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Proximate Composition of Leaves of the African Rosewood (*Pterocarpus erinaceus*)

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Abstract

Plants have always been exploited worldwide for food, medicines, shelter, and other purposes because they are readily available, affordable and acceptable to a large populace of the world. The study was conducted to gather information on the proximate composition of fresh and dry leaves of *Pterocarpus erinaceus*. The proximate composition of the leaf samples was determined using the standard methods of analysis of the Association of Official Analytical Chemists (AOAC). Proximate analysis of the fresh leaf samples of the plant shows a higher moisture content compared to the dry leaf samples. The total fat and total ash contents of the fresh leaf samples were however lower compared to values recorded for the dry leaf samples. The dry matter content of fresh leaf samples was also lower compared to that of the dry leaf samples. Fresh leaf samples again recorded the least crude protein content compared to dry leaf samples. Carbohydrates content in fresh leaf samples was higher compared to dry leaf samples. Generally, higher proximate values were recorded for dry leaf samples than for fresh leaves. Dry matter and moisture contents were detected in high quantities in both fresh and dry leaf samples of *P. erinaceus*. These results could be a justification for the multiple uses of the plant leaves across Sub-Saharan Africa. Further research should be carried out on the mineral, phytochemical and vitamin composition between the fresh and dry leaves of the plant.

Keywords

Proximate Analysis, *Pterocarpus Erinaceus*, Dry Matter, Carbohydrates, Fodder

1. Introduction

Tree species play a significant role by contributing immensely to the food, income, and health needs of a large proportion of the population of Africa [1] [2]. Sub-Saharan Africa contains high flora of which many of the species are believed to possess high food and medicinal properties thereby contributing enormously to the food and health needs of the people [3]. Throughout Africa, wild tree products do not only contribute significantly to the food requirements of the majority of people but also to income security in rural areas where they are harvested for consumption and for sale to provide supplementary income for households [4].

The genus (*Pterocarpus*) belongs to the family Fabaceae and the subfamily (*Faboideae*). More than 60 of the species are believed to exist in different parts of the world including Africa and Asia. Approximately 20 species are believed to be native to Africa [2]. The species (*Pterocarpus erinaceus*) commonly known as Barwood, African Kino, African rosewood, or African teak is an averaged-sized tree that grows up to the height of about 15 - 25 m. The crown is rounded but opens with long shoots bending toward the ground. The tree bole can be branchless or straight and can be up to 10 m high under good environmental conditions [5] [6].

The plant is widely distributed across West and Central Africa and is specifically native to the following countries; Guinea, Gambia, Ghana, Benin, Senegal, Nigeria, and the Central African Republic [5] [7]. Rosewood is widely acclaimed to produce very high-quality timber for both local and foreign consumption. In recent years, the species is overly exploited in many Sub-Saharan African countries owing to the high demand for its timber and other related products in both local and international timber markets [2] [8] [9].

*Pterocarpu*s *erinaceus* foliage is known to provide excellent fodder for livestock. In many Sub-Saharan African countries, the foliage and immature pods of the plant are harvested for feeding livestock, especially during the dry season when livestock feed becomes increasingly scarce [1] [5]. In Sub-Saharan Africa, *Pterocarpus erinaceus* is known to be one of the most exploited plant species for traditional medicinal purposes. Various parts of the plant are harvested by traditional healers for the treatment of many ailments in many rural communities across Africa [8]. Leaves of *P. erinaceus* are used for the treatment of severe fever, the bark for the treatment of toothache and mouth-related diseases, and the exudates or resins are used for the treatment of stomach ulcers, diarrhea, dysentery, and intestinal worm infections. In North America and Europe, *P. erinaceus* was widely used for the treatment of chronic diarrhea until the middle of the 20^{th} Century [1] [10] [11]. **Figure 1** below depicts the image of *P. erinaceus*.

The nutritional composition of various leguminous tree species in Sub-Saharan Africa including *P. erinaceus* has long been studied and reported [2] [12]. Studies have indicated that plant nutrients such as proteins, carbohydrates, and fats are necessary to the lives of humans and all living organisms. Vitamins and minerals are equally essential for tissue functioning, the prevention of various diseases, and hormonal regulations [1] [13]. Proximate analysis of *Pterocarpus erinaceus* leaves revealed that the plant contains average nutritional attributes

Figure 1. *Pterocarpus erinaceus* plant.

such as Carbohydrates, Crude proteins, Crude fat, Fatty acid, Total ash, Crude fibre, Dry matter, and Moisture content [2] [5] [8]. The stem bark of *Pterocarpus erinaceus* is also known to produce moderate nutritive values of Carbohydrates, Proteins, Dry matter, and fats including essential vitamins and minerals [1].

Studies have shown relative variations in nutritive values between fresh and dry leaves of some plant species [10] [14] [15]. *P. erinaceus* has been extensively used in traditional herbal medicine, the wood industry, and the livestock industry as one of the top browse species for livestock in Sub-Saharan Africa including Ghana [8] [10] [16]. Despite the extensive research on the nutritional, phytochemical, vitamin and mineral compositions of the leaves and bark of the plant [1] [2], presently there is insufficient information on the nutritive composition between the fresh and dry leaves of the plant. This study was therefore conducted to provide information on the proximate composition between the fresh and dry leaves of *P. erinaceus*.

2. Materials and Methods

2.1. The Study Area

The study was conducted in the Tamale Metropolis. Geographically, the Tamale Metropolis lies between latitudes 9˚16' and 9˚34' North and longitudes 0˚36' and 0˚57' West of the equator [17]. Tamale has a tropical climate with summers being much rainier than winters. The average annual rainfall of Tamale is around 893 mm per annum and the average annual temperature is 28.4˚C [18]. The most important economic trees in the area are *Parkia biglobosa*, *Azadirachta indica*, *Acacia spp*, *Khaya senegalensis*, *Vitellaria paradoxa*, and *Adansonia digitata* (see **Figure 2**). The main soil types that have resulted from natural phenomena include sand, clay, and laterite ochrosols. These soil types are inadequately protected resulting in serious erosion during the rains [19]. The area is poorly endowed with natural water bodies. The only natural water systems are a few seasonal streams that contain water during the rainy season and dry up quickly during the dry season each year [20]. Agriculture is the main occupation in the area followed by the service and sales sectors which are mostly done by people in urban and suburban areas [17].

2.2. Methods

2.2.1. Collection and Preparation of Plant Materials

Fresh but matured leaves of *Pterocarpus erinaceus* were harvested at the midsection of the tree in the outskirt of the Tamale Municipality in July 2022 at coordinates; 9˚24'27"N 0˚51'11.999"W and were mixed together thoroughly. The plant was taxonomically identified in the Department of Biodiversity and Conservation Management, University for Development Studies Tamale. The leaves were sorted out and washed under running tap water and left to dry at room temperature for about 2 hours. They were spread on a tray and placed in an Oven-Air dryer (Memmert F110) at 60˚C for about 4 - 5 hours and homogenized using (MISTRAL 50L art. 650P grinding mill) into fine flour. The homogenized samples were kept in a plastic film containment for proximate analysis at the Savanah Agricultural Research Institute (SARI) laboratory in Nyankpala, Tamale.

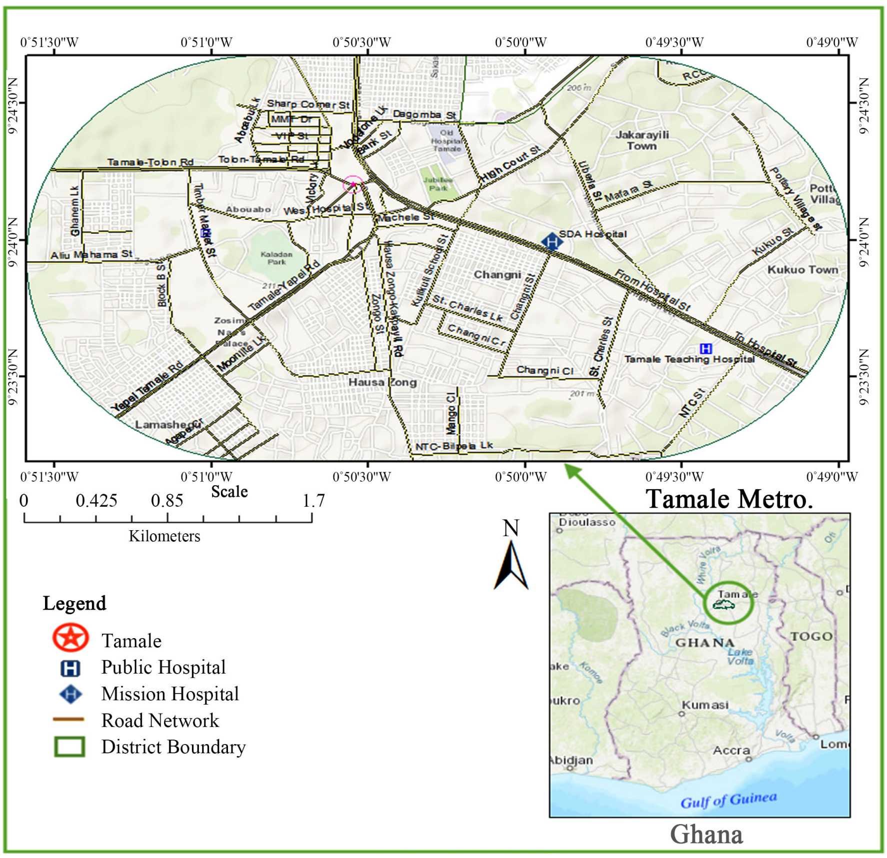

Figure 2. Map of the study area.

2.2.2. Proximate Composition Determination and Data Analysis

The proximate composition of the samples was determined using the standard methods of analysis of the Association of Official Analytical Chemists [21]. The following proximate compositions were determined; Protein, Fats, Moisture content, Total ash, Carbohydrates, and Dry Mather. Each proximate constituent was replicated three times (see Appendix I). The moisture content of the samples was determined by the air-oven dry method where 5 g of the sample in moisture was weighed and placed in a can or dish and dried to a constant weight at 105˚C in a dry oven. Moisture content% = weight of fresh sample − weight of dry samples/weight of fresh samples × 100.

Total ash content was determined using the muffle furnace maintained at 550 − 600˚C within four hours till grey ash was obtained. Ash% = Weight of ash/weight of sample × 100.

The crude fat was determined by the Soxhlet extraction method using ether as the extraction solvent. Crude fat (% of DM) = weight of fat/weight of sample × 100.

The crude protein of the samples was determined by the micro-Kjeldahl method.

Crude Protein (CP)% = Total Nitrogen (N_T) × 6.25 (Protein factor).

Carbohydrate and dry matter contents were determined by taking the difference of the sum of all the proximate compositions from 100%. That is: 100% − (Fat% + moisture% + ash% + protein%).

The data obtained were analyzed using Microsoft excel and the results were presented and summarized using descriptive statistics (percentages).

3. Results and Discussion

The results of the proximate analysis of the leaf samples of *Pterocarpus erinaceus* are represented in Table 1. The highest nutritional value recorded from the analysis was for dry matter and this was obtained from the dry leaf samples. The least nutritional value recorded was for total fat and was obtained in fresh leaf samples.

Table 1. Proximate composition values (%) of fresh and dry leaves of *P. erinaceus*.

Parameters%	Fresh leaves	Dry leaves
Total fat	3.56 ± 0.09	7.15 ± 0.18
Total ash	4.81 ± 0.09	9.66 ± 0.16
Dry matter	49.75 ± 0.15	64.13 ± 0.07
Moisture content	50.24 ± 0.15	35.86 ± 0.07
Crude Protein	11.01 ± 0.34	22.14 ± 0.64
Carbohydrates	30.36 ± 0.34	25.17 ± 0.82

The results presented are mean ± SEM (n = 3).

The crude protein content of the fresh leaf samples of *P. erinaceous* was lower at 11.01 ± 0.34 than that of the dry leaf samples at 22.14 ± 0.64. These values were higher than those reported for *Amaranthus hybridus* leaf samples at 3.56 ± 0.09 and *Detarium microcarpum* pulp at 4.65 ± 0.10 [12] [22]. Both values were however lower than those reported for *P. mildbraedii* leaves at 26.5 ± 0.4 (Akinyeye *et al*., 2010). The moisture value of the fresh leaf samples of *P. erinaceus* was 50.24 ± 0.15 higher than the value recorded for the dry leaf samples of 35.86 ± 0.07. The moisture content for both fresh and dry leaves was however higher than those reported for the stem bark of *P. erinaceus* 1.85 ± 0.26 and the leaves extract of *P. mildbraedii* 13.3 ± 0.0 [1] [2].

The Carbohydrate value of the fresh leaf samples of *P. erinaceus* was slightly higher at 30.36 ± 0.34 than that of the dry leaf samples at 25.17 ± 0.82. These values are higher than those reported for *Moringa oleifera* seeds [15]. They were however lower than those reported for the edible leaves of *Adansonia digitata* at 57.04 ± 1.59 [12].

The dry matter content of both the fresh and dry leaf samples of *P. erinaceus* was 49.75 ± 0.15 and 64.13 ± 0.07 respectively. These values are lower than those reported for *Adansonia digitata* leaf samples at 93.02 ± 0.8 [12]. They are however higher than those reported for the stem bark of *P. erinaceus* at 39.33 ± 0.05 [1].

The total ash content of the fresh leaf samples of *P. erinaceus* was 4.81 ± 0.09 and that of the dry leaf samples was 9.66 ± 0.16 respectively. These values in this study are lower than those reported for *Pterocarpus marsupium* leaf samples at 12.4 ± 0.68. They are however slightly higher than the total ash values recorded for *Rauwolfia serpentina* leaf samples at 4.8 ± 0.23 [23].

The total fat value of the fresh leaf samples of *P. erinaceus* was 3.56 ± 0.09 lower than the value recorded at 7.15 ± 0.18 for dry leaf samples. In the present study, these values are lower than those reported for *Ipomoea aquatica* and *Achyranthes aspera* leaves at 16.37 ± 0.67 and 23.26 ± 0.65 respectively [13]. They were however higher than the total fat values reported for *P. erinaceus* stem bark at 0.45 ± 0.50 [1].

4. Conclusion and Recommendation

The study revealed that both fresh and dry leaves of *Pterocarpus erinaceus* are rich sources of vital food components such as crude protein, carbohydrates, dry matter, total ash, and fats. The values of these nutrients varied considerably between the fresh and the dry leaves of the plant. Higher values were recorded in the dry leaves of *Pterocarpus erinaceus* across all the food nutrients except for moisture and carbohydrates which recorded higher values in fresh leave samples. The presence of these food substances in both fresh and dry leaves of the plant makes it a potential food plant. It is recommended that; 1) further research should be done to compare the phytochemical composition between the fresh and dry leaves of *P. erinaceus*. 2) further research should be carried out to compare the minerals and vitamins composition of the fresh and dry leaves of *P. erinaceus*.

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Data Availability

All data and materials have already been included in this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviations

P. erinaceus: *Pterocarpus erinaceus*;
P. mildbraedii: *Pterocarpus mildbraedii.*

Appendix

Raw Proximate Composition Values of Fresh and Dry Leaves of *P. erinaceus*

Sample ID	Reps	%Total Fat	%Total ash	%Dry matter	%Moisture	%Crude Protein	%Carbohydrates
		Dry Leaf	**Dry Leaf**	**Dry Leaf**	**Dry Leaf**	**Dry Leaf**	**Dry leaf**
Leaf	1	7.363704257	9.94795247	64.25250238	35.74749762	22.68647126	24.2543744
Leaf	2	7.303529412	9.382362452	64.00058644	35.99941356	22.87962688	24.4350677
Leaf	3	6.794086905	9.67511092	64.15116961	35.84883039	20.85673054	26.82524124
Mean		7.153773524	9.668475281	64.13475281	35.86524719	22.14094289	25.17156111
Standard Deviation		0.312947442	0.282853391	0.126757814	0.126757814	1.116345958	1.434975958
Standard Error		0.18068029	0.163305481	0.073183658	0.073183658	0.644522639	0.828483755
		Fresh Leaf	**Fresh Leaf**	**Fresh Leaf**	**Fresh Leaf**	**Fresh Leaf**	**Fresh leaf**
Leaf	1	3.686899312	4.980794697	50.06854137	49.93145863	11.35878525	30.04206211
Leaf	2	3.62669663	4.658977923	49.65676765	50.34323235	11.36128316	30.00980994
Leaf	3	3.366633917	4.7942508	49.55241174	50.44758826	10.33501299	31.05651403
Mean		3.56007662	4.81134114	49.75924025	50.24075975	11.01836047	30.36946203
Standard Deviation		0.170209136	0.161587651	0.272897275	0.272897275	0.591797589	0.59522298
Standard Error		0.098270291	0.093292674	0.157557315	0.157557315	0.341674497	0.343652148