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COMPARATIVE NUTRITIONAL AND MINERALS COMPOSITION OF *AZADIRACHTA INDICA*, *EUCALYPTUS GLOBULES* AND *MELIA AZEDARACH*

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Abstract *The current study was carried out to evaluate the comparative nutritional and mineral composition of Azadirachta indica, Eucalyptus globules, and Melia azedarach leaves, bark, and seed. The dried powder of these plant parts was analyzed for nutrition compositions such as moisture, ash, fat, fiber, protein, carbohydrate, and energy using standard methods. Sodium, potassium, and calcium were analyzed using Flame Photometer. While Manganese, Zinc, Iron, Copper, Chromium, and Magnesium were determined using an Atomic Absorption Spectrophotometer. The proximate range in these plants are; moisture (4±0.2- 15.0±0%), ash (9±00-4±00%), Fats (17±00- 0.5±00%), Fiber (15±00-7±00%), Protein (8.73±00-2.0±00%), CHO (71.19±00-50±00%) and Energy Kcal/100g (379.5-285.5%). While the minerals composition (mg/Kg) range is; Sodium (1900±02-390±00), Potassium (2000±01-900±00), Manganese (36±01- 20±01), Zinc (120±02-1.5±01), Iron (120±00-9±00), Copper (3±00-0.1±00), Chromium (0.60±00-0.20±00), Magnesium (100±00-0.30±00), Calcium (2200±02-300±01), Phosphorus (1700±02-180±01). It can be inferred from the results of this study, that these plants' bark, seed, and leaves contain a significant number of nutrients and minerals that aid in their therapeutic capabilities and serve as good forage, therapeutic, and nutritional supplements for livestock. It can also aid its medicinal properties for human consumption.*

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Keywords: *Neem; Chinese neem; proximate composition; elemental composition; health benefits; nutraceutical; food; feed*

Introduction

The nutrition and proximate composition analysis of herbs and plants provide precious data and facilitate to entrance of the worth of the sample. It gives information on crude protein, fixed carbon, volatile matter, ash, moisture, fiber content, etc. Ash is the non-organic remaining organic matter and water has been expelled by temperature, which gives a calculation of the total quantity of elements within the food (Igwenyi *et al*., 2017). Several elements are vital to human being nutrition mount up in various divisions of herbs. The plants and herbs build up elements necessary for the development of the ecosystem. The main elements such as sodium, chlorine, potassium, sulfur, magnesium, phosphorus, and calcium provide acid-base and water balance, shape the composition of the tissues, and function in basal metabolism and cells. Trace elements in maximum quantity like chromium, iodine, fluoride, copper, manganese, silicon, iron, and zinc form considerable health toxicity for humans and have grown a field of meticulous concern and uppermost main concern in ecosystem research. Trace minerals could be straightly taken up through the leaf of herbs or they accrue in the earth and through plants' roots they reach them. Trace minerals also have preventive and creative roles in fighting against diseases (Ani *et al*., 2020).

Azadirachta indica commonly called Neem is an evergreen plant, grown in numerous regions of South Asia. All pieces of this medicinal plant have been utilized as conventional therapy for family medication against numerous ailments from ancient times. *Azadirachta indica* has been broadly utilized as Homeopathic, Unani, and Ayurveda medicine (Madaki *et al*., 2016). More than 140 substances such as Nimbin, azadirachtin, steroids,

Phenol compounds, triterpenoids, flavonoids, and alkaloids have been extracted from various neem parts (Oyeyemi *et al*., 2020). The neem seed possessed has a maximum quantity of oil. Neem oil is broadly utilized as a lubricant, insecticide, and medicine for various ailments like tuberculosis and diabetes. The neem leaves could be utilized as medicine against fever, eczema, and diabetes. The bark can prepare toothbrushes and the roots can be utilized against insects and heal diseases (Madaki *et al*., 2016).

The important medicinal plant Eucalyptus belongs to the order Myrtles and Myrtaceae and is a great evergreen and aromatic genus tree inhabitant to Tasmania and Australia, and effectively planted and introduced in many countries of the world (Ani *et al*., 2020). Numerous Eucalyptus species leaf extracts have been endorsed in cosmetic formulations and as food additives (Eman, 2017). The numerous Eucalyptus species have been underexploited and undervalued as a source of essential fatty acids, mineral elements, and dietary fiber. Nearly whenever the essential oils are extracted, the cake or residues of the leaves are received as an unused waste creating the surrounding pollution (Takahashi *et al*., 2004).

The *Melia azedarach* commonly called Chinese neem is a resident plant of Southern Australia and Asia with significant pesticidal activities. This tree is mainly used as a decorative plant and has been adopted in subtropical and tropical countries (Italo *et al*., 2009). Leaves are utilized against resolvent, deobstruent, diuretic, antilithic, anthelmintic, scrofula and leprosy. Roots are efficiently applied as deobstruent and resolvent. Seed oil is the chief vigorous medicinal product of the plant and applied as an antimicrobial agent against ulcers and sores that observe no indication to cure. It is also applied to cure rheumatism and skin ailments like scabies and ringworm. Inside, the oil is helpful in leprosy and malaria fever. In South Asia this plant have many conventional application. The extracts of fresh leaves are applied topically on burns and as oral cavity wash against gingivitis. Bark of stem infusion 30-50 mL is applied orally two times a day for Gonorrhea. Leaves extracts orally administered (5mL) three times a day against piles and for pyrexi two times a day orally administered (5-10mL) (Abdul *et al*., 2011).

Thus the present study was design to determine and compare the nutrition and mineral composition of leaves, bark and seed of *Azadirachta indica*, *Eucalyptus globules* and *Melia azedarach*.

Materials and Methods

Plant Material Collection

The *Melia azedarach* and *Eucalyptus globulus* leaves, bark and seed were collected from Experimental Research Farm of Pakistan Council of Industrial Scientific and Industrial Research (PCSIR) Laboratories Complex, Peshawar Khyber Pakhtunkhwa-Pakistan. While the *Azadirachta indica* leaves, bark and seed were purchased from the local Board Bazar of Peshawar, Khyber Pakhtunkhwa-Pakistan. The plant parts collected were carefully washed with tape water to eliminate the soil, dirt particles and any unwanted materials. These parts were dried in a shaded room for a period of 10 days. The dried samples were grinded using Standard Model No.3 Wiley Mill USA into powder form and kept in an air tight brown glass bottle at 10 °C in a cooled incubator (Gallenkamp –UK) until used.

Nutritional analysis

The proximate compositions of the powdered samples were analyzed in Food Technology Center of PCSIR Laboratories Complex Peshawar, Khyber Pakhtunkhwa-Pakistan following the standard food analysis methods.

Moisture Content Determination

Moisture quantification was determined applying oven-dry method using Electric Oven (Memmert-Germany) while the weight loss carried because of evaporation at 100±02 °C temperature from the samples. The constant reduction in weight of each sample symbolized the quantity of moisture occurred in a samples (AOAC, 1990).

$$\text{Moisture (\%)} = \frac{\text{Sample weight} - \text{final weight of sample dried}}{\text{Sample weight}} \times 100$$

Ash content Determination

Each sample was taken in China crucible, weigh empty crucible and then take a five (05) gram of sample into each China crucibles, record weight. Charring of the samples were carried out in a Fuming Hood (ESCO- EFH-4A1, Singapore) to stop further smoking. Then kept the samples in a Muffle Furnace (Witeg- Korea) at 600 °C for 8 h (AOAC, 1990), cooled in desiccator and weigh until constant weights were obtained at room temperature. The ash calculation was carried out using the following formula;

$$\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{Sample weight}} \times 100$$

Crude Fiber Determination

About 2 g fat free sample of each plant was taken into a fiber flask and added H_2SO_4 (0.255 N) 100 mL. Afterward the blend was under reflex was heated for one hour in Heating Mantle,-Electrothermal (Made in England). The heated blend was filtered using a fiber sieve cloth. The obtained difference was thrown off and the residue was shifted into the flask to which NaOH (0.313 M)

1000mL was poured and again for one hour heated under reflex. The blend was again filtered using fiber sieve cloth and to dissolve any organic ingredients acetone 10 mL was added. The residue was rinsed on the sieve cloth twice earlier than it was lastly shifted into a crucible pre-weighed. The crucible along with residue was kept at 105°C overnight in an oven (Memmert-Germany) to evaporate the moisture. The oven dehydrated crucible having residue was kept in a desiccators and finally weighted (W1) for ashing in a Muffle Furnace (Witeg- Korea) for four hour at 550°C (AOAC, 1990; Shovon *et al*., 2013). The crucible holding grey and white ash (without carbonaceous compounds) was shifted for cooling into a desiccator and weighted to gain W2. The crude fiber % was calculated using the following formula;

$$\text{Crude fiber (\%)} = [\{(W1-W2)/\text{sample weight}\} \times 100]$$

Crude fat Determination

Crude fat (%) was quantified in plant powder samples applying extraction technique using Soxhlet Apparatus (Quickfit-England). The oil content of the dried plant powder samples were extracted in an organic solvent (*n*-Hexane) at 40-60 °C and pursuing to reflex for six hour. The crude fat (%) was determined from the following formula (AOAC, 1990).

$$\text{Crude fat (\%)} = \frac{\text{Fat in sample}}{\text{Sample weight}} \times 100$$

Crude Protein Quantification

The Micro Kjeldahl (Bloc Digest, Spain) equipment was used to determine the crude protein followed the method (AOAC, 1990). The Nitrogen (N) percentage was estimated applying bellow equation;

$$N (\%) = \{(S - B) \times N \times 0.014 \times D \times 100\}/ (W)$$

Where, 0.014= constant value, w = weight of sample, S-B= Titration value, D = dilution factor, N = Normality of titrant value (0.02 N H_2SO_4). Finally crude protein was calculated by multiply the subsequent N content by 6.25 conventional factors. Therefore, crude protein (%) = N % x 6.25.

Carbohydrate Determination

Carbohydrate quantification in plants powder samples was estimated applying difference method (Hagos 2018; Ulfat *et al*., 2016).

Total Carbohydrates (%) = [100- % (Fiber + Ash + Moisture + Fat + Protein)]

Total Energy Determination

Estimation of total energy value of the plants powder was determined using the method of (Satter *et al*., 2014) applying the following formula as describe in Equation;

Total Energy (Kcal/100g) = (% Fat × 9.3) + (%Protein × 4.1) + (%Carbohydrates × 4.1)

Minerals Analysis

Wet digestion

Briefly, plants powder of 1.0 g was initially digested with 20mL of acid blend (20mL H_2SO_4, 80mL Perchloric acid, 650 mL Conc. HNO_3) through weighing the powder into a digestion flask by go after the adding of the 20mL of acid blend. The digestion flask comprising the digestion acid mixture and the plant powder were heated awaiting an apparent digest was gained. The digest was afterward diluted with distilled H_2O to 500 mL mark. The digestion was carried out in Fume Hood (ESCO-EFH-4A1, Singapore). After getting the digests, liquid of the plain digest were used for Atomic Absorption Spectrophotometer (Z-2000, Hitachi-Japan) applying filters that harmonized the various minerals. The quantification of elements was estimated with their calibration curves make with their standards solutions. Manganese (Mn), Zinc (Zn), Iron (Fe), Copper (Cu), Chromium (Cr) and Magnesium (Mg) were estimated using Atomic Absorption Spectrophotometer (AOAC, 1990). While Sodium (Na), calcium (Ca) and potassium (K) were estimated using Flame Photometer (Jenway PFP7-UK).

The Phosphorus (P) was quantified using Molybdate Technique. Briefly, approximately 10% trichloroacetic acid (9.5 mL) and 0.5ml of mineral digest were pour into a test tube. This was go after by stirring for five minute and afterward filtered through a filter paper (Grade 42-Whatman®). The filtrate about 5 mL was subsequently poured into a Cuvette. In addition, 5mL of the working standard and 5 mL of trichloroacetic acid were also poured in two Cuvette that denoted standard and blank respectively. Approximately, 0.5mL of molybdate reagent was subsequently added to each tube and blend. Likewise, H_2SO_4 reagent 0.2mL was poured and the materials were sealed, blend and permitted to set for ten minute. The optical density of the test plant powder solution and standard were recorded at 660 nm using Spectrophotometer (UV-1700, Shimadzu, Japan) with the control set at zero (Shovon et al., 2013). The % P was next measured as:

% P = (Sample absorbance/Standard absorbance) × Conc. of standard (5mg/dL) ×100

Statistical Analysis

Analysis of variance (ANOVA) was used to compare the difference between groups considered at significant level of $p < 0.05$ with the aid of an SPSS programme (Version21). Collected data obtained from various parameters of processed vegetable samples were subjected to statistical analysis using SPSS (version 12.00) computer programmed to compute ANOVA techniques.

Results and Discussion

Results

Quantitative Proximate Constituents

The result of the quantitative proximate of the neem is presented in table 1. The results showed that moisture content (%) of leaves was 8.0±0.5, seed was 15±01 and bark was 6.0±0. The ash content (%) of leaves was 7.2±0.2, the seeds containing 7.0±01 and the bark was 8.0±0. The fat (%) in the leaves was 1.78±0, seed was 17±0 and bark was 1.0±0. The analysis shown that the neem leaves fiber content was 10.38±0 %, seeds have 7.0±0 % and the bark revealed 14.0±01 % fiber content. The Protein (%) of the neem leaves comprised of 8.73±0 %, seeds were 4.0±0 % and bark showed 2.50 ±0 % proteins content. The carbohydrate content in the neem leaves showed 63.91±0 % carbohydrates, seed is comprised of 50±0 % carbohydrates while the bark having 68.5±0 % carbohydrates. The energy value (Kcal/100g) of neem leaves was 314.78, seed was 379.5 and bark was 300.4. These values indicate that leaves of neem can serve as good source of energy because carbohydrate and fat are known to be the main source of energy for organism which includes human, animal, or microorganism.

The proximate composition of *Eucalyptus globules* is presented in table 2. The moisture content in the *E. globules* leaves was 6.17 ±0%, seeds having 05±0.1% and bark have 4.0±0.2% moisture content. The ash content in the leaves of *E. globules* was 5.35 ±0%, seeds was 4.0±0% and bark was 6.0±0.4%. The fat composition of leaves was 1.23±0%, seed was 03±0 % and bark was 0.5 ±0%. The fiber (%) in the *E. globules* leaves was 12.30±01, seeds was 8.0±0.5 and bark revealed 15.0±01% fiber content. While the Protein (%) values of leaves (8.73±0), seeds (4.0±0) and bark (2.50 ±0). The carbohydrates (%) composition revealed that leaves showed 63.91±0, seed (50±0) and bark (68.5±0). The *E. globules* leaves showed 314.78 Kcal/100g of energy, the seed having 379.5 Kcal/100g and bark was 300.4 Kcal/100g. The result of the quantitative proximate of the *Melia azedarach* is presented in table 3. The results showed that the maximum moisture content was observed in seed (8.5±0%), followed by leaves (7.53±01%) and bark (6.0±0%). The highest as content was calculated in seeds (9.0±0%) and the lowest was observed in the bark (07±0%) and the moderate values was 7.90 ±0% in the leaves. The fat composition of the Chinese neem leaves was 1.72 ±0%, seeds was 5.5±0 % and bark was 1.2±0%. The fiber value of Chinese neem leaves was 10.72±01%, seeds were 13±0 % and bark was 15.0±0 %. The Protein percentage values in Chinese neem leaves was 5.96±01, seeds was 6.0±0 and bark showed 2.0 ±0. While the % carbohydrates in leaves of Chinese neem showed 66.17±0, seed is comprised 58±0 and bark was 68.3±0. The energy values in the leaves showed 311.73 Kcal/100g, seed 313.55 Kcal/100g and bark was 299.39 Kcal/100g. The results of the proximate analysis of the plants demonstrated that, the leaf has nutritive value in that it contains moisture content, crude protein, ash content, crude fibre, carbohydrate and fat. The recommended daily allowances of nutrients are shown in table 7.

Minerals Composition

The minerals composition (mg/kg) of *Azadirachta indica* is shown in table 4. The results showed that Na content in the leaves of neem was estimated 1900±02. The seed showed minimum Na of 1500±02 and the bark revealed the least Na of 900±01. The K in the leaves of neem was determined as 2000±01. The estimated value of K in seed was 1800±02 while bark showed the least K of 1100±02. The Leaves of neem showed Mn content as 31 ±01. The Mn in seed was 28±01 mg/kg while bark showed the least Mn of 25±01. The Zn content in Leaves of neem was 106 ±01. The seed revealed lower content of Zn 85±01 while the bark showed least Zn 60±02. The neem leaves Fe was 09±00, while the Fe in seed and bark were 12±0.5 and 15±0 respectively. The Cu, Cr and Mg contents were very low as seen in table 4. The Leaves of neem showed highest value of Ca 1300±01. The seed revealed lower content of Ca 900±01, while the bark showed lowest content of Ca 300±01. The Leaves of neem showed highest value of P 450 ±0.5. The seed revealed lower content of P 320±01, while the bark showed lowest content of phosphorous 120±01. Minerals (mg/kg) Quantification of *Eucalyptus globules* are shown in table 5. The results show that Na content in the leaves was 800 ±0. The seed showed minimum Na of 650±0 and the bark revealed the least Na of 390±01. The K in the leaves was determined as 1600 ±02. The estimated value of K in seed was 1280±03 while bark showed the least K of 980±02. The leaves showed Mn content as 36±01. The Mn in seed was 30±01 while bark showed the least Mn of 20±01. The Zn content in leaves, seed and bark were 3.5 ±01, 2.5±03 and 1.5±02 respectively. The leaves Fe (50 ±00), seed (30±0) and bark (25±0). The Cu and Cr contents in all parts are very low. The leaves, seed and bark Mg contents were 100 ±0.0, 70±0.5 and 45±0.5 respectively. The leaves of Ca were 2200 ±02, seed was 1800±02 and bark was 1120±01. The maximum P content is observed in leaves, minimum is measured in bark and moderate is calculated in seed. Minerals quantification (mg/kg) of *Melia azedarach Linn* are shown in table 6. The mineral contents estimated that leaves show a higher concentration followed by seeds and bark for all elements composition. The Cr, Cu and Fe composition observed low contents as compared with the rest minerals analyzed. The K content in leaves (1400±00 mg/Kg), seeds (1200±02 mg/Kg) and bark (900±00mg/Kg) shows a highest concentration as compared to the other analyzed minerals. The recommended daily allowance (RDA) of minerals intake is shown in table 8.

Table 1. Proximate Composition of *Azadirachta indica*

Parameters	Leaves	Seed	Bark
Moisture%	08.00±0.5	15.00±01	06.00±00
Ash%	07.2±0.2	07.00±01	08.00±00

Fat%	01.78±00	17.00±00	01.00±00
Fiber%	10.38±00	07.00±00	14.00±01
Protein%	08.73±00	04.00±00	2.50±00
Carbohydrate%	63.91±00	50±00	68.5±00
Energy value (kcal/100g)	314.378±00	379.5±00	300.4±00

All data were expressed as mean ± SD of triplicate experiment (n = 3)

Table 2. Proximate Composition of *Eucalyptus globulus*

Parameters	Leaves	Seed	Bark
Moisture%	6.17±00	05±0.1	04±0.2
Ash%	5.35±00	04±00	06±0.4
Fat%	1.23±00	03±00	0.5±00
Fiber%	12.30±01	08±0.5	15±01
Protein%	6.76±00	05±0.2	03±0.5
Carbohydrate	71.19±00	68±00	65.5±00
Energy kcal/100 g	331.034±00	327.2±00	285.5±00

All data were expressed as mean ± SD of triplicate experiment (n = 3)

Table 3. Proximate Composition of *Melia azedarach Linn*

Parameters	Leaves	Seeds	Bark
Moisture%	7.53±01	8.5±00	6.5±00
Ash%	7.90±00	09±00	07±00
Fat%	1.72±00	5.5±00	1.2±00
Fiber%	10.72±01	13±00	15±00
Protein%	05.96±01	6.0±00	2.0±00
Carbohydrate%	66.17±00	58±00	68.3±00
Energy kcal/100 g	311.729±00	313.55±00	299.39±00

Each value represents of average in triplicates ± SD

Table 4. Minerals composition (mg/kg) of *Azadirachta indica*

Minerals	Leaves	Seeds	Bark
Sodium	1900±02	1500±2	900±01
Potassium	2000±01	1800±2	1100±2
Manganese	31±01	28±01	25±01
Zinc	106±01	85±01	60±02
Iron	09±00	12±0.5	15±00
Copper	0.20±00	0.19±00	0.24±00
Chromium	0.43±00	0.24±00	0.50±00
Magnesium	3.8±0.01	2.5±0.01	0.30±00
Calcium	1300±01	900±01	300±01
Phosphorus	450±0.5	320±01	120±01

ND=Not detected, All data were expressed as mean ± SD of triplicate experiment (n = 3)

Table 5. Minerals (mg/kg) Quantification of *Eucalyptus globules*

Minerals	Leaves	Seeds	Bark
Sodium	800±00	650±00	390±00
Potassium	1600±02	1280±03	980±02
Manganese	36±01	30±01	20±01
Zinc	3.5±01	2.5±03	1.5±01
Iron	50±00	30±00	25±00
Copper	0.2±00	0.1±00	0.25±00
Chromium	0.6±00	0.5±00	0.4±00
Magnesium	100±00	70±0.5	45±0.2
Calcium	2200±02	1800±02	1120±01
Phosphorus	1700±02	1200±01	870±01

ND=not detected, All data were expressed as mean ± SD of triplicate experiment (n = 3).

Table 6. Minerals Quantification (mg/kg) of *Melia azedarach Linn*

Minerals	Leaves	Seeds	Bark
Sodium	1100±01	1000±03	800±02
Potassium	1400±00	1200±02	900±00
Manganese	27±02	35±01	25±01

Zinc	115±03	120±02	99±01
Iron	120±00	60±00	20±00
Copper	03±00	02±00	01±00
Chromium	0.43±00	0.30±00	0.20±00
Magnesium	28±0.5	23±0.2	09±0.5
Calcium	1500±02	1300±02	700±02
Phosphorus	345±0.5	270±01	180±01

ND=Not Detected, All data were expressed as mean ± SD of triplicate experiment (n = 3).

Table 7. RDA of Nutrients (Okunrobom et al., 2011; Uraku and Nwankwo 2015)

Nutrients	RDA in females aged 40- 50 years old (g/day)	RDA in males aged 40-50 years old (g/day)
Moisture	-	-
Ash	-	-
Crude fibre	25	38
Fats and Oils	20 -35% of calories	20 -35% of calories
Proteins	46	56
Carbohydrates	130	130

Table 8. RDA Recommended Daily Intake of Minerals (Edori *et al*., 2017)

Metal	Recommended Daily Allowances (mg)	Tolerable Upper Intake Limit (mg)
Sodium (Na)	1500	2300
Potassium (K)	4700	-
Magnesium (Mg)	310	400
Manganese (Mn)	1.8	11
Zinc (Zn)	11	40
Iron (Fe)	08	45
Calcium (Ca)	1000	2500
Copper (Cu)	900µg	10000µg

Discussion

Proximate composition

Moisture substance is the quantity of H_2O in a matter. Moisture is a vital substance of various foods, (Datta *et al*., 2019) 20% of the whole H_2O utilization is in the course of food water. Moisture quantification is a sign of the foodstuff moisture activity (Ani *et al*., 2020). It is applied to assessed how susceptible and stable a food substances is to deteriorate by microorganisms (Ani *et al*., 2020). The water composition of the investigated herbs are minimum and obey the degree of values requisite as secure range for storeroom for food plants resources (Umar *et al*., 2007). This minimum quantification showed that the leaves could be kept for an extended period without the microbial growth development.

Moisture quantity of foodstuff is affected by storage condition, variety and type (Madaki *et al*., 2016; Garba and Mungadi 2019). Though, various values have always been recognized through numerous scientists and these might be accredited to the season variation, in which the plants parts were collected, techniques of extraction and geographical locations. The ash material is measurement of elemental sign of any foodstuff. It is the scum rest behind all the water content has been eliminated and the biological substances such as organic acid, vitamins, carbohydrates, protein and fat has been burned and ashed in a oven at 500°C to 600°C (Ali et al., 2024). The raw lipid quantification is minimum and supposed for a leaves plants as the research have been investigated that leaves vegetables are deprived origin of fats (Ejoh *et al*., 1996). A food that provides 1-2% of its calorific energy as fat is consider to be enough for human because the elevated fat eating create an obesity and heart diseases (Kris-Etherton *et al*., 2002). Additionally hence, lipid is necessary in food because it provide as good origin of energy, protects and insulate internal tissues, contributes to vital cell procedures and help to transport of fat soluble vitamins (Ani *et al*., 2020). Crude fiber in plant or food is a sign of the degree of non-digestible lignin and carbohydrate (Karoly, 2011). The maximum fiber quantification might boost waste removal such as fat, sterol and bile acid (Garba and Mungadi 2019). The research revealed that high fiber eating could accounted to minimize in the incidence of digestive disorders, obesity, hypertension, diabetes, colon cancer, heart diseases and gastric problems (FAO, 1990; SCAN 2008). This is for the reason that it assists absorption and digestion of fat and glucose. However crude fiber boost up digestibility, its occurrence in maximum quantity may lead stomach disorders and reduced nutritional utilization due to maximum composition of cellulose and minimum lignin which is not digestible in human being (Ani *et al*., 2020). The plant fiber assists in the curing of diabetes, colon cancer and heart diseases (Hagos, 2018). Fibre work as a genuine broom in the intestine, soak up poisonous compounds and eliminated toxic compounds like biliary acids, cholesterol originator

(Roger, 1999). Fiber provides steadiness to faeces. Further, in the gastrointestinal tract function fiber has physiological effects on it due to boosting the decrease of tracolonic pressure, which is useful in enteric cancer (Okwu and Emenike, 2007). Proteins are utilized to synthesized antibodies, hormones, enzymes and tissues required for proper body function and homeostasis. Similarly, the fat macromolecules gives energy and numerous additional functional substances like hormones, cholesterol and vitamins (Yusuf and Bello 2024). The plants and herbs are consider is a modest foundation of protein however little while match up to the recommended dietary allowance (RDA) for protein of 46g for adult weighing 50kg and 56g for individual weighing 70kg (Trumbo *et al*., 2002). As a plant, Proteins from plant origins are consider to have minimum quality however when blended with other resources of protein such as protein of animal origin can create sufficient dietary worth (Pamela *et al*., 2005). Additionally, every tree and herbs foods which gives more than twelve percent protein is measured a good protein source (Hassan and Umar, 2006).

Carbohydrate is significant macromolecules which gives foundation of energy for metabolism and participate in shape synthesis like as in biosynthesis of RNA and DNA for suitable biological functions of the body (Yusuf and Bello 2024). Carbohydrates produce energy which is necessary to the body because they are vital nutrient needed for sufficient food. They transport energy to much body system like blood, muscle and brain (Ani *et al*., 2020). The study showed a moderate energy calorific value, but generally it has been observed that vegetables have minimum energy value. On the other hand plants have maximum energy value could be regarded as highly quality food and designates that it could be utilized as diet or might be comprised as ingredients of food supplements (Datta *et al*., 2019). The degree of nutritional composition occurred in the plants, tree and herbal samples calculate its roles in the body and its differs from energy provision, making up tissues, cells, blood and fastening up and restore of worn-out tissues. Consequently, as foundation of energy the plants might be utilized as sources of energy. Though, amino acids are related with crude protein. It is predictable to be up to least amount of twelve percent of energy value in the different plant's types (Olanipekun *et al*., 2021). The biological assessment of medicine, drugs and compounds is significant parameters to check improper handlings or adulteration in drugs. The water content in any drugs should be keep at minimum degree to stop microorganism's growth in at some stage in storage. The quantity of ash is applied to estimate the purity and quality of raw drugs. It designates the occurrence of numerous adulterations such as silicate, oxalate and carbonate (Mukhan and Khabiruddin 2018).

The quantitative proximate (Garba and Mungadi 2019) of the neem leaves extracts calculated that moisture content (2.12%), ash content (10.8%), fibre (16.20%), carbohydrate (50.53%), protein (14.53%), fat (5.82%) and energy value (1,399.39Kj/100g). Proximate analysis of neem seed showed (Okoye *et al*., 2010) that oil yield (18%), moisture (60.00%), ash (10.00%), protein (9.63%), crude fibre (6.00%), carbohydrate (2.37%) and calorific value (210KJ/Kg). The results (Monday and Godwin 2017) showed that the proximate composition of neem leaves ranged from (12.10 to 14.30) %, (3.88 to 4.03) %, (1.22 to 4.04) %, (2.89 to 3.18) % and (9.25 to 10.86) % for moisture, ash, protein, fat and fibre. The study (Okoye *et al*., 2010) revealed that the high moisture content of neem seed implied the seed should be properly dried before storage in order to avoid the invasion of microbes which can lead to spoilage because much moisture content reduces storage value (Okoye *et al*., 2010).The proximate analysis of neem leaves (Oyeyemi *et al*., 2020) measured moisture (11.30-12.31%), crude protein (17.18-20.98%), crude fat (2.15-2.70%), ash content (8.17-9.11%), crude fiber (4.50-4.72%) and carbohydrate (50.38-56.15%). The differences in these values as compared to the current study values are due to the geographical distribution, genetic variability as well as equipments, procedures and even researchers differences.

Minerals Composition

Minerals are mainly vital in the diet, yet although they contain merely 4-6% in our body. Their deficiency and excess in tissues and organs produce illness. It is extremely significant to understand the probable outcome of minerals on biological properties of medicinal plants extracts (Javid *et al*., 2017). Metals act an important and vital job in human body, such as K and Na control acid base balance and body fluid osmotic pressure (Bashir and Ali 2013). Sodium is the main extracellular fluid of the tissues and an ingredient of lymph, plasma and blood fluid. It assists in the preservation of ions balance between the extracellular and intracellular surroundings. The elevated consumption of Na creates hypernatremia (too small H2O in the tissue) or dehydration. This condition is connected with body lethargy, weakness and in serious situation coma or seizures. Deficiency of Na creates the hyponatremia which is prominently originated by cruel vomiting or diarrhea. Hyponatremia symptoms might be comprised muscle spasms, hallucinations, fatigue, confusion and headache (Edori *et al*., 2017). Potassium (K) is an electrolyte or intracellular ions which control muscle and heartbeat functions as well as contribute in neuron communications. It is very vital minerals in electrolyte balance and maintains fluid in animals and human beings. Overdose or excessive of K in the tissue create K poisonous in body called hyperkalemia which may be dangerous if not treated, leading cardiac arrest, paralysis of lungs and unbalanced of heartbeat. While its deficiency called hyporkalemia which is created by fluid loss because of harsh diarrhea or vomiting as well as cause muscle cramping and weakness (Edori *et al*., 2017).

Manganese (Mn) acts a very significant job during physiological reactions for the reason that Mn is an ingredient as well as booster of various enzymes (Naseem *et al*., 2012). Manganese is a vital mineral for animal and plant growth and is a good antioxidant. It shortage create reproductive issues in mammals, and exceeded quantity causes various brain and lung ailments. The allowable standard of Mn is 20mg/Kg for eatable herbs, the allowed nutritional ingestion of Mn is 2-5mg/day and the maximum standard for Mn is 11 mg/day (Gul *et al*., 2022). Zinc is significant in immunity, sex functions, cellular differentiation, protein replication and synthesis (Pathak *et al*., 2004). The current study plants parts powder contains Zn, although in little quantity is some cases, Zn is vital in the tissue because its regulate insulin, cell growth, boost immune system, reinstate dehydration and control diarrhea (Igara et al., 2016). Iron is necessary ingredients of proteins and functions as catalysts for various enzymes like cytochrome oxidase and required hemoglobin synthesis (Ani *et al*., 2020). It contributes in power transportation in plants and as well manages obesity by make easy oxidation of biomolecules (Ani *et al*., 2020). The basic physiological job of Fe is the electron transport in the respiratory chain process that comes to an end in the oxidation of metabolic hydrogen ion (H^+). Iron is an extremely vital ingredient of myoglobin and hemoglobin. Various Fe scarcities lead to a disease condition known as anemia. Signs comprising such as headache, fatigue and parasthesia which could be develop as an outcome of intracellular enzymes malfunction (Igwenyi *et al*., 2017). The Fe content in the current study plants shows that neem (leaves 09 mg/Kg, seed 12mg/Kg and bark 15mg/kg), Eucalyptus (leaves 50mg/kg, seed 30mg/kg and bark 25mg/kg) and *Melia azedirach* (leaves 120 mg/kg, seed 60 mg/kg and bark 20mg/kg). These values are higher than recommended dietary allowance (RDA) in females aged 40-50 years old (18 mg/day), RDA in males aged 40-50 years old (08 mg/day and Tolerable upper intake levels (45 mg/day). These plants parts can be utilized in diets and food to reduce the anemia. Copper is as well a vital microelement however it is poisonous if consumed in an elevated quantity. The safe limit quantity to be occurred in eatable herbal plants is three (03) mg/Kg (Mohammad *et al*., 2013). Copper is a vital mineral essential for crop development and growth. It acts a significant job in physiological reactions and balance alkaloid buildup in therapeutic herbs. It is applied as a remedy for arthritis, chest and wound inflammation. Though, high maximum degree exposure is connected renal damage, liver injure, depression, allergies, hair loss and inflammation of brain tissues (Gul *et al*., 2022). Chromium (Cr) has both dangerous and beneficial effects on human being health depend on its oxidation state, exposure period and uptake. The trivalent structure of Cr (III) is a significant nutrient for man and as recognized by World Health Organization (WHO, 2000), Cr daily consumption from 50 to 200 μg/day for the metabolism of fatty acids, protein and carbohydrate. But, Cr elevated amount in the tissue create a dangerous health problems. Furthermore, hexavalent Cr (VI) is 10-100 folds more dangerous as compared with Cr (III), which could create a skin problems and allergies (Sharma *et al*., 2020). Though, Mg is a crucial ingredient of kinases, enzyme cofactor, teeth, bones etc. The Magnesium statuses significantly influence the kidneys and digestive system health status. The Magnesium is soaked up in the intestine and next shifted into the blood to tissues and cells. Symptoms of Mg shortage or toxicity diseases in man comprised depressed profound tendon reflexes and respiration (Murray *et al*., 2000).

Calcium (Ca) plays act a role of ingredients of teeth and bones, control of nerve and muscles functions. Calcium act as blood coagulation, by activation of the translation of prothrombin into thrombin and as well as gets contribution in clotting of milk (Murray *et al*., 2000). Its insufficiency leads rickets because of inadequate calcification due to calcium phosphate of the bones in development children. The bones consequently leftovers deformed and soft by the body weight. In old persons, it creates osteomalacia, a widespread bones demineralization. It can as well cause osteoporosis, metabolism disease due to decalcification of bones with a maximum occurrence of crack, that is a disorder where Ca is leaked from the bones and as a result the bones turn into porous, weak and finally break (Murray *et al*., 2000). The phosphorus substances are the main ingredients in the cell and tissue of the body and are significantly related with various metabolic pathways, such as those connecting in body fluids buffers. It is a vital component of the energy currency of cell (adenosine triphopshate-ATP), nucleic acids and phosphorylated metabolic intermediates (Igwenyi *et al*., 2017).The Ca concentration in Eucalyptus camadulensis and Eucalyptus citriodora leaves (Bello et al., 2013) were found very high (2.72 % = 27200mg/kg and 2.5 % =25000mg/kg) as compared to our findings. The mineral compositions (mg/Kg) of the neem leaf extracts were determined in a study of (Garba and Mungadi 2019) showed that Zn (0.1572), Na (5.7302), Mg (0.5802), K (9.0) and Fe (3.68). The proximate and minerals variation of neem leaves composition of the study (Muyiwa *et al*., 2020); neem leaves minerals (Offer, 2014); proximate and mineral composition of leaves of *Azadirachta indica* (Monday and Godwin 2017); Proximate and minerals composition of seed of *Melia azedarach* (Mukhan and Khabiruddin 2018); Eucalyptus camaldulensis leaves powder proximate composition (Eman, 2017); *Eucalyptus camadulensis* and *Eucalyptus citriodora* leaves powder proximate and minerals composition (Bello et al., 2013) and *Melia azedarach* fruit and leaves (Italo *et al*., 2009). The differences of these findings as compared to our current study are due to the harvesting time of plants parts, digestion methods, procedures, equipments genetic variability, operator's hands, geographical distribution, climate conditions, plants parts differences, soil fertility and climate differences. In the current study plants leaves, seed and bark would be a better source of nutrition (proximate composition) and minerals content. Therefore, it will be useful if the study plants are added to meal diet, feed and used in food formulation to help in malnutrition and feed. Further it also helped to develop a high nutrition and minerals supplements related food and feed, especially in the poor, third world and under develop countries to substitute a nutrition and minerals food supplements and feed supplements for fish, animal and poultry which are export from high-tech developed countries, saves foreign exchange and create job opportunities.

Conclusion

The present findings indicates that the *Azadirachta indica, Eucalyptus globules* and *Melia azedarach* leaves, seeds and bark possessed an significant nutritive and minerals values which when utilized and explored would be helpful to animals and human lives. These plants might supply useful and healthy feed and food formulation by offering various elements and nutrients, as these plants have high carbohydrate, ash, fiber and minerals composition. These plants have good quality minerals and nutritional values and consequently based on this these plants are utilized in feed industry. The current data is especially helpful for the national and local authorities of quality control, importers and exporters of herbal raw materials and drugs businessman, general public's who utilized herbal drugs and medicine, herbal mother tincture preparation, Homeopathic and Tibs practitioners.

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All authors contributed equally.

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All data generated or analyzed during the study are included in the manuscript.

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