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ORIGINAL RESEARCH PAPER, SHORT COMMUNICATION AND REVIEW

The approximate mineral and phytochemical content of the leaves, stem bark, and roots of *Pterocarpus erinaceus* in India

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Abstract
Proximate analysis of dried *Pterocarpus erinaceus* leaves (DPE), stem bark (DSB) and root (DSR) contained moisture (9.11%, 7.61%, 7.02%), crude protein (7.60%, 5.11%, 4.33%), crude fibre (12.2%, 25.6%, 18.5%), ether extracts (0.58%, 0.42%, 0.30%), ash (12.6%, 10.5%, 10.2%) and carbohydrates (45.4%, 38.0%, 37.2%) respectively. Mineral composition of DPE revealed the presence of calcium (108.6 mg/100 g), phosphorus (60.38 mg/100 g), potassium (39.7 mg/100 g), magnesium (12.51 mg/100 g), zinc (10.44 mg/100 g), manganese (8.55 mg/100 g), cobalt (1.16 mg/100 g), copper (4.58 mg/100 g), sodium (25.2 mg/100 g) and iron (16.13 mg/100 g) while those of DSB and DSR contained calcium (90.60, 91.55 mg/100 g), phosphorus (40.11, 43.80 mg/100 g), potassium (30.2, 30.0 mg/100 g), magnesium (9.93, 8.90 mg/100 g), zinc (7.55, 7.00 mg/100 g), manganese (5.20, 4.88 mg/100 g), cobalt (1.11, 1.00 mg/100 g), copper (2.40, 2.21 mg/100 g), iron (19.6, 18.4 mg/100 g) and iron (11.0, 10.67 mg/100 g). The phytochemical analysis of DPE, DSB, and DSR revealed that it contains high levels of flavonoids (11.20, 7.51, 7.20 mg/g), tannins (8.81, 4.91, 4.10 mg/g), steroids (1.61, 1.14, 1.02 mg/g), glycosides (4.42, 1.20, 6.19 mg/g), phenols (41.5, 30.4, 31.2 mg/g), saponins (28.6, 15.1, 14.0 mg/g), alkaloids (19.6, 15.8, 25.3 mg/g), flavonoids (11.20, 7.51, 7.20 mg/g), tannins (8.81, 4.91, 4.10 mg/g), and terpenoids (1.40, 0.65, 0.55 mg/g), respectively. According to the findings, DPE, DSB, and DSR are rich in minerals and phytochemicals, and they can be utilized as a natural substitute for antibiotics in animal production.
Keywords: *Pterocarpus erinaceus*, proximate, phytochemicals, antibiotics, minerals.

1. Introduction

The interest in plants with antimicrobial properties has been rekindled by the current issues surrounding the use of antibiotics, the increased prevalence of multiple-drug resistant strains of various pathogenic organisms, including *Salmonella typhi*, *Escherichia coli*, *Staphylococcus aureus*, *Shigella flexneri*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Enterococcus faecalis*, *Listeria monocytogenes*, *Bacillus cereus*, and others (Voravuthikunchai; Kitpipit, 2003).

According to Shittu and Alagbe (2020), medicinal plants typically include minerals and phytochemicals that are thought to be secure, efficient, and eco-friendly. Primary and secondary metabolites are the two categories into which they are separated. Common sugar, amino acids, proteins, and chlorophyll are examples of primary metabolites; alkaloids, flavonoids, tannins, terpenoids, and phenol are examples of secondary metabolites (Singh et al., 2022; Kumar et al., 2005). As per the World Health Organization's 2000 definition, a medicinal plant is any plant that has compounds in one or more of its organs

that have therapeutic value or act as precursors for the semi-synthesis of chemo-pharmaceuticals. More than 50,000 species of medicinal plants having pharmacological qualities exist worldwide (WHO, 2000).

Pterocarpus erinaceus, which is determined to be rich in nutrients and phytochemicals, is one of the prospective plants. The tree is medium-sized, deciduous, and leguminous; it is a member of the Fabaceae family (Maryam et al., 2017). Its maximum height is 12 to 15 m; its leaves are alternate, imparipinnate, and can reach a length of 30 cm; its stipules are often short, linear or narrowly triangular, and they are typically early caducous; and its leaflets can reach up to 11 and are alternate, occasionally sub-opposite (Maryam et al., 2017).

The fruit is an indehiscent pod that is compressed and resembles a disk. It is green when young and can have a diameter of up to 7.5 cm. It has a thicker center that is typically woody or corky and contains one to three seeds. The stem bark is black and scaly (Maryam et al., 2017). With more than 80 species spread around the globe, the plant can be found in much of West and Central Africa, as well as several regions of Asia, including India (Heuze et al., 2019).

Pterocarpus erinaceus leaves, stems, and roots have been found to contain chemical components such as saponins, tannins, flavonoids, terpenoids, and quantities of alkaloids (Gabriel; Onigbajo, 2010). Pterocarpus erinaceus has historically been used to treat a variety of illnesses, including fever, diarrhea, coughing, ulcers, intestinal worms, toothaches, anemia, leprosy, hemorrhage, dysentery, rheumatism, urinary tract infections, malaria, bowel disorders, rapid ejaculation, and headaches (Ahmed et al., 2017). The plant extract's anti-helminthic, anti-cancer, anti-malarial, anti-hyperglycemic, anti-inflammatory, anti-rheumatic, and antipyretic properties were discovered through pharmacological screening (Ahmed et al., 2017; Gabriel and Onigbajo, 2010). There have also been reports of its antiviral (Ahmed et al., 2017), antibacterial (Akinyeye et al., 2010), antioxidant (Yusuf et al., 2020), immune-stimulatory, and antidiarrheal properties.

Analyzing *Pterocarpus erinaceus* bioactive compounds or special metabolites may help address the growing problem of antibiotic resistance and may also result in the development of novel medications that effectively prevent and treat a range of human and animal illnesses.

This study aimed to evaluate the approximate mineral and phytochemical content of the leaves, stem bark and roots of *Pterocarpus erinaceus* in India.

2. Material and Methods

2.1 Experimental location

The experiment is being conducted at the Department of Microbiology at Sumitra Research Laboratory in Gujarat, India, which is situated between 23o 13' N and 72o 41' E, is where the experiment was conducted. Every laboratory apparatus and kit was used in accordance with the manufacturer's instructions. Analytical grade reagents and chemicals were all utilized.

2.2 Reagents

The solutions include potassium ferricyanide, sodium hydroxide, hydrochloric acid (HCL), distilled water ethanol, Kjeldahl tab, picric acid solution, ferric chloride ($FeCl_3$) solution, sulphuric acid (H_2SO_4), sodium hydroxide (NaOH), copper sulphate ($CuSO_4$), sodium carbonate, Folin-Denis reagent, aluminum chloride, sodium nitroprusside, potassium hydroxide, zinc acetate solution, and sulphuric acid (H_2SO_4).

2.3 Gathering, preparing, and identifying plant materials

Fresh *P. erinaceus* leaves, stem bark, and roots were collected at the research farm of Sumitra Research Institute in Gujarat, India, from several tree strands. The institute's Biological Science department received the collected samples and used them to properly identify and authenticate them. For the leaves, stem bark, and roots of Pterocarpus erinaceus, the voucher specimen numbers AA/09A/2024A, AA/09A/2024B, and AA/09A/2024C were assigned to each sample.

Separate plant parts were cleaned under running tap water and then placed in a plastic sieve to let the water drain for fifteen minutes. After that, the plant parts were shade-dried for fifteen days on a clean surface, or until each sample reached a consistent weight. Using an electric blending machine, the dried leaves, stem bark, and roots of *P. erinaceus* were pulverized. The powdered samples were then sealed in a plastic container with a label for additional laboratory analysis.

2.4 Dried Pterocarpus erinaceus leaves (DPE), stem bark (DSB), and root (DSR) proximate analysis

The approximate composition of the leaves (DPE), stem bark (DSB), and roots (DSR) of Pterocarpus erinaceus was measured using a DA 7250 near infrared (NIR) analyzer, which takes six minutes to evaluate a sample. Each sample, weighing 200 grams, was run through a sample collection vat that was attached to a monitor (scanning grating transmittance for results display). The apparatus was configured to show data at a wavelength between 570 and 1100 nm for optimal efficiency.

2.5 Dried Pterocarpus erinaceus leaves (DPE), stem bark

(DSB), and root (DSR) mineral content

A fully automated atomic absorption spectrophotometer graphite furnace system (Model: AAS-4000) was used to analyze the minerals in DPE, DSR, and DSB. The spectrometer system, whose light source was a hollow cathode lamp, was calibrated at a wavelength of 185-910 nm with a modulation frequency of 100 Hz for effective analysis. These are the specifications of the monochromator chamber: blazing wavelength (250 nm), focus (300 nm), band width (0.1 nm to 2.0 nm), and ± 0.15 nm, 0.02 nm, and 0.05 nm for wavelength accuracy, resolution, and repeatability. The temperature range of 3000°C, detection limit of Cd < 0.004 ng/mL, repeatability of Cu < 2.0%, Cd < 2.0%, and sensitivity of 50 ng/mL Absorption > 0.40 Abs are set for the graphite furnace analyzer. Results on minerals are generated via the data processing unit which contains AA Win Pro software with PC windows 7 Professional operating system.

2.6 Quantitative evaluation of phyto-constituents in dried Pterocarpus erinaceus leaves (DPE), stem bark (DSB) and root (DSR)

2.6.1 Assay for total flavonoids

Using the aluminum chloride colorimetric technique described by Tolari et al. (2012), the total flavonoid concentration was determined. Each sample was added in two grams to a 10-milliliter volumetric flask that held four milliliters of distilled water. Three milliliters of 5% $NaNO_2$ were added to the mixture above. 0.3 mL of 10% $AlCl_3$ was added after 5 minutes. After adding 2 milliliters of 1 M sodium hydroxide (NaOH) at the sixth minute, the amount was increased to 10 mL using distilled water. After thoroughly mixing the solution, the absorbance at 510 nm was measured in comparison to the prepared reagent blank.

2.6.2 Estimating the overall content of phenols

The Makkar et al. (1997) approach was utilized to assess the sample's total phenolic content. In a test tube, two grams of each sample were added, and 1 mL of distilled water was used to fill the tube. Subsequently, the test tube was filled with 2.5 mL of sodium carbonate solution (20%) and 0.5 ml of *Folin-Ciocalteu* reagent (1:1 with water). The tubes were quickly left in the dark for 40 minutes after the reaction liquid was vortexed, and the absorbance at 725 nm was measured in comparison to the reagent blank.

2.6.3 Total saponin evaluation

The saponins were analyzed using Madhu et al. (2016) spectrophotometric technique. In a nutshell, 100 mL of isobutyl alcohol was added to a 250 mL beaker containing 2 g of the finely powdered dry material. To guarantee even mixing, the mixture was shook for five hours on a UDY shaker. Following that, 20 mL of a 40% saturated solution of $MgCO_3$ were added to a 100 mL beaker after the liquid was filtered through Whatman No. 1 filter paper. A clean, colorless solution was obtained by filtering the resultant combination one more. After pipetting one milliliter of the colorless filtrate into a 50 mL volumetric flask, two milliliters of 5% $FeCl_3$ solution were added, and the volume was topped off with distilled water. After that, this was let to stand for 30 min so that a blood-red color might form. A saponin stock solution was used to prepare the 0-10 ppm saponin standard. After thoroughly mixing the solution, the absorbance at 380 nm was measured in comparison to the prepared reagent blank.

2.6.4 Estimating the amount of alkaloids

Alkaloids were quantitatively determined using titrimetric and distillation techniques, as explained by Madhu (2016). In short, 20 mL of 80% pure alcohol were added to 2 g of finely ground sample that was weighed into a 100 mL beaker to create a smooth paste. After transferring the mixture to a 250 mL flask, additional alcohol was added to bring the total amount of magnesium oxide to 1 g.

For one and a half hours, the mixture was broken down in a boiling water bath with periodic shaking and a reflux air condenser. The mixture was run through a *Buchner* funnel while it was still hot. After pouring the residue back into the flask and digesting it again for thirty minutes with 50 mL of alcohol, the alcohol evaporated. The lost alcohol was replaced with distilled water. Three drops of 10% HCl were added once all of the alcohol had evaporated.

The entire solution was then transferred to a 250 mL volumetric flask, and to create a uniform mixture, 5 ml of zinc acetate solution and 5 mL of potassium ferricyanide solution were well mixed. After thoroughly mixing the solution, the absorbance at 650 nm was measured in comparison to the prepared reagent blank. Analysis of tannins The amount of tannins was calculated using the Madhu et al. (2016) approach. A 50 mL beaker was filled with 2.0 g of the sample. A water bath set at 77-80 ºC was filled with 20 mL of 50% methanol, covered with parafilm, and left for an hour.

A thorough shaking was performed to guarantee even mixing. A double-layered Whatman No. 41 filter paper was used to filter the extract before being transferred into a 100 mL volumetric flask. After adding 20 mL of water, 2.5 mL of *Folin-Denis* reagent, and 10 mL of 17% NaOCOO were added and thoroughly mixed. After thoroughly mixing in water to make the mixture up to the mark, it was let to stand for 20 min. The end of the range will see the development of a bluish-green color. Similar to the 1 mL sample above, 0-10 ppm was handled. After thoroughly mixing the solution, the absorbance at 760 nm

was measured in comparison to the prepared reagent blank.

2.6.5 Estimate of total glycosides

A 250 mL conical flask was filled with 2.0 g of the sample. After adding 50 cc of chloroform, the Vortex mixer was agitated for an hour. A conical flask was filled with the filtered mixture. After adding 10 mL of pyridine and 2 mL of 2% sodium nitroprusside, everything was well shaken for ten minutes. After that, 3 mL of 20% NaOH were added to create a brownish-yellow color. From a stock glycoside standard of 100 mg/mL^{-1}, a glycoside standard with concentrations ranging from 0 to 5 mg/ml was created. Like the sample above, the series of standards 0-5 mg/mL received the same treatment. The optical density of the spectrophotometer was adjusted to 510 nm.

2.6.6 Calculating the overall amount of steroids

Each sample was weighed to provide 5 g in a 100 mL beaker. After 30 min of shaking on a shaker, 20ml of a chloroform-methanol (2:1) mixture was added to dissolve the extract. The entire blend up until the steroids are gone. A 30 mL test tube was filled with 1 mL of the filtrate, 5 mL of alcoholic KOH, and thoroughly shaken to create a homogeneous mixture. Subsequently, the mixture was incubated for ninety minutes at 37-40 ºC in a water bath. After allowing it to cool to ambient temperature, 10 mL of petroleum ether and 5 mL of distilled water were added. On the water bath, this evaporated to a dry state. After adding 6 mL of *Liebermann-Buchard* reagent to the residue in a dry container, the absorbance was measured using a spectrophotometer at 620 nm in wavelength.

2.6.7 Estimating terpenoids

A 50 mL conical flask was filled with 2.0 g of each sample, 20 mL of a 2:1 chloroform-methanol combination and shaken well. The mixture was then let to stand for 15 min. After discarding the acquired supernatant, the precipitate was again rinsed with a 20 mL chloroform-methanol combination in preparation for another centrifugation. In 40 mL of 10% sodium dodecyl sulphate (SDS) solution, the precipitate that was produced was dissolved. To the above, 1 mL of 0.01M ferric chloride solution was added at 30-second intervals, thoroughly shaken, and left to stand for 30 min. Using a digital spectrophotometer set to 510 nm, standard concentrations of terpenoids were measured.

2.7 Examining statistics

The Statistical Analysis System (SAS, version 9.4) PROC ANOVA GLM Analysis of variance and the *Student's T*-test were used to analyze the data that were gathered.

3. Results

3.1 Proximate composition in dried Pterocarpus erinaceus leaves (DPE), stem bark (DSB) and root (DSR)

Outcome on the proximate composition in dried Pterocarpus erinaceus leaves (DPE), stem bark (DSB) and root (DSR) is presented in (Table 1). Dried Pterocarpus erinaceus leaves (DPE) contained greater ($P < 0.05$) levels of moisture (9%), crude protein (7%), ether extracts (0.58%), ash (12%) and carbohydrate (45%) compared to *P. erinaceus* stem bark (DSB) and root (DSR) which contained moisture (7%, 7%), crude protein (5%, 4%), crude fibre (25%, 18%), ether extracts (0.42%, 0.30%), ash (10%, 10%) and carbohydrate (38% and 37%) respectively.

Table 1. Outcome on the proximate composition in dried *Pterocarpus erinaceus* leaves (DPE), stem bark (DSB) and root (DSR).

Variables (%)	**[1]DPE**	**[2]DSB**	**[3]DSR**	***P*-value**
Moisture	9.11 ± 0.10^{a}	7.61 ± 0.13^{b}	7.02 ± 0.08^{b}	< 0.01
Crude protein	7.60 ± 0.56^{a}	5.11 ± 0.51^{b}	4.33 ± 0.42^{c}	< 0.01
Crude fibre	12.2 ± 0.06^{c}	25.6 ± 0.08^{a}	18.5 ± 0.07^{b}	0.02
Ether extracts	0.58 ± 0.02^{a}	0.42 ± 0.01^{b}	0.30 ± 0.01^{c}	< 0.01
Ash	12.6 ± 1.96^{a}	10.5 ± 1.10^{b}	10.2 ± 0.98^{b}	0.01
Carbohydrate	45.4 ± 3.81^{a}	38.0 ± 2.92^{b}	37.2 ± 2.03^{b}	0.03

Note: ± SEM (n = 3). [1]*Pterocarpus erinaceus* leaves. [2]*Pterocarpus erinaceus* stem bark. [3]*Pterocarpus erinaceus* root. Source: Authors, 2023.

3.2 Results on the mineral composition in dried Pterocarpus erinaceus leaves (DPE), stem bark (DSB)

and root (DSR)

Results on the mineral composition in dried Pterocarpus erinaceus leaves (DPE), stem bark (DSB) and root (DSR) is presented in (Table 2). DPE contained higher ($P < 0.05$) levels of calcium (108 mg/100 g^{-1}), phosphorus (60 mg/100 g^{-1}), potassium (39 mg/100 g^{-1}), zinc (10 mg/100 g^{-1}), manganese (8 mg/100 g^{-1}), copper (4 mg/100 g^{-1}), sodium (25 mg/100 g^{-1}) and iron (16 mg/100 g^{-1}) compared to DSB and DSR which contains calcium (90 mg/100 g^{-1}; 91 mg/100 g^{-1}), phosphorus (40 mg/100 g^{-1}; 43 mg/100 g^{-1}), potassium (30 mg/100 g^{-1}; 30 mg/100 g^{-1}), magnesium (9 mg/100 g^{-1}; 8 mg/100 g^{-1}), zinc (7 mg/100 g^{-1}; 7 mg/100 g^{-1}), magnesium (5 mg/100 g^{-1}; 4 mg/100 g^{-1}), copper (2 mg/100 g^{-1}; 2 mg/100 g^{-1}), sodium (19 mg/100 g^{-1}; 18 mg/100 g^{-1}) and iron (11 mg/100 g^{-1}; 10 mg/100 g^{-1}) respectively.

Table 2: Results on the mineral composition in dried *Pterocarpus erinaceus* leaves (DPE), stem bark (DSB) and root (DSR).

Variables (mg/100 g^{-1})	**[1]DPE**	**[2]DSB**	**[3]DSR**	***P*-value**
Calcium	108.6 ± 0.17[a]	90.60 ± 0.10[b]	91.55 ± 0.22[b]	< 0.01
Phosphorus	60.38 ± 0.51[a]	40.11 ± 0.42[b]	43.80 ± 0.38[b]	0.02
Potassium	39.7 ± 0.00[a]	30.2 ± 0.00[b]	30.0 ± 0.00[b]	0.01
Magnesium	12.51 ± 0.09[a]	9.93 ± 0.07[b]	8.90 ± 0.05[b]	0.01
Zinc	10.44 ± 0.65[a]	7.55 ± 0.51[b]	7.00 ± 0.61[b]	< 0.01
Manganese	8.55 ± 0.01[a]	5.20 ± 0.02[b]	4.88 ± 0.02[b]	0.02
Cobalt	1.16 ± 0.01	1.11 ± 0.01	1.00 ± 0.02	0.01
Copper	4.58 ± 0.77[a]	2.40 ± 0.62[b]	2.21 ± 0.50[b]	< 0.01
Sodium	25.2 ± 2.50[a]	19.6 ± 1.92[b]	18.4 ± 1.90[b]	0.02
Iron	16.13 ± 0.41[a]	11.00 ± 0.66[b]	10.67 ± 0.50[b]	< 0.01

Note: ± SEM (n = 3). [1]*Pterocarpus erinaceus* leaves. [2]*Pterocarpus erinaceus* stem bark. [3]*Pterocarpus erinaceus* root. Source: Authors, 2023.

3.3 Results on the phyto-constituents in dried Pterocarpus erinaceus leaves (DPE), stem bark (DSB) and root (DSR)

Results on the phyto-constituents in dried Pterocarpus erinaceus leaves (DPE), stem bark (DSB) and root (DSR) presented in (Table 3). DPE contained higher ($P < 0.05$) concentration of terpenoids (1.40 mg/g), flavonoids (11 mg/g^{-1}), steroids (1 mg/g^{-1}), phenols (41 mg/g^{-1}), saponins (28 mg/g^{-1}) and tannins (8 mg/g^{-1}) compared to DSB and DSR which contains tannins (4 mg/g^{-1}; 4 mg/g^{-1}), terpenoids (0.65 mg/g^{-1}; 0.55 mg/g^{-1}), saponins (15 mg/g^{-1}; 14 mg/g^{-1}), flavonoids (7 mg/g^{-1}; 7 mg/g^{-1}), steroids (1 mg/g^{-1}; 1 mg/g^{-1}) and phenol (30 mg/g^{-1}; 31 mg/g^{-1}) respectively.

Concentrations of glycosides and alkaloids was higher in DSR (6 mg/g^{-1}; 25 mg/g^{-1}), intermediate in DPE (4 mg/g^{-1}; 19 mg/g^{-1}) and lowest in DSB (1 mg/g^{-1}; 15 mg/g^{-1}).

Table 3. Results on the phyto-constituents in dried *Pterocarpus erinaceus* leaves (DPE), stem bark (DSB) and root (DSR).

Variables (mg/g^{-1})	[1]DPE	[2]DSB	[3]DSR	*P*-value
Tannins	8.81 ± 0.47^{a}	4.91 ± 0.26^{b}	4.10 ± 0.20^{a}	0.003
Terpenoids	1.40 ± 0.12^{a}	0.65 ± 0.10^{b}	0.55 ± 0.08^{b}	0.001
Saponins	28.6 ± 0.63^{a}	15.1 ± 0.19^{b}	14.0 ± 0.21^{b}	0.002
Flavonoids	11.20 ± 0.02^{a}	7.51 ± 0.01^{b}	7.20 ± 0.01^{b}	0.001
Steroids	1.61 ± 0.02^{a}	1.14 ± 0.02^{b}	1.02 ± 0.01^{b}	0.001
Glycosides	4.42 ± 0.81^{b}	1.20 ± 0.10^{c}	6.19 ± 2.03^{a}	0.002
Alkaloids	19.6 ± 5.10^{b}	15.8 ± 4.06^{c}	25.3 ± 4.42^{a}	0.001
Phenols	41.5 ± 2.70^{a}	30.4 ± 1.88^{b}	31.2 ± 1.90^{b}	0.001

Note: ± SEM (n = 3); [1]*Pterocarpus erinaceus* leaves. [2]*Pterocarpus erinaceus* stem bark. [3]*Pterocarpus erinaceus* root. Source: Authors, 2023.

4. Discussion

Moisture content obtained in this sample indicates that samples can be stored for a relatively long time without deteriorating (Alagbe et al., 2023). The moisture content obtained in this study is higher than those obtained for *Dysphania ambrosiodes* leaves (6.31%), *Crassocephalum crepidioides* leaves (6.66%) and *Piliostigma thonningii* leaves (4.6 %) reported by Falowo et al. (2023) and Tijjani et al. (2012). Crude protein values obtained for DPE, DSB and DPE was low compared to values obtained for *Momordica charantia* stem bark (10.22%), *Combretum zenkeri* leaves (20.1 %), *Moringa olifera* leaves (25.68%) reported by Ujowundu et al. (2010); Alinnor & Oze (2011) and Moyo et al. (2011). The low crude protein in DPE, DSB and DPE suggests that it cannot be used to replace protein in the diet of animals (NRC, 1994).

The ether extract content in DPE (0.58%), DSB (0.42 %) and DPE (0.30%) recorded is low. According to Adewale et al. (2022), leaves of *P. erinaceus* in Osun state contains 13.63% crude protein which is higher than 7.60% recorded in this study. The variation can be linked to geographical location, age of plant as well as specie of plant used (Alagbe et al., 2022). Dietary fibre intake helps to prevent coronary heart disease (Alagbe et al., 2022).

Earlier studies have reported 22.02%, 22.05% and 22.01% for leaves of *Ocimum gratissimum*, *Parquetin nigrescen* and *Morinda lucida* reported by Abiodun et al. (2017). The ash content in DPE is higher than those recorded for DSB and DSR. This suggests that DPE had a high mineral content compared to the other samples. However, value in all the samples (DPE, DSB and DSR) were higher than those recorded for the leaves of *Momordica charantia* (7.80%) and *P. nigrescen* (12.0%) reported by Bakare et al. (2010) and Abiodun et al. (2017) respectively. Similarly, DPE had a higher concentration of carbohydrate relative to DSB and DSR.

This indicates that DPE is capable of supplying enough energy to enable the efficient performance of all organs in the body (Raimi et al., 2014). However, values obtained in all samples (DPE, DSB and DSR) were lower than those obtained for the leaves of Veronia amgydalina (54.00%), *Chenopodium ambrosiodes* (43.76%), *Mangifera indica* (40.23%), *O. gratissimum* (50.06%) and *Morinda lucida* (51.66%) reported by Abiodun et al. (2017).

Concentrations of cobalt in DPE (1.16 mg/100 g^{-1}), DSB (1.11 mg/100 g^{-1}) and DSR (1.00 mg/100 g^{-1}) were not significantly ($P > 0.05$) different. The result obtained suggests that DPE contains higher concentrations of minerals compared to those DSB and DSR. Dietary supplementation of DPE in animals can positively influence the activities of enzymes and cell growth repair (Angelova et al., 2014). Iron and Copper are responsible for the production of haemoglobin, cell growth and repairs as well as immune functions (Fairweather and Hurrell, 1996).

Synthesis of deoxyribonucleic acid, ribonucleic acid and metabolic processes are facilitated by the presence of Zinc in the diet of animals (Hall et al., 1991). Manganese aids in the metabolism of carbohydrates, fats and proteins in the body (He; MacGregor, 2008; Hoffmann; Berry, 2008). The mineral composition recorded for DSB was lower than Cu (10.88 mg/100 g^{-1}), Fe (18.65 mg/100 g^{-1}) and P (27.30 mg/100 g^{-1}) reported by Maryam et al. (2017). However, values obtained in this study is in agreement with the reports of Osuagwu (2008).

The result obtained suggests that DPE, DSB and DSR contains phytochemicals or phyto-constituents with several pharmacological properties such as: anti-plasmodial, anti-parasitic, antiviral, antifungal, antimicrobial anti-carcinogenic, antiepilepsy, antifertility, hepato-protective, anti-allergic, antimalarial, Antidiabetic, anti-hyperlipidemic, anti-allergic, antimalarial, anti-filarial, antineoplastic, rheumatic pains, dermato-protective, immune-modulator, antiseptic, carminative, digestive, febrifuge, laxative, antipyretic, immunological disorders, antioxidant amongst others (Bidlack et al., 2000; Shittu et al., 2021).

For their biological needs, such as protection against insect and fungal invasion and herbivorous animal attacks, plants create a wide variety of chemical substances known as phytochemicals (Alagbe et al., 2020). Additionally, they include a wide range of compounds that scavenge free radicals, such as flavonoids, phenols, vitamins, and terpenoids, which are very active antioxidants (Cai; Sun, 2003; Singh et al., 2022). For example, saponins have been demonstrated to have hypolipidemic and anticancer activity, making them significant therapeutic agents (Olajere, 2014).

Anabolic steroids, or steroids, have been shown to help animals with wasting diseases and osteoporosis retain their nitrogen (Madziga et al., 2010; Alagbe et al., 2022). It has been proposed that flavonoids have antibacterial, antioxidant, and immune-stimulatory properties. They can also directly scavenge free radicals and indirectly combat oxidative stress by acting as antioxidants via the Nrf2/HO^{-1} pathway (Alagbe; Ushie, 2022). The most abundant chemical in DPE, DSB, and DSR is phenol, which has antibacterial, antioxidant, and other properties (Madziga et al., 2010). Anti-bacterial, anti-diarrhea, anti-inflammatory, and antioxidant qualities are said to be present in tannins (Dhan et al., 2007; Alagbe et al., 2022). An excessive amount of tannins can impede the body's ability to absorb calcium and iron (Madziga et al., 2010).

Many pharmacological actions are exhibited by alkaloids, including analgesic, anti-malarial, anti-arrhythmic, and vasodilatory effects (Ríos; Recio, 2005; Butler, 2005). According to reports, terpenoids disrupt membranes, which prevents the release of prostaglandins and autacoids and has anti-diarrhea and antibacterial properties (Doughari et al., 2009; Alagbe, 2019).

5. Conclusion

In conclusion, compared to DSB and DSR, DPE has higher quantities of nutrients and minerals. All of the samples, meanwhile, are not suitable for use in animal feed as protein supplements. Its pharmacological qualities were demonstrated by the presence of phytochemicals such as tannins, alkaloids, flavonoids, steroids, and saponins, among others.

The results of this study and a prior experiment indicate that *Pterocarpus erinaceus* bioactive secondary metabolite content may be influenced by a variety of factors, including location, climate, plant age, and processing method.

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Alagbe Olujimi John: compilation of result, statistical analysis, writing and making corrections. *Muritala, Daniel Shittu*: compilation of result and making corrections. *Aduragbemi Yetunde Adesina*: compilation of result. *Chesa Jummai Grace*: compilation of result. *Kadiri Mercy Cincinsoko*: sourcing of test ingredients and making corrections. *Bamigboye Samson Oluwafemi*: compilation of result. *Effiong Erikanobong*: compilation of result.

Ethics

Authors should address any ethical issues that may arise after the publication of this manuscript.