Eldin, 1971). The predominant vegetation is grasslands and gallery forests (Guillaumet and Adjanohoun, 1971). The natives are from the ethnic group senoufo.

Tiassale, in the South-east of Cote d'Ivoire, is about 120 km from Abidjan. It is a forest area (Guillaumet and Adjanohoun, 1971) with tropical climate (Eldin, 1971). Three ethnic groups, namely Abidji, Elomoin and Souamlin are present in Tiassale. Also, in these two cities, we find people from Mali and Burkina Faso, to whom the natives refer as regards health care by traditional medicine.

Ethnomedical survey

Ethnomedical information was collected during the interviews following the instructions on ethnobotanical and ethnopharmacological surveys proposed by Etkin (1983), Waller (1983) and Hedberg (1983). The surveys were conducted in the areas of Ferkessedougou and Tiassale which were selected because some of us are natives of Ferkessedougou and Tiassale. This was an advantage for the interviews. During 7 semi-structured interviews, a questionnaire was applied to the healers and traditional practitioners who were known to be knowledgeable in medicinal uses of plants. The ages of all the people used ranged between 35 and 75 years. We used 15 persons in the town of Ferkessedougou and the surrounding villages of Pissankaha, Village C (SUCAF-CI) and Parhoualakaha. In Tiassale, 3 people were interviewed. Each person was interviewed three times during the periods of February to June 2001 and March to April 2002 for the area of Ferkessedougou and from March to June 2009 for Tiassale. In each occasion, we took again the same questionnaire in order to confirm the robustness of the received information. The questionnaire included the local name and plant parts used, other diseases treated, practices of harvest, receipts, modes of administration, side-effects, etc.

In most case, we accompanied the healers in the bush to see the plants that they indicated to us at the time of the interviews. Voucher specimens of the recorded medicinal plants were collected by us with the informant, dried and processed according to standard practice, identified and then stored together at the Laboratory of Botany of the Swiss Center of Scientific Research in Cote d'Ivoire (CSRS) and at the University of Abobo-Adjame. The nomenclature follows the flora of Cote d'Ivoire (Ake Assi, 2001), of tropical of West Africa (Hutchinson and Dalziel, 1954-1972; Lebrun and Stork, 1991, 1992, 1995, 1997).

Selection of plant species for quantification of iron content

For the determination of iron content, 11 plant species were selected among the most available, accessible and known by the populations for the treatment of anaemia and associated diseases (Table 1). The plant parts were collected or bought in August 2009 in Tiassale because of its proximity with Abidjan where the laboratory analyses were carried out.

Preparation of plant samples

Three (3) g of each plant samples were weighed and subjected to dry washing in a well cleaned porcelain crucible at 450°C in a muffle furnace during 24 hours. Ashes were allowed to cool at room temperature. The ashes (0.3 g) were dissolved in 5 ml of concentrated hydrochloric acid in order to precipitate all the particles towards the bottom of the crucible. Final volume was adjusted to 50 ml with distilled water. The solution was filtered twice with filter paper.

Quantification of iron content of plant samples

The total iron content in the standard solution and samples of selected plants was obtained by phenanthroline method (AOAC, 1975; Pearson, 1976) modified using analysis by absorption spectrophotometer. The principle of the reaction is based on the formation of an orange red complex of orthophenanthroline and ferrous ion (fer^{2+}) detectable in UV-VIS at 510 nm. To 1 ml of each solution to be studied, we added respectively 1 ml of hydrochlorate hydroxylamine (10 g of hydrochlorate hydroxylamine in 50 ml of distilled water), 2 ml of the buffer solution of sodium acetate (8.5 g of sodium acetate, 12 ml of acetic acid and 88 ml of distilled water), 2 ml of orthophenanthroline solution (0.1 g of orthophenanthroline in 80 ml of distilled water with 80 °C). After 30 minutes of stabilization, the absorbance was measured with the spectrophotometer (510 nm). Iron determination was carried out for a range of concentrations from 0.01 to 0.06 mg/g of iron standard solution (100 mg/ml). Three measures were recorded, and then the arithmetic mean calculated. The iron concentration of each sample was calculated graphically using a calibration curve in the linear range by plotting the extract concentration vs the corresponding iron content. Then, the content of iron of each sample is calculated by using the following formula:

Iron content (mg/100 g) = (CxDFx10x100)/P

C: Iron concentration of the sample, obtained from the calibration curve (mg/g)

DF: Dilution Factor, P: Mass of ash (g)

Results

Thirty (30) plant species covering 28 genera and 22 families were recorded (Table 1). Among these medicinal herbs, 17 were recorded in the Ferkessedougou region and 13 in Tiassale. The richest families were Fabaceae, Ceasalpiniaceae and Euphorbiaceae with 3 plant species. The interviewees did not mention side effects for any of the listed plants, which were reported to be used in the preparation of 30 medical remedies for the treatment of anaemia. The most used parts were the stem bark (32%), leaves and stems (24%), followed by the leaves (21%), roots (13%) and whole plants (10%).

Table 1: Some medicinal plants used in Ferkessedougou and Tiassale (Cote d'Ivoire) for treatment of anaemia

Plant species	Family	Life forms, distribution	Therapeutic indications	Part used	Preparation and administration
Adansonia digitata L.	Bombacaceae	mp, A, SZ	Anaemia, wound, tonic	Stem bark	Decoction, beverage, twice
Amaranthus spinosus L.	Amaranthaceae	Th, pt, GC-SZ	Anaemia, cough	Whole plant	Decoction, beverage, twice
Anogeissus leiocarpus (DC.) Guill. & Perr.	Combretaceae	mp, A, SZ	Anaemia, intestinal worms	Stem bark, leaves	Decoction, beverage, twice
Bridelia ferruginea Benth.	Euphorbiaceae	mp, A, GC-SZ	Anaemia, intestinal worms, tonic	Leaves	Decoction, beverage, twice
Cajanus cajan (L.) Millsp.	Fabaceae	np, Ind, i, SZ	Anaemia, wound, skin diseases	Leaves and stem	Decoction, beverage, twice
Detarium microcarpum Guill. & Perr.	Caesalpiniaceae	mp, A, SZ	Anaemia	Leaves	Decoction, beverage, twice
Detarium senegalense J. F. Gmel.	Caesalpiniaceae	mp, A, GC-SZ	Anaemia	Leaves	Decoction, beverage, twice
Faidherbia albida (Delile) A. Chev.	Mimosaceae	mp, A, SZ	Anaemia, tonic for livestock	Leaves	Decoction, beverage, twice
Ficus platypphylla Del.	Moraceae	mp, A, SZ	Anaemia	Stem bark, roots	Decoction, beverage, twice
Harungana madagascariensis Lam. ex Poir.	Hypericaceae	mp, AM, GC	Anaemia, abdominal pain, gastric ulcer	Stem bark	Decoction, beverage, twice
Hoslundia opposita Vahl.	Lamiaceae	np, AM, GC-SZ	Anaemia, skin diseases	Leaves and stem	Decoction, beverage, twice
Imperata cylindrica var. *africana* (Anderss.) C.E. Hubbard.	Poaceae	Gr, AM, GC-SZ	Anaemia, abdominal pain, sinusitis	Whole plants	Decoction, beverage, twice
Justicia secunda Vahl	Acanthaceae	mp, A, GC	Anaemia, abdominal pain	Leaves and stem	Decoction, beverage, twice
*Khaya senegalensis (*Desv.) A. Juss.	Meliaceae	mP, A, SZ	Anaemia, sterility, intestinal worms	Stem bark	Decoction, beverage, twice
Lannea acida A. Rich	Anacardiaceae	mp, A, GC-SZ	Anaemia	Stem bark, roots	Decoction, beverage, twice
Lannea barteri (Oliv.) Engl	Anacardiaceae	mp, A, GC-SZ	Anaemia	Stem bark	Decoction, beverage, twice
Lophira lanceolata van Tiegh. ex Keay	Ochnaceae	mP, A, SZ	Anaemia, diarrhoea with blood	Stem bark and dried leaves	Decoction, beverage, twice In infants and children, baths
Milicia excelsa L.	Moraceae	MP, A, GC	Anaemia, cough	Stem bark	Decoction, beverage, twice

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Olax subscorpioidea Oliv.	Olacaceae	mp, A, GC	Anaemia, intestinal worms	Roots	Decoction, beverage, twice
Phyllanthus amarus Schum. & Thonn.	Euphorbiaceae	np, pt, GC	Anaemia	Whole plant	Decoction, beverage, twice
Pterocarpus erinaceus Poir	Fabaceae	mp, A, SZ	Anaemia	Stem bark	Decoction, beverage, twice
Ricinus communis L.	Euphorbiaceae	mp, PT, i	Anaemia, skin diseases	Leaves and stem	Decoction, beverage, twice
Securidaca longepedunculata Fres.	Polygalaceae	mp, A, SZ	Anaemia, intestinal worms	Roots, leaves	Decoction, beverage, twice
Sorghum bicolor (L.) Moench	Poaceae	Th, PT. i	Anaemia	Dried stem	Decoction, beverage, twice
Stylosanthes erecta P. Beauv.	Fabaceae	Ch, A, GC-SZ	Anaemia, amenorrhoea	Whole plant, leaves and stem	Decoction, beverage, twice
Tapinanthus dodoneifolius (DC.) Danser	Loranthaceae	Ep, A, GC-SZ	Anaemia	Leaves	Decoction, beverage, twice
Tectona grandis L. f.	Verbenaceae	mP, Ind, i	Anaemia, malaria	Leaves and stem, stem bark	Decoction, beverage, twice
Thalia geniculata L.	Marantaceae	np, A, GC-SZ	Anaemia, hemorroids	Leaves and stem	Decoction, beverage, twice
Vitellaria paradoxum C. F. Gaertn	Sapotaceae	mp, A, SZ	Anaemia, intestinal worms, rheumatism	Roots	Decoction, beverage, twice
Waltheria indica L.	Sterculiaceae	np, pt, GC-SZ	Anaemia, intestinal worms	Leaves and stem	Decoction, beverage, twice

Life forms: Ch = Chamephytis; Ep = Epiphytis; Gr = Rhizomatous geophytis; mp = Microphanerophytis; MP = Megaphanerophytis ; mP = Mesophanerophytis ; np = Nanophanerophytis; Th = Therophytis
Distribution: A = African Taxa (Intertropical Africa); AM = Taxa common to Africa and Madagascar; GC = Taxa of the Guineo-Congolian (rainforest); i = Cultivated Taxa; Ind = Taxa from India ; PT = Paleotropical Taxa common to Africa, Asia, Australia, Pacific islands; pt = Taxa common to all tropical countries of the world; SZ = Taxa of the Sudano-zambesian region (savanna, steppes).

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Tableau 2: Iron contents of studied plant species from Cote d'Ivoire

Plant speices	Organ used	Content (mg/100 g)
Amaranthus spinosus	Whole plant	236,6
Cajanus cajan	Leaves and stems	140
Hoslundia opposita	Leaves and stems	100
Imperata cylindrica	Whole plant	170
Justicia secunda	Leaves and stems	26,6
Khaya senegalensis	Stem bark	33,3
Milicia excelsa	Stem bark	143,3
Ricinus communis	Leaves and stems	70
Stylosanthes erecta	Leaves and stems	206,6
Tectona grandis	Leaves	266,6
Thalia geniculata	Whole plant	133,3

All these medicinal herbs were used in the form of decoctions, administered mostly by the oral route. Only decoction of *Lophira lanceolata* was prescribed as baths.

We noted that the diagnosis of the healers essentially is based on the observation of the symptoms such as the paleness of the mucous of eyes and mouth and fingertips. Some of the recorded plants also were prescribed against malaria, intestinal worms, and tiredness or as tonic.

Among the 30 medicinal herbs, 4 are cultivated or introduced; the 26 others are spontaneous species (Table 1). Certain plants from savannah origin are used both in the areas of Ferkessedougou (zone of savannah) and Tiassale (forest zone). Such plants are *Khaya senegalensis*, *Imperata cylindrica*, *Hoslundia opposita*, *Stylosanthes erecta* and *Waltheria indica*. The determination of iron content of 11 of the recorded plant showed that all contain iron in various amounts (Table 2). *Tectona grandis*, *Amaranthus spinosus* and *Stylosanthes erecta* achieved the highest contents with 266.6 mg/100 g, 236.6 mg/100 g and 206.6 mg/100 g respectively. *Ricinus communis* (70 mg/100 g), *Justicia secunda* (26.6 mg/100 g) and *Khaya senegalensis* (33.3 mg/100 g) had the lowest contents. The other plant species that had moderate iron contents ranging between 100 and 170 mg/100 g, and were *Hoslundia opposita*, *Imperata cylindrica*, *Cajanus cajan*, *Thalia geniculata* and *Milicia excelsa*.

Discussion

Anaemia is very common and the incidence is likely to increase in future, there is need to prevent it or seek for more cost-effective and better treatment strategies (Ogbe et al., 2010). In many African countries like Cote d'Ivoire, people have developed traditional care for treating anaemia. In this study, we carried out ethnomedical surveys in Northern (Ferkessedougou) and South-eastern (Tiassale) Cote d'Ivoire on medicinal plants used against anaemia and examined several of them for iron content. Thirty medicinal herbs and 30 receipts are used in traditional medicine in Ferkessedougou and Tiassale against anaemia. Some of these plants such as *Tectona grandis*, *Justicia secunda* and *Adansonia digitata* also are used against anaemia by Abbey and Krobou in the region of Agboville, Southern Côte d'Ivoire (N'guessan et al., 2010). *J.*

secunda also was mentioned in other parts of Africa such as Congo against anaemia. According to Moswa et al. (2005), *J. secunda* is a very well-known plant in its utilisation as anti-anaemic by the population of Kinshasa. *Justicia secunda* is originally from tropical America. It has been recently introduced in the Democratic Republic of Congo (Moswa et al., 2005) and Côte d'Ivoire. *T. grandis* and *J. secunda* were indicated by healers in Tiassale while *A. digitata* is used in Ferkessedougou. The wide use of the plants from savannah like *Khaya senegalensis* and *A. digitata* in forest areas could be explained by the mixing of populations, which has allowed exchange of knowledge about medicinal plants. Such plants were introduced into the South by people from Northern Côte d'Ivoire, Mali and Burkina Faso. Later, the use of these plants was spread due to their reputation and multiple therapeutic properties.

In this study, the 11 investigated plants showed the presence of iron in various quantities. This result justifies and supports in part their traditional use in the treatment of anaemia. The iron content of *Khaya senegalensis* (Sanni et al., 2005) and *Justicia secunda* (Moswa et al., 2005) was already reported. This is the first report of the iron content of *Amaranthus spinosus*, *Thalia geniculata*, *Imperata cylindrica* and *Stylosanthes erecta*. High iron content of 266.6 mg/100 g was determined for *Tectona grandis*. This species possesses anti-anaemic effects on the phenylhydrazine-induced anaemia in rats (Diallo et al., 2008). All these findings are in agreement with the traditional use of *T. grandis* in the treatment of anaemia.
Amaranthus spinosus showed high iron content of 236.6 mg/100 g; its anti-anaemic activity has not been studied to date. However other species of the genus, *Amaranthus hybridus* showed anti-anaemic effects in rat (Ogbe et al., 2010). Certainly, the genus *Amaranthus* might be of interest for the treatment of anaemia. *Stylosanthes erecta*, with iron contents of 206.6 mg/100 g also is a promising medicinal plant for treating anaemia. To our knowledge, its anaemic potential has not been studied.

Disappointingly in this study, we noted that the most popular plants contained low iron content. This was the case with *Khaya senegalensis* and *Justicia secunda*. *K. senegalensis* showed an anti-anaemic activity on phenylhydrazine-induced anaemia in the rat (Sanni et al., 2005), anthelmintic (Ademola et al., 2004) and antiplasmodial (El Tahir et al., 1999) properties, that supports its use against anaemia. In this study, *Justicia secunda* contains low iron contents of 26.6 mg/100 g. Contradictory findings reported high iron content (240.9 mg/100 g) for this plant harvested in Democratic Republic of Congo (Moswa et al., 2005). This difference in iron content might be explained by ecological and growth conditions of the samples from Cote d'Ivoire and Congo. It is recognized that the use of chemical products such as fertilizers can have effects on the growing of medicinal plants, thus influencing chemicals and biological activities (Fennell et al., 2004).

Iron plays a significant role in the haematopoiesis. However, the therapeutic potential of the herbs cannot be established on the basis of available iron content alone as other factors play a role in the absorption of iron in the body (Omolo et al., 1997). Such factors are alkaloids, flavonoids, saponins, tannins, calcium, zinc, vitamins C and K (N'guessan et al., 2010). For example, the flavonoids have veinotonic properties and protect capillaries (Bruneton, 1999). Vitamin C contributes to the bioavailability of iron in the body (Staubli Asobayire, 2000). The presence of saponins, tannins as well as zinc and calcium was reported for *Khaya senegalensis* (Sanni et al., 2005) and alkaloids for *Justicia secunda* (Moswa et al., 2005). These phytochemicals could account for their anti-anaemic effects. This study gave evidence that the medicinal plants used in Côte d'Ivoire can play a role in part in improving health conditions of people affected by anaemia, particularly those suffering from iron deficiency anaemia. For the most promising plants, we plan to determine the presence and content of certain hematopoietic factors such as folic acid, vitamins C and A, supporting the bioavailability of iron and evaluate their anti-anaemic activity.

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