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PHYTOCHEMICAL AND NUTRITIONAL COMPOSITION OF COMMONLY USED MEDICINAL PLANTS FOR THE TREATMENT OF ANAEMIA IN KWARA STATE, NIGERIA

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ABSTRACT

Ethnobotanical investigation revealed commonly used medicinal plants (Detarium microcarpum, Ficus sur, Jatropha gossypifolia, Khaya seneglensis, Mangifera indica, Parquetina nigrescens, Sorghum bicolor, Talinum triangulare, Tamarindus indica and Theobroma cacao) for treating anaemia in Kwara State, Nigeria. Plant parts used were subjected to phytochemical screening and proximate analysis using standard methods. Three preparation methods were revealed to be used commonly; (i) decoctions and Infusions (33.33 %), (ii) powdery form (22.22 %) and (iii) Concoction (11.11 %). Our study reported the use-value (%) of three plant habits (tree, 70 %; herbs, 20 %; and shrubs, 10 %) and of the plant-parts (leaves; 50% and bark; 50 %). Phytochemical screening recorded Alkaloids (D. microcarpum [486.67 ± 6.01] and J. gossypifolia [93.33 ± 1.67]), Anthraquinones [J. gossypifolia (93.33 ± 1.67); K. senegalensis (75.00 ± 2.89) and S. bicolor (6.67 ± 1.67)], Cardiac-glycosides[J. gossypifolia (78.33 ± 4.41) and S. bicolor (13.33 ± 1.67)], Flavonoids [Tamarindus indica (850.00 ± 7.64) and P. nigrescens (86.67 ± 4.41)], Phenolics [M. indica (75.43 ± 0.88) and T. cacao (9.40±0.58)] Saponins(F. sur [1258.33 ± 11.7] and M. indica [155.00 ± 10.41]), Tannins (Sorghum bicolor [1865.00 ± 7.64] and T. cacao [326.67 ± 7.26)], and Terpenoids [T. triangulare (1260.0 ± 7.64) and S. bicolor (35.00 ± 0.00)] in varying concentrations. Our proximate analysis detected ash, crude fibre, carbohydrate, moisture, protein, and ether extract content in different concentrations. In addition, micro-nutrient was significantly high (P≤0.05) in M. indica (Calcium [256.67±4.41] and Magnesium [90.00 ± 2.89], J. gossypifolia (Zinc, 0.53 ± 0.33) and T. triangulare (Iron, 16.37±0.88). From the results obtained it is evident that the studied plants contain several secondary metabolites which may have contributed to their anti-anaemic properties thereby, making them good sources of nutraceuticals for the management and treatment of Anaemia. Further studies are therefore recommended to determine the exact agent responsible for this activity in the plants and a possible mechanism of action.

KEY WORDS: *ethnobotany, anaemia, decoctions, phytomedicines, nutraceuticals.*

INTRODUCTION

According to World Health Organization (WHO), population of anaemia patients are increasing (approximately 2billion) with 50 % of all cases attributed to Iron-deficiency (WHO, 2001). The negative consequence of Iron-deficiency (anaemia) on cognitive, children physical development and adults work productivity has become major concern (Stoltzfus, 2001). High prevalence of anaemia in surgical patients may increase the risk of post-operative morbidity and mortality (WHO, 2003). Intriguingly, anaemia has been recognized as public health problem for many years, however, little progress has been reported and the global prevalence remains unacceptably high. International organizations such as WHO and United Nations Children's fund (UNICEF) therefore re-emphasized the urgent need to combat anaemia and stressed the importance of recognizing its multifactorial etiology for developing effective control programmes.

The new health agenda in Nigeria and Africa focuses on the institutionalization of traditional medicine in parallel with orthodox medicine into the national health care scheme. In order to move the health agenda forward in Africa, orthodox medicine has been complemented with traditional medicine as recorded (Elujoba *et al*., 2005). Traditional medicine has been the focus for wider coverage of primary health care delivery in Africa and the rest of the world (Elujoba, *et al*., 2005). It comprises the use of plant, animal or mineral materials for healing (WHO, 1978). Moreover, our study majorly focuses on phytomedicine (Plant medicine) type.

Phytomedicine has played a key role in world health care and has been a reliable source of medicine to a larger African population (about 80%, Calixto, 2000). Phytomedicine has demonstrated its contribution to reduce of excessive mortality, morbidity and disability due to diseases such as HIV/AIDS, malaria, tuberculosis, sickle-cell anemia, diabetes, mental disorders (Elujoba, *et al*., 2005; Gbadamosi *et al*., 2012) and microbial infections (Okigbo, *et al*., 2005; Adeyemi, *et al*., 2014).

The present study was carried out to identify indigenous plants used by Kwara indigenes to cure anaemia, investigate the phytochemical constituents and nutritional components responsible for the acclaimed anti-anaemic potentials.

MATERIALS AND METHODS

Study Area.

The survey was carried out in Ilorin city, capital of Kwara State in Nigeria. The area is dominated by different ethnic groups including Baruba, Fulani, Hausa, Nupe, Yoruba, and few Foreigners. The city is a host of five Local Governments Areas*: Ilorin East, Ilorin West, Ilorin South, Asa* and *Moro*. The city covers an area of 105km^2 with a population of 847,582 (NPC, 2006). The indigenes engage in various occupations such as farming since the city is an open entity for nearby settlements like *Ganmo, Ile apa, Ajase ipo*, etc. In addition, features such as educational institutions (Universities, Polytechnics and Colleges of Education), diverse cultures and guninea sanannah vegetation are part of the characteristics of the study area.

Collection and Identification of Plant materials

Dried plant samples were used for this study. The plant parts of *Parquetina nigrescens, Sorghum bicolor, Detarium microcarpum, Jatropha gossypifolia, Mangifera indica, Khaya senegalensis, Tamarindus indica, Talinum triangulare, Ficus sur* and *Theobroma cacao*

were purchased from a local herbal market (*Oja tuntun)* in Ilorin, Kwara State. The plants were identified, authenticated in University of Ilorin Herbarium (UILH) and voucher specimens were deposited for proper documentation.

Processing of Plant materials

The plant parts purchased were air dried at room temperature (ca. one week) to ascertain thorough dryness of the plant materials. We mechanically (mortar with pestle) chopped these parts into smaller pieces and ensured the final powdery form is uniform. Afterwards, they were stored in airtight glass containers prior to use.

Phytochemical Screening

The phytochemical screening of the samples was carried out using standard procedures (Harbone, 1984; Sofowora, 1993; Evans, 1996; Raaman, 2006; Tiwari *et al.,* 2011; Gbadamosi, *et al*., 2012).

Proximate Analysis of the Plant sample

We conducted proximate analysis using standard methods previously reported methods (AOAC, 1993; Ajai *et al*., 2012; Gbadamosi, *et al*., 2012; Oselebe *et al*., 2012) to determine the presence and concentrations of protein, fat, crude fiber, ash and dry matter.

Statistical analysis

The quantitative results were further analyzed with Analysis of variance (ANOVA) incorporated in Statistical Analysis System (SAS). Means of all the data were separated using Duncan's Multiple Range Test (DMRT) and significance test at $p \leq 0.05$.

RESULTS AND DISCUSSIONS

Our ethnobotanical survey recorded ten species (*Detarium microcarpum, Ficus sur, Jatropha gossypifolia, Khaya seneglensis, Mangifera indica, Parquetina nigrescens, Sorghum bicolor, Talinum triangulare, Tamarindus indica* and *Theobroma cacao*) commonly used amongst the Kwara indigenes to cure anaemia, four herbal recipes preparation methods (Table 1) and the use-values [Decoction and Infusion (33.33 %), powder (22.22 %) and Concoction (11.11 %)].

The study categorized the encountered plants used for treating anaemia in Kwara state into three plant habits with tree having the highest use-value trees [trees, 70%; herbs (20%), and shrubs (10%)]. Two plant parts used have equal use-value [leaves and bark (50 % each), Table 2].

Our phytochemical analysis revealed the presence of seven secondary metabolites viz; Saponins, Alkaloids, Tannins, Flavonoids, Anthraquinones, Terpenoids, Cardiac-glycosides and Phenolics (Table 3) in varying concentrations (Table 4).

Saponin concentration was high in *F. sur* (1258.33 ± 11.7) while *M. indica* (155.00 ± 10.41) had the lowest concentration. There was no significant ($P \leq 0.05$) difference between saponin content of *S. bicolor* (238.33 ± 6.01) and *D. microcarpum* (241.67 ± 10.17).

Highest alkaloid concentration was observed in *D. microcarpum* (486.67 ± 6.01) while the lowest was recorded in *J. gossypifolia* (93.33±1.67). Significantly ($P \leq 0.05$) no differences between alkaloid content in *T. indica* (135.00 ± 8.66) and *M. indica* (151.67 ± 6.01) as well as between *F. sur* (223.33 ± 4.41) and *T. triangulare* (235.00 ± 8.66).

Tannin content was between 1865.00 ± 7.64 (highest, *S. bicolor*) and 326.67 ± 7.26 (lowest, *Theobroma cacao*). Similarly, there was no significant ($P \leq 0.05$) difference between

tannin concentration in *F. sur* (571.67 ± 11.67) and *T. indica* (578.33 ± 7.26), as well as between *K. senegalensis* (1243.33 ± 11.67) and *T. triangulare* (1243.33 ± 10.14).

Our study recorded highest flavonoid content in *T. indica* (850.00 ± 7.64) and least in *P. nigrescens* (86.67 ± 4.41). Nonetheless, no significant (P≤0.05) difference between the flavonoid content of *T. cacao* (356.67 ± 4.41) and *J. gossypifolia* (368.33 ± 6.01).

We observed highest anthraquinone concentration in *K. senegalensis* (75.00 ± 2.89) while *S. bicolor* (6.67 ± 1.67) had lowest concentration. However, no significant difference (P≤0.05) between *J. gossypifolia* (11.67 ± 1.67) and *P. nigrescens* (13.33 ± 1.67) as regards anthraquinone content.

Terpenoid concentration in *T. triangulare* (1260 ± 7.64) was significantly high compared to *S. bicolor* (35.00 ± 0.00) which was the lowest. We observed no significant (P≤0.05) differences between the terpenoid content in *D. microcarpum* (60.00 ± 2.89) and *T. cacao* (78.33 ± 6.01) as well as between *M. indica* (243.33 ± 13.01) and *F. sur* (265.00 ± 7.64).

The study revealed highest Cardiac glycoside content in *J. gossypifolia* (78.33 ± 4.41) while *S. bicolor* (13.33 ± 1.67) had the lowest. Moreover, no significant difference (P≤0.05) was observed between the Cardiac glycoside content of *D. microcarpum* (16.67 ± 1.67), *S. bicolor* (13.33 ± 1.67)*, M. indica* (16.67 ± 1.67) and *T. cacao* (18.33 ± 3.33).

Phenolic content of the samples differs significantly, the highest value was recorded in *M. indica* (75.43 ± 0.88) while *T. cacao* had the least (9.40 ± 0.58).

Further, the proximate analysis was presented for moisture, protein, ether extract, ash, crude fibre, and carbohydrate content in varying proportionss (Table 5).

The results of the proximate analysis showed that, moisture content of *D. microcarpum* (8.83 ± 0.67) and *S. bicolor* (8.87 ± 0.88) were both significantly high while the least concentration was recorded in *T. cacao* (7.87 ± 0.88). Although, there were no significant (P≤0.05) difference between the moisture content recorded in *K. senegalensis* (8.13 ± 0.68) and *T. triangulare* (8.17 ± 0.88), as well as between *F. sur* (8.50 ± 0.58) and *J. gossypifolia* (8.43 ± 0.58).

Detarium microcarpum (21.27 ± 0.88) had the highest protein content. There was no significant (P≤0.05) difference between the protein content of *M. indica* (13.73 ± 0.88) and *P. nigrescens* (13.73 ± 0.33), and the least was recorded in both respectively.

Ether extract content of *T. triangulare* (4.10 ± 0.58) was significantly high while the least value was recorded in *D. microcarpum* (2.37 ± 0.88). There was no significant (P≤0.05) difference between the ether extract content in *F. sur* (2.73 ± 0.88), *K. senegalensis* (2.80 ± 0.58) and *P. nigrescens* (2.77 ± 0.88), and also between *J. gossypifolia* (3.13 ± 0.88) and *T. cacao* (3.10 ± 0.58).

This study revealed that, *J. gossypifolia* (7.43 ± 0.88) is rich in ash content compared to *T. indica* (5.67±0.33) with the least concentration. No significant (P≤0.05) differences between the ash content of *F. sur* (5.77 ± 0.88), *P. nigrescens* (5.83 ± 0.12), and *T. indica* (5.67 ± 0.33); between *D. microcarpum* (6.43 ± 0.67) and *M. indica* (6.33 ± 0.88).

Crude fibre content was significantly high in *F. sur* (14.13 ± 0.88) and least in *T. cacao* (9.67 ± 0.88). Our results didn't establish significant (P≤0.05) difference between crude fibre content of *D. microcarpum* (12.30 ± 0.58) and *T triangulare* (12.47 ± 0.88); and between *K. senegalensis* (13.43 ± 0.88) and *S. bicolor* (13.47 ± 0.88),

Carbohydrate content ranged between 51.53 ± 0.15 (highest, *Ficus sur*) and 41.93 ± 0.18 (lowest, *Parquetina nigrescens*). We observed no significant (P≤0.05) difference between carbohydrate content in *D. microcarpum* (48.73 ± 0.19) and *J. gossypifolia* (49.13 ± 0.17).

In addition, our study revealed the presence of essential elements and the concentrations (Mean ± SEM) in studied plants (Table 6). The Calcium (Ca^{++}) content was high in *M. indica* (256.67 ± 4.41) while *K. senegalensis* had the lowest. There was no significant (P≤0.05) difference between Ca^{++} content of *F. sur* (148.33 ± 4.41), *P. nigrescens* (136.67 ± 7.62), *S. bicolor* (156.67±13.64) and *T. triangulare* (135.00±7.64); and between *K. senegalensis* (83.33 ± 1.64) and *T. cacao* (85.00 ± 7.64).

Mangifera indica (90.00 ± 2.89) had the highest Magnesium (Mg^{++}) content while the lowest was recorded in *K. senegalensis* (33.33 ± 4.41). No significant (P≤0.05)difference between Mg^{++} content in *J. gossypifolia* (51.67 ± 1.67) and *T. triangulare* (48.33 ± 1.67).

Zinc (Zn^{++}) content in *D. microcarpum* (0.47 ± 0.33), *J. gossypifolia* (0.53 ± 0.33) and *Theobroma cacao* (0.50 ± 0.58) were significantly high while the least was recorded in *P. nigrescens* (0.50 ± 0.00). No significant (P≤0.05) difference between the Zn^{++} content detected in *K. senegalensis* (0.23 ± 0.33), *M. indica* (0.23±0.33) and *S. bicolor* (0.23 ± 0.33); and between *F. sur* (0.33 ± 0.33) and *T. indica* (0.33 ± 0.33).

Iron (Fe^{++}) content in *Talinum triangulare* (16.37±0.88) was significantly high and least in *F. sur* (6.33 ± 0.88). Significantly, (P≤0.05)no difference between Fe^{++} content in *D. microcarpum* (9.13 ± 0.88) and *T. cacao* (9.33 ± 0.88), and between *J. gossypifolia* (8.53 ± 0.88) and *P. nigrescens* (8.53 ± 0.12).

TABLE 1: Herbal recipes for the treatment of Anaemia in Kwara State, Nigeria.

S/N	Herbal Combination & Dosage	Method of Preparation
1	The leaves of *Parquentina nigrescens* should be squeezed with water and 150 ml of the juice should be taken twice daily.	Infusion
2	The leaves of *Sorghum bicolor* and the bark of *Theobroma cacao* are boiled with water and 250 ml of the preparation should be taken twice.	Decoction
3	The barks of *Detarium microcarpum* and *Harungana maadagascariensis* are cut into pieces, dried and ground into powder. One teaspoonful of the powder should be taken with hot pap once daily.	Powder
4	The leaves of *Jatropha gossypifolia* is squeezed with water, added with milk and half stainless cup should be taken daily.	Infusion
5	The bark of *Mangifera indica* and small quantity of *Aframomum melegueta* fruits are dried and ground into powder. One tablespoonful of the powder should be taken once daily.	Powder
6	The bark of *Ficus sur* and the bark of *Khaya senegalensis* are boiled with the addition of sugar. Tea cup should be taken twice daily.	Decoction
7	The leaves of *Sorghum bicolor,* leaf of *Khaya grandifolia* and leaves of *Tamarindus indica* are boiled. Half a cup should be taken twice daily.	Decoction
8	The leaves of *Parquetina nigrescens* and the leaves of *Talinum triangulare* are squeezed with water. Half of a stainless cup should be taken daily.	Infusion
9	The bark of *Theobroma cacao* is boiled with water and mixed with hot pap as baby food.	Concoction

TABLE 2: Profile of selected plants used

S/N	Botanical Name	Family	Common Name	Habit	Part used
1	*Detarium microcarpum*	Leguminosae	Arira (Y)	Tree	Bark
2	*Ficus sur*	Moraceae	Opoto (Y)	Tree	Bark
3	*Jatropha gossypifolia*	Euphorbiaceae	Lapalapa-pupa (Y)	Shrub	Leaves
4	*Khaya seneglensis*	Meliaceae	Oganwo (Y)	Tree	Bark
5	*Mangifera indica*	Anacardiaceae	Mangoro (Y)	Tree	Bark
6	*Parquetina nigrescens*	Asclepiadaceae	Ubombo/ Ewe ogbo (Y)	Tree	Leaves
7	*Sorghum bicolour*	Poaceae	Oka baba (Y)	Herb	Leaves
8	*Talinum triangulare*	Portulaceae	Gbure (Y)	Herb	Leaves
9	*Tamarindus indica*	Fabaceae	Ajagbon (Y)	Tree	Leaves
10	*Theobroma cacao*	Malvaceae	Koko (Y)	Tree	Bark

***Legend**
Y = Yoruba Language

TABLE 3: Results of the qualitative phytochemical screening of the powdered plant samples.

S/N	Samples	SAP	ALK	TAN	FLAV	ANTH	TERP	C.GLY	PHEN.
1	*Detarium microcarpum*	+	++	++	++	+	+	-	++
2	*Ficus sur*	+++	+	++	+	-	++	+	+
3	*Jatropha gossypifolia*	+	+	+++	++	-	+++	+	+
4	*Khaya senegalensis*	+	+	++++	+++	+	+	+	+++
5	*Mangifera indica*	+	+	++	++	+	++	-	+++
6	*Parquetina nigrescens*	+++	++	++++	+	-	+++	+	+++
7	*Sorghum bicolour*	+	++	++++	++	-	-	-	++
8	*Talinum triangulare*	++	+	+++	+	+	++++	+	+++
9	*Tamarindus indica*	++	+	+++	+++	+	++++	+	+++
10	*Theobroma cacao*	+	++	++	++	-	+	-	+

***Legend**
SAP-Saponin; ALK-Alkaloids; TAN-Tannin; FLAV-Flavonoids; ANTH-Anthraquinones; TERP-Terpenoids; C.GLY-Cardiac Glycoside; PHEN-Phenolics
Highly present (++++), moderately present (+++), Present (++), lonely present (+), Trace (-).

Plants play important roles in health and are known for their biological activities (Ianovici *et al*, 2010; Omoboyowa *et al*., 2013). About 3.4 billion people in developing regions over the years have come to depend on plants as alternative drug sources (Doughari, 2012). Anaemia is a condition characterized by inadequate red blood cells or insufficient haemoglobin thereby leading to oxygen shortage in the tissues. In the developing regions, consequent to high prevalence rate of this condition, utilization of medicinal plants for the treatment of anaemia have become rampant.

The medicinal abilities of plants have been attributed to the bioactive agents or compounds they contained. Quantitative phytochemical screening carried out in this study, revealed that *F. sur* had the highest saponin content followed by *P. nigrescens.* Meanwhile, *D. microcarpum* had highest alkaloid content. *S. bicolor* was high in tannin which disagrees with the report by Gbadamosi *et al.* (2012) that tannin was absent in S. *bicolor*. In addition, *T. indica* had highest amount of flavonoid, *T. triangulare* recorded highest amount of terpenoid and *M. indica* was recorded to contain phenolics in abundance. This study revealed the presence of

Alkaloids which are strong analgesics and are responsible for the stimulation of the central nervous system (Madziga *et al.,* 2010) and these may help anaemic patients in relieving the pains associated with anaemia.

TABLE 4: Results of the quantitative phytochemical screening of the powdered plant samples

S/N	Samples	SAP	ALK	TAN	FLAV	ANTH	TERP	C.GLYC	PHEN.
1	*Detarium microcarpum*	241.67±10.17^{c}	486.67±6.01^{g}	333.33±6.67^{at}	423.33±6.01^{f}	61.67±1.67^{f}	60.00±2.89^{b}	16.67±1.67^{a}	20.43±0.88^{e}
2	*Ficus Sur*	1258.33±11.67^{h}	223.33±4.41^{c}	571.67±11.67	160.00±7.64^{c}	16.67±1.67^{bc}	265.00±7.64^{c}	73.33±4.41^{de}	12.37±0.88^{b}
3	*Jatropha gossypifolia*	188.33±4.41^{b}	93.33±1.67^{a}	721.67±17.26	368.33±6.01^{e}	11.67±1.67^{ab}	850.00±7.64^{e}	78.33±4.41^{e}	13.47±0.88^{c}
4	*Khaya senegalensis*	285.00±7.64^{d}	273.33±4.41^{d}	1243.33±11.6	770.00±5.00^{h}	75.00±2.89^{g}	928.33±6.01^{f}	63.33±4.41^{c}	68.33±0.12^{h}
5	*Mangifera Indica*	155.00±10.41^{a}	151.67±6.01^{b}	355.00±10.41	463.33±10.14^{g}	51.67±4.41^{e}	243.33±13.01^{c}	16.67±1.67^{a}	75.43±0.88^{j}
6	*Parquetina nigrescens*	858.33±10.14^{g}	446.67±6.01^{f}	1726.67±9.27	86.67±4.41^{a}	13.33±1.67^{ab}	761.67±11.9^{d}	51.67±1.67^{b}	70.40±0.58^{i}
7	*Sorghum Bicolor*	238.33±6.01^{c}	383.33±9.28^{e}	1865.00±7.64	256.67±6.01^{d}	6.67±1.67^{a}	35.00±0.00^{a}	13.33±1.67^{a}	46.13±0.88^{f}
8	*Talinum triangulare*	368.33±10.14^{e}	235.00±8.66^{c}	1243.33±10.1	21.67±6.01^{b}	68.33±1.67^{fg}	1260.00±7.64^{h}	43.33±1.67^{b}	59.37±0.12^{g}
9	*Tamarindus indica*	431.67±4.41^{f}	135.00±8.66^{b}	578.33±7.26^{c}	850.00±7.64^{i}	43.33±4.41^{a}	1031.67±4.41^{g}	66.67±4.41^{cd}	17.43±0.88^{d}
10	*Theobroma Cacao*	176.67±6.01^{ab}	473.33±10.14^{g}	326.67±7.26^{at}	356.67±4.41^{e}	23.33±1.67^{f}	78.33±6.01^{b}	18.33±3.33^{a}	9.40±0.58^{a}

***Legend**

SAP-Saponin; ALK-Alkaloids; TAN-Tannin; FLAV-Flavonoids; ANTH-Anthraquinones; TERP-Terpenoids; C.GLY-Cardiac Glycoside; PHEN-Phenolics

Value represents the Mean of three replicates ± Standard error of mean (SEM).

Values having different letters along the same column are significantly different at (P≤0.05**)**

TABLE 5: Results of the proximate analysis of powdered plant samples

S/N	Samples	Moisture Content (%)	Crude Protein (%)	Ether Extract (%)	Ash (%)	Crude Fibre (%)	Carbohydrate (%)
1	*Detarium microcarpum*	*8.83±0.67^{e}	21.27±0.88^{i}	2.37±0.88^{a}	6.43±0.67^{bc}	12.30±0.58^{e}	48.73±0.19^{e}
2	*Ficus sur*	8.50±0.58^{cd}	17.53±0.88^{e}	2.73±0.88^{b}	5.77±0.88^{a}	14.13±0.88^{h}	51.53±0.15^{g}
3	*Jatropha gossypifolia*	8.43±0.88^{cd}	19.10±0.58^{g}	3.13±0.88^{c}	7.43±0.88^{e}	12.77±0.58^{f}	49.13±0.17^{e}
4	*Khaya senegalensis*	8.13±0.67^{b}	14.43±0.88^{b}	2.80±0.58^{b}	6.63±0.88^{cd}	13.43±0.88^{g}	54.57±0.33^{h}
5	*Mangifera indica*	8.27±0.88^{bc}	13.73±0.88^{a}	3.23±0.88^{cd}	6.33±0.88^{bc}	10.37±0.15^{b}	48.07±0.32^{d}
6	*Parquetina nigrescens*	8.33±0.88^{bcd}	13.73±0.33^{a}	2.77±0.88^{b}	5.83±0.12^{a}	11.27±0.88^{c}	41.93±0.18^{a}
7	*Sorghum bicolour*	8.87±0.88^{e}	19.53±0.88^{h}	3.43±0.88^{de}	6.27±0.67^{b}	13.47±0.88^{g}	51.57±0.12^{g}
8	*Theobroma cacao*	7.87±0.88^{a}	16.23±0.12^{d}	3.10±0.58^{c}	6.77±0.88^{d}	9.67±0.88^{a}	43.63±0.88^{b}
9	*Tamarindus indicus*	8.53±0.88^{d}	15.23±0.88^{c}	3.67±0.88^{e}	5.67±0.33^{a}	11.73±0.88^{d}	44.83±0.24^{c}
10	*Talinum triangulare*	8.17±0.88^{b}	18.03±0.88^{f}	4.10±0.58^{f}	7.37±0.88^{e}	12.47±0.88^{e}	50.13±0.88^{ef}

***Legend**

Value represent the Mean of three replicates ± Standard error of mean (SEM).

Values having different letters along the same column are significantly different at (P≤0.05).

TABLE 6: Results of micro-nutrient analysis of powdered plant samples

S/N	Samples	Ca++	Mg++	Zn++	Fe++	Cr++
1	*Detarium microcarpum*	*233.33±6.00^{d}	76.67±6.00^{e}	0.47±0.33^{d}	9.13±0.88^{e}	0.00±0.00
2	*Ficus sur*	148.33±4.41^{b}	46.67±1.67^{bc}	0.33±0.33^{c}	6.33±0.88^{a}	0.00±0.00
3	*Jatropha gossypifolia*	183.33±6.00^{c}	51.67±1.67^{c}	0.53±0.33^{d}	8.53±0.88^{d}	0.00±0.00
4	*Khaya senegalensis*	83.33±1.67^{a}	33.33±4.41^{a}	0.23±0.33^{bc}	11.90±0.21^{f}	0.00±0.00
5	*Mangifera indica*	256.67±4.41^{e}	90.00±2.89^{f}	0.23±0.33^{bc}	7.57±0.14^{c}	0.00±0.00
6	*Parquetina nigrescens*	136.67±7.26^{b}	55.00±0.00^{cd}	0.50±0.00^{a}	8.53±0.12^{d}	0.00±0.00
7	*Sorghum bicolor*	156.67±13.64^{b}	63.33±1.67^{d}	0.23±0.33^{bc}	15.30±0.15^{g}	0.00±0.00
8	*Theobroma cacao*	85.00±7.64^{a}	36.67±1.67^{ab}	0.50±0.58^{d}	9.33±0.88^{e}	0.00±0.00
9	*Tamarindus indica*	246.67±10.14^{de}	80.00±7.64^{ef}	0.33±0.33^{c}	7.13±0.88^{b}	0.00±0.00
10	*Talinum triangulare*	135.00±7.64^{b}	48.33±1.67^{c}	0.13±0.33^{ab}	16.37±0.88^{h}	0.00±0.00

***Legend**
Value represent the Mean of three replicates ± Standard error of mean (SEM).
Values having different letters along the same column are significantly different at ($P \leq 0.05$).

Flavonoids and phenolics are antioxidants and help in free radical scavenging (Kar, 2007) therefore, with continuous usage of these anti-anaemic plants, the tissue damages caused by iron overload can be combatted. Previous studies have shown that saponins are present in plants used for anaemia treatment and this has also been confirmed in this study. It has been reported that saponins and cardiac glycosides present in medicinal plants may be responsible for their haematopoietic properties (Modupe and Oladiji, 2015; Gbadamosi *et al.,* 2012). This could however, be due to the class of saponins present in the plants (either steroidal or triterpenoidal) although this has not yet been confirmed. However, it could also be due to the synergistic action of all the phytochemicals present.

The plants had a high amount of crude protein with *D. microcarpum* having the highest (21.27%). Adequate amount of protein is needed for haemoglobin synthesis and erythrocyte production (Sumaia *et al.,* 2016) and its deficiency can lead to onset of anaemia. Therefore, high protein content in these plants could contribute to their anti-anaemic action. High fibre content reported in these plants also helps in the reduction of serum cholesterol and reduces the risk of coronary heart diseases. The high carbohydrates content in the studied plants makes them good sources of energy. In addition, high ash content revealed in the plants show that they are good sources of minerals which could act as cofactors for proper enzyme functioning and oxygen transport.

Talinum triangulare had the highest iron content although all the plants had high iron, calcium, magnesium content. Chromium was absent in all the plants. The mineral content especially iron may be responsible for its anti-anaemic properties as these minerals may probably be directly absorbed into the blood with the help of the other components of the plants hence conferring the medicinal properties on the plants, this is congruent with past report (Modupe & Oladiji 2015) that the high iron content of *M. indica* could be responsible for its haematopoietic action. Based on the nutritional properties of these plants, they will be reliable sources of nutraceuticals for treatment and management of various health conditions.

CONCLUSIONS

This study therefore suggests that these plants could be carrying out their anti-anaemic activities based on a synergistic action of the phytochemicals present or the mineral contents of

the plants or its protein content. Further studies are therefore necessary to determine the exact agent responsible for this activity in the plants and a possible mechanism of action.

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