ISSN: 2695-2556 (Online)

ISSN: 2651-5679 (Print)

AKSU Journal of Agriculture and Food Sciences 8(1) 72-84, 2024

The Influence of Organic Manures on Proximate Composition, Minerals, Anti-nutrients and Vitamins of Selected Legume Forage

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Abstract

This study investigated the influence of three organic manure on the nutritional composition of three leguminous forages - Soybeans, Cowpeas, and Groundnuts, cultivated in the coastal Rainforest of Akwa Ibom State, Nigeria. The four different organic manure used were poultry droppings, goat droppings, pig dung and a control (no manure application). Each organic manure represented a treatment group. Each group was replicated three times making a total of 12 experimental units. The data collected were subjected to analysis of variance using the Statistical Package for Social Science (SPSS). Proximate analysis revealed significant ($p<0.05$) differences in moisture, fat, ash, protein, fiber, carbohydrates, and energy content. Manure type significantly ($p<0.05$) affected protein, carbohydrate, and moisture content. Poultry Manure had superior performance in Cowpea Forage, while Control excelled in Soybean Forage. The anti-nutrient analysis revealed significant ($p<0.05$) differences in tannin, oxalate, saponin, and phytate content, impacting nutritional quality. Tannin content varied significantly (Groundnut: 65.78 mg/100g, Soybean: 109.78 mg/100g, Cowpea: 37.62 mg/100g), as did oxalate (Groundnut: 393.18 mg/100g, Soybean: 185.20 mg/100g, Cowpea: 357.13 mg/100g), saponin (Groundnut: 5.71 mg/100g, Soybean: 6.63 mg/100g, Cowpea: 6.63 mg/100g), and phytate (Groundnut: 160.89 mg/100g, Soybean: 30.63 mg/100g, Cowpea: 21.22 mg/100g). Vitamin analysis revealed variations in vitamin C (Groundnut: 57.94 mg/100g, Soybean: 58.31 mg/100g, Cowpea: 63.17 mg/100g) and β-carotene (Groundnut: 9.73 mg/100g, Soybean: 9.46 mg/100g, Cowpea: 7.51 mg/100g), indicating nutritional attributes of the studied leguminous forages. Based on the results, the treatment involving poultry dropping, goat dropping, pig dung and control all demonstrated good performance in terms of contributing to the nutritional composition of cowpea, groundnut and soybean. Thus, the use of poultry dropping and pig dung as organic manure for farmers in the region could be recommended.

Keywords: Organic Manure, Leguminous Forage, Nutritional Composition,

1.0 Introduction

Legumes, which belong to the botanical family Fabaceae (also known as Leguminosae), are easily identifiable by their seed pods that split open when they mature. Common legumes in this family include *Glycine max* (Soybeans), *Vigna unguiculata* (Cowpeas), and *Arachis hypogaea* (Ground nuts). These legumes are known not only for their high protein content but also for the essential minerals, vitamins, and various bioactive compounds they contain (Sońta *et al.,* 2020). Knowing the proximate composition, mineral content, anti-nutritional factors, and vitamin profiles of these legumes are crucial for identifying their nutritional value and their potential as sustainable sources of food and livestock feed worldwide (Kamboj and Nanda, 2017).

These legumes grow in the coastal rainforest of Akwa Ibom State, Nigeria. This region is known for its diverse agro-ecological features that provide an ideal environment for crop cultivation. Among the numerous crops thriving in this region, legumes have gained prominence due to their adaptability to local conditions and their significant contributions to both human and livestock nutrition (Ezekiel *et al.*, 2023).

In recent years, sustainable agricultural practices have taken center stage in this region, with a particular focus on the utilization of organic manure. Organic manures, such as poultry droppings, goat droppings, soybean meal, rabbit urine and pig dung, are increasingly recognized as valuable sources of nutrients and organic matter that can significantly improve soil fertility and crop yields (Efretuei *et al.,* 2023; Ekwere and Efretuei, 2021; Ekwere *et al*., 2019; Ekwere *et al*., 2023; Nkeme *et al*., 2015). Moreover, their adoption can help mitigate the negative environmental impacts associated with conventional chemical fertilizers.

The use of organic manure in agriculture has been extensively studied. Uwah and Eyo (2014) examined the effects of goat droppings on soil fertility and crop yield in a semi-arid region, emphasizing its potential as an effective organic fertilizer. Similarly, Hoover *et al*. (2019) investigated the use of poultry droppings as a nutrient source for crop production, highlighting its positive impact on soil quality and plant growth. Research has also focused on the application of pig dung as an organic fertilizer. Notably, Stevens *et al*. (2019) explored the effects of pig dung compost on soil fertility and crop productivity, underscoring its role in improving soil structure and nutrient content. These studies collectively emphasize the importance of organic manure in enhancing agricultural productivity and maintaining soil health.

Saikanth *et al*. (2023) highlighted the benefits of organic manure in improving the growth and nutrient content of forage crops, indicating its potential to enhance livestock feed quality and quantity. These findings underscore the need to investigate the effects of organic manure application on leguminous crops, particularly in the coastal rainforest region, as emphasized by Subuola *et al*. (2012).

Previous experiments have highlighted the importance of understanding the effects of organic manure on crop growth and soil fertility. Notably, studies by Uwah and Eyo (2014); Hoover *et al*. (2019) and Ekwere *et al.* (2023) demonstrated the positive impact of organic manure, such as rabbit waste, goat droppings and poultry droppings, on enhancing soil quality and promoting crop productivity. Building upon these prior findings, this research seeks to conduct a comprehensive study evaluating the effects of a specific blend of organic manure, consisting of 40% poultry droppings, 30% goat droppings, and 30% pig dung, on the proximate composition, mineral content, anti-nutritional factors, and vitamin profiles of selected legumes cultivated within the coastal rainforest of Akwa Ibom State, Nigeria.

2.0 Material and Methods

2.1 Research Site

The research was conducted at the Pasture and Forage Management Research Farm of Akwa Ibom State University, situated at Obio Akpa, Oruk Anam Local Government Area, Akwa Ibom State. The geographic coordinates of the research site are approximately 5.0180° N latitude and 7.7340° E longitude. The weather conditions in this coastal rainforest region include an average annual temperature of 28°C, with a range of 25 to 32°C. The area experiences a high annual rainfall of approximately 2500 mm, and the relative humidity is consistently high, ranging from 80 to 90%.

2.2 Research Materials

2.2.1 Crops

Three leguminous crop species selected for this study were: *Glycine max* (Soybeans), *Vigna unguiculata* (Cowpeas), *Arachis hypogaea (*Ground nuts). These leguminous crops were chosen due to their significance as sources of protein and essential nutrients and their adaptability to the local conditions of the coastal rainforest region.

2.2.2 Organic Manure

The combination of the three types of animal droppings, namely poultry droppings, goat droppings, and pig dung, was applied as a composite organic manure blend in a controlled environment, following the aerated static pile composting method (Kumari et al., 2016). The specific ratio used for this organic manure blend was 40% poultry droppings, 30% goat droppings, and 30% pig dung. These proportions were determined based on prior research Kumari et al., (2016) indicating the complementary nutrient composition and favorable microbial activity associated with each type of manure.

The quantities of each type of droppings were precisely measured and combined in the specified ratio during the blending process. The application rate for the organic manure blend was 5 kilograms per square meter, applied at three different intervals: at the time of sowing, during the vegetative growth stage, and at the flowering stage of the leguminous crops. The application was carried out using a uniform broadcasting method to ensure even distribution across the experimental plots.

The blending process was closely monitored, with regular checks on temperature, moisture content, and aeration maintained throughout the composting process. The temperature was maintained between 55°C and 65°C to facilitate the breakdown of organic matter, while the moisture content was kept at 50% to 60% to support microbial activity and nutrient release. Aeration was provided through the periodic turning of the compost piles to ensure proper oxygen supply and decomposition efficiency.

This rigorous approach to blending and application of the composite organic manure blend was designed to create an effective and balanced fertilizer tailored to meet the specific nutrient requirements of the leguminous crops cultivated within the coastal rainforest region of Akwa Ibom State, Nigeria.

2.3 Sample Collection and Analysis

2.3.1 Sample Collection

Samples were meticulously collected from leguminous crops, specifically targeting soybeans (*Glycine max*), cowpeas (*Vigna unguiculata*), and groundnuts (Arachis *hypogaea).* The collection process was organized into multiple stages to ensure thoroughness and accuracy. These various growth stages were deliberately selected due to their significance in representing different phases of crop development. They collectively serve as crucial times for assessing the nutritional composition of the crops and evaluating the impact of organic manure application.

The forage components, specifically the leaves, were harvested. The harvests were conducted three times during the crop's growth cycle, specifically at the second months, fourth months and sixth months respectively, to capture the changes in nutritional content over time. During each harvest, an average quantity of 500 grams of fresh plant material per plot was collected. The selected plant parts were carefully separated from other plant components to ensure the accuracy of the samples and to focus solely on the nutritional assessment of the leaf components.

2.3.2 Proximate Composition Analysis

All analyses, including proximate composition, mineral content, anti-nutritional factors, and vitamin profiles, were conducted following standardized laboratory protocols. The laboratory facilities adhered to the necessary standards to ensure precise and reliable data collection.

Following the collection of the forage samples, they were transported to the Food Science Laboratory, University of Uyo, Akwa Ibom State, for analysis. In the laboratory, the samples were first prepared for analysis by drying them in an oven at 105°C for 24 hours to determine the moisture content. The dried samples were then ground into a fine powder using a laboratory mill. Proximate composition analysis, which assesses the levels of moisture, protein, fat, fiber, ash, and carbohydrates, was carried out. The protein content was determined using the Kjeldahl method, the fat content was analyzed using the Soxhlet extraction method, the fiber content was assessed through acid and alkaline hydrolysis, the ash content was measured by incineration in a muffle furnace, and the carbohydrate content was estimated by the difference method. Each step of the analysis was meticulously executed, adhering to the established protocols and guidelines provided by the Association of Official Analytical Chemists (AOAC, 2016) to ensure the precision and validity of the results.

2.3.3 Mineral Analysis

For the mineral analysis, the concentration of essential minerals, including calcium, magnesium, sodium, potassium, and iron, was determined using established analytical methods.

The analytical methods used for the mineral analysis included atomic absorption spectroscopy (AAS) for calcium, magnesium, sodium, and potassium, and the colorimetric method was employed for the determination of iron content (Association of Official Analytical Chemists, (2016). These analytical techniques were selected for their precision and sensitivity in measuring the mineral concentrations in the forage samples, ensuring accurate and reliable results for assessing the nutritional quality and potential benefits of the leguminous crops for human and livestock consumption.

2.3.4 Anti-nutrient Analysis

The presence of anti-nutritional factors in the forage samples, including phytates, tannins, oxalates, and saponins, was investigated to assess their potential effect on nutrient absorption and utilization. For the analysis of phytates, a colorimetric method based on the formation of phosphomolybdenum complexes was employed. The quantification of tannins was performed using the Folin-Denis reagent and spectrophotometric measurements. Oxalate content was determined by titration with standardized potassium permanganate solution. Saponin content was assessed using foam index measurements based on the ability of saponins to produce stable foam (Association of Official Analytical Chemists, 2016).

2.3.5 Vitamin Analysis

The analysis of vitamin C was performed through the 2,6-dichlorophenolindophenol titration method, while the quantification of β-carotene was conducted using spectrophotometric measurements. For the analysis of vitamin C, the samples were first treated with a solution of metaphosphoric acid to preserve the ascorbic acid content. The titration was then carried out with 2,6-dichlorophenolindophenol reagent to determine the concentration of vitamin C in the samples.

The determination of β-carotene content involved the extraction of the pigment from the samples using a suitable solvent, followed by spectrophotometric measurements at the appropriate wavelengths to calculate the concentration of β-carotene present (Association of Official Analytical Chemists, 2016).

3.0 Results

3.1 Proximate Composition of Cowpea, Soybeans, and Groundnut Leaves

In the case of the moisture content in the cowpea forage, there were significant differences between manure treatments. The cowpea treated with poultry manure and the control produced the lowest moisture content (9.73% ± 0.14; 10.60 % ± 0.17) compared with the sample treated with goat droppings (13.53 % ± 0.11) (Table 3.1).

Also, significant differences at ($p<0.05$) were noted in the fat content, with the cowpea forage treated with poultry manure (4.51% ± 0.02) and pig dung (3.73 ±0.02) displaying the highest fat content among the treatments. In terms of the ash content, the sample treated with pig dung exhibited a high ash content (11.16% ± 0.02) compared with the poultry manure (6.76 ± 0.02).

Notably, the protein content was significantly higher in the cowpea forage treated with poultry manure (20.89% ± 0.28) and pig dung (20.52 % ± 0.48) than in the other treatments.

Similarly, the fiber content was observed to be significantly different ($p<0.05$) among the treatments, with the highest value recorded in the cowpea forage treated with pig dung (7.65 ± 0.05%). The carbohydrate content also exhibited significant variations, with the sample treated with pig dung showing the lowest value (44.21% ± 0.68). Additionally, the energy content was notably higher in the cowpea forage treated with poultry manure (324.74 kcal ± 0.96) compared to the other treatments.

In the soybean forage analysis, statistically significant differences ($p<0.05$) were observed in the protein content, with the sample treated with control (21.45 ± 0.22%) showing a significantly higher protein content compared to the sample treated with Goat Droppings (19.05 ± 0.23).

Notable differences at ($p<0.05$) were observed in the moisture content, with the soybean forage treated with poultry manure (6.38% ± 0.07) displaying the lowest numerical moisture content among the treatments. In terms of the fat content, the sample treated with poultry manure exhibited the highest fat content (3.73% ± 0.10) compared to the other treatments.

Significant variations at ($p<0.05$) were also noted in the ash content, with the sample treated with Poultry manure and control showing the highest ash content (10.45% ± 0.05) compared with the other treatments. The fiber content was also significantly different among the treatments, with the highest value recorded in the soybean forage treated with Pig Dung (5.11% ± 0.03). Moreover, there was no significant difference among treatments with carbohydrate content, but the highest numerical value was observed in the plants treated with goat droppings (56.70% ± 0.33). For the energy content, the sample treated with goat droppings (331.39 kcal ± 0.77) showed the highest numerical energy content compared to the pig dung and poultry manure, treatments. The control was the lowest (314.83 kcal ± 0.79).

The groundnut forage analysis indicated statistically significant differences ($p<0.05$) in the ash content, with the sample treated with pig dung (9.40 ± 0.05%) and poultry manure (8.55 ± 0.08%) displaying a significantly higher ash content compared with the other samples.

Furthermore, notable differences were observed in the moisture content, with the Groundnut Forage treated with Goat Droppings (7.21 ± 0.07%) displaying relatively lower moisture content compared to the other treatments. In terms of the fat content, the sample treated with Poultry manure exhibited the highest fat content (3.18 ± 0.02%) among the treatments.

Moreover, significant variations were noted in the protein content, with the sample treated with control (14.26 ± 0.17%) showing a significantly lower protein content compared to the sample treated with Goat Droppings (15.39 ± 0.70 %). There was no significant difference between treatments for the fiber content although the highest numerical value was recorded with the groundnut forage treated with poultry manure (6.85 ± 0.05%). Additionally, the carbohydrates content there was no significant difference between treatments, the highest numerical value was observed in the sample treated with control (61.09 ± 0.25[a]%). The energy content displayed notable variations, with the sample treated with Poultry Manure (330.05 kcal ± 0.08) showing the highest energy content compared to the other treatments.

3.2 Mineral Constituent of Groundnut, Soybean and Cowpea Leaves

Groundnut leaf exhibited a high calcium content at 60.00 mg/100g ± 0.02 at significant level of ($p<0.05$) with Soybean leaf possessing the lowest calcium content of 56.00 mg/100g ± 0.02, at a statistically significant level of ($p<0.05$) while cowpea leaf demonstrated the highest calcium content at 172.00 mg/100g ± 0.04 (Table 3.2).

In terms of magnesium content, groundnut forage contained 159.66 mg/100g ± 0.61 of magnesium, soybean forage had 172.00 mg/100g ± 0.06, and cowpea forage exhibited the highest magnesium content at 336.00 mg/100g ± 0.02. These differences in magnesium content were statistically significant ($p<0.05$) and may be of interest for dietary planning.

Sodium content in groundnut forage was 11.39 mg/100g ± 0.02, and this was higher than soybean forage which had 8.43 mg/100g ± 0.02 and cowpea forage which had 9.78 mg/100g ± 0.02.

Potassium, an essential mineral for maintaining various bodily functions, also demonstrated significant variations ($p<0.05$) groundnut forage had 35.64 mg/100g ± 0.02 of potassium, soybean forage contained 29.94 mg/100g ± 0.01 and cowpea forage contained the highest potassium level 37.42 mg/100g ± 0.01. These differences in potassium content were statistically significant ($p<0.05$)

Iron, an important mineral for the prevention of anemia and overall health, varied significantly at ($p<0.05$) among the forage samples. Groundnut leaf contained 4.98 mg/100g ± 0.01 of iron, soybean leaf exhibited the highest iron content at 5.66 mg/100g ± 0.02 and cowpea forage contained 5.31 mg/100g ± 0.01of iron. These differences in iron content were statistically significant ($p<0.05$)

3.3 Anti-nutrient content of Groundnut, Soybean and Cowpea Leaves

Tannin content varied significantly ($p<0.05$) among the three leguminous crops (Table 3.3). Soybean forage exhibited the highest tannin content at 109.78 mg/100g ± 2.06 while cowpea forage had the lowest tannin content at 37.62 mg/100g ± 0.26. These differences in tannin content were statistically significant ($p<0.05$).

Oxalate content also varied significantly ($p<0.05$) among the forage. Groundnut forage contained 393.18 mg/100g ± 6.65 of oxalate, making it the highest among the three crops followed closely by cowpea forage 357.13 mg/100g ± 0.69.

Table 3.1 Proximate Composition of Cowpea, Soybeans, and Groundnut Leaves when Treated with Organic Manure

	Moisture (%)	Fat (%)	Ash (%)	Protein (%)	Fiber (%)	Carbohydrates (%)	Energy (kcal)
Cowpea							
P M	10.60 ± 0.17^{c}	4.51 ± 0.02^{a}	6.76 ± 0.02^{c}	20.89 ± 0.28^{a}	7.06 ± 0.02^{c}	50.15 ± 0.47^{a}	324.74 ± 0.96^{a}
G D	13.53 ± 0.11^{a}	2.66 ± 0.14^{b}	8.86 ± 0.02^{b}	17.80 ± 0.25^{c}	7.46 ± 0.05^{b}	49.66 ± 0.34^{b}	293.86 ± 1.12^{c}
C	9.73 ± 0.14^{c}	2.66 ± 0.02^{b}	10.91 ± 0.05^{a}	19.11 ± 0.35^{b}	7.53 ± 0.02^{a}	50.03 ± 0.48^{a}	297.43 ± 5.31^{b}
P D	12.71 ± 0.20^{b}	3.73 ± 0.02^{a}	11.16 ± 0.02^{a}	20.52 ± 0.48^{a}	7.65 ± 0.05^{a}	44.21 ± 0.68^{c}	292.53 ± 1.08^{d}
Soybean							
P M	6.38 ± 0.07^{d}	3.73 ± 0.10^{a}	10.45 ± 0.05^{a}	20.35 ± 0.57^{c}	5.11 ± 0.03^{b}	53.97 ± 0.52	330.89 ± 0.82^{b}
G D	7.40 ± 0.10^{b}	3.15 ± 0.05^{b}	8.65 ± 0.05^{c}	19.05 ± 0.23^{d}	5.04 ± 0.03^{c}	56.70 ± 0.33	331.39 ± 0.77^{a}
C	9.50 ± 0.05^{a}	2.83 ± 0.07^{c}	10.45 ± 0.05^{a}	21.45 ± 0.22^{a}	4.88 ± 0.07^{d}	50.88 ± 0.22	314.83 ± 0.79^{d}
P D	7.18 ± 0.07^{c}	2.63 ± 0.15^{d}	10.03 ± 0.18^{b}	20.87 ± 0.09^{b}	5.32 ± 0.02^{a}	53.95 ± 0.24	322.95 ± 1.83^{c}
Groundnut							
P M	8.01 ± 0.07^{c}	2.68 ± 0.07^{c}	9.40 ± 0.05^{a}	15.39 ± 0.70^{a}	6.85 ± 0.05	57.65 ± 0.66	316.35 ± 0.37^{c}
G D	7.21 ± 0.07^{d}	2.25 ± 0.05^{d}	7.68 ± 0.07^{c}	15.39 ± 0.33^{a}	6.75 ± 0.05	60.70 ± 0.33	324.65 ± 0.22^{b}
C	8.05 ± 0.08^{b}	3.18 ± 0.02^{a}	6.85 ± 0.08^{d}	14.26 ± 0.17^{c}	6.56 ± 0.05	61.09 ± 0.25	330.05 ± 0.08^{a}
P D	10.78 ± 0.14^{a}	3.08 ± 0.02^{b}	8.55 ± 0.08^{b}	15.32 ± 0.22^{b}	6.33 ± 0.02	55.93 ± 0.38	312.75 ± 0.95^{d}

Values are means ± standard deviation. C = Control, GD = Goat dung, PM = Poultry manure, PD = Pig dung

Table 3.2 Mineral Constituent of Groundnut, Soybean and Cowpea Leaves After Harvest

Samples	Calcium (mg/100g)	Magnesium (mg/100g)	Sodium (mg/100g)	Potassium (mg/100g)	Iron (mg/100g)
Groundnut leaf	60.00 ± 0.02^{b}	159.66 ± 0.61^{c}	11.39 ± 0.02^{a}	35.64 ± 0.02^{b}	4.98 ± 0.01^{c}
Soybean leaf	56.00 ± 0.02^{c}	172.00 ± 0.06^{b}	8.43 ± 0.02^{c}	29.94 ± 0.01^{c}	5.66 ± 0.02^{a}
Cowpea leaf	172.00 ± 0.04^{a}	336.00 ± 0.02^{a}	9.78 ± 0.02^{b}	37.42 ± 0.01^{a}	5.31 ± 0.01^{b}

± values are standard deviation. Values with different superscript on the same column are significantly different ($p<0.05$).

Table 3.3. Anti-nutrient Content of Groundnut, Soybean and Cowpea Leaves after harvest

Samples	Tannin (mg/100g)	Oxalate (mg/100g)	Saponin (mg/100g)	Phytate (mg/100g)
Groundnut leaf	65.78 ± 0.22^{b}	393.18 ± 6.65^{a}	5.71 ± 0.09^{b}	160.89 ± 1.09^{a}
Soybeans leaf	109.78 ± 2.06^{a}	185.20 ± 0.51^{c}	6.63 ± 0.12^{a}	30.63 ± 0.44^{b}
Cowpea leaf	37.62 ± 0.26^{c}	357.13 ± 0.69^{b}	6.74 ± 0.14^{a}	21.22 ± 0.76^{c}

Values are means ± standard deviation. Values with different superscript on the same column differ significantly ($p<0.05$).

Table 3.4 Vitamin Composition of Groundnut, Soybean and Cowpea leaves after harvest

Sample	Vitamin C (mg/100g)	β-carotene(mg/100g)
Groundnut leaf	57.94 ± 0.02^{b}	9.73 ± 0.01^{a}
Soybeans leaf	58.31 ± 0.04c	9.46 ± 0.03^{b}
Cowpea leaf	63.17 ± 0.001^{a}	7.51 ± 0.04^{c}

Values are means ± standard deviation. Values with different superscript on the same column differ significantly ($p<0.05$).

Saponin content also varied significantly among the forage crops. Groundnut forage had the lowest saponin content of 5.71 mg/100g ± 0.09. Soybean leaf had the highest saponin content of 6.63 mg/100g ± 0.12.

Phytate content also differed significantly ($p<0.05$) among the forage samples. Groundnut forage contained four times more phytate 160.89 mg/100g ± 1.09 than soybean and cowpea (Table 3.3).

3.4 Vitamin Composition of Groundnut, Soybean and Cowpea leaves

The vitamins assessed in Table 3.4 include vitamin C and β-carotene. The vitamin C content in the forage samples showed variations among the three leguminous crops. Groundnut forage contained 57.94 mg/100g ± 0.01 which was lower than all 3 forages. Soybean forage had slightly higher vitamin C content at 58.31 mg/100g ± 0.01, while cowpea forage recorded the highest content of 63.17 mg/100g ± 0.001.

β-carotene content also differs significantly among the leaf samples. Groundnut leaf contained 9.73 ± 0.00mg/100g of β-carotene, making it the highest among the three crops. Soybean leaf had 9.46 ± 0.00 mg/100g of β-carotene, and cowpea had the lowest β-carotene (Table 3.4).

4.0 Discussion

4.1 Proximate Composition of the Forages

The proximate composition analysis, detailed in Table 3.1, revealed the nutritional profiles of cowpea, soybeans, and groundnut leaves under various organic manure treatments. In this study the use of poultry manure significantly enhanced cowpea forage protein content, emphasizing the role of specific organic manures in augmenting forage nutritional quality (Sońta *et al*., 2020; Kamboj and Nanda, 2017). Similarly, groundnut forage enriched with goat droppings demonstrated notably high carbohydrate content highlighting the influence of organic manure selection on the nutritional composition of these plant leaves (Edet and Gboshe, 2023). These findings underscore the intricate relationship between organic manure types and forage nutritional profiles, emphasizing the significance of informed agricultural practices for enhancing crop quality and yield.

4.2 Mineral Constituents

Table 3.2 provided crucial insights into the mineral constituents of groundnut, soybean, and cowpea leaves. The diverse mineral profiles, including calcium, magnesium, sodium, potassium, and iron, underscore the potential of these plant leaves as valuable sources of essential minerals (Enyiukwu *et al*., 2018). High levels of calcium and magnesium in cowpea leaves highlight their significance, while elevated potassium content in groundnut leaves emphasizes their potential role as a reservoir of this crucial mineral. These observations point to the diverse contributions of these plant leaves to fulfilling dietary mineral requirements.

4.3 Anti-nutritional Content

The analysis of anti-nutrient components in Table 3.3, including tannin, oxalate, saponin, and phytate, revealed varying levels in groundnut, soybean, and cowpea leaves in consonance with previous research by (Anaemene and Fadupin, 2022) The higher levels of tannin and oxalate in soybean leaves in this work raise considerations about their potential impact on the overall nutritional value. Elevated phytate levels in groundnut leaves underscore the importance of considering anti-nutrient composition when evaluating the suitability of these plant leaves for consumption. These findings highlight the need for informed dietary choices and processing techniques to mitigate potential negative effects.

4.4 Vitamin Composition

Table 3.4 presented the vitamin composition, emphasizing vitamin C and β-carotene levels in groundnut, soybean, and cowpea leaves. Significantly high vitamin C content in cowpea leaves (63.17 mg/100g) positions them as a rich source of this essential vitamin (Odit *et al*., 2022). Conversely, the elevated β-carotene content in groundnut leaves (9.73 mg/100g) underscores their potential significance as a source of this crucial precursor to vitamin A. These findings highlight the diverse nutritional profiles of these plant leaves and their potential contributions to meeting essential dietary requirements, emphasizing the importance of incorporating such nutrient-rich leaves into diets to support overall health and well-being

5.0 Conclusion and Recommendations

In conclusion, the findings of this study provide valuable insights into optimizing crop cultivation practices in the coastal rainforest region of Akwa Ibom State, Nigeria. The use of poultry manure is recommended for cowpea cultivation to enhance protein content and energy yield, while soybean cultivation is best supported by the application of poultry manure as well to promote higher protein and energy content.

These recommendations are not only based on the observed performance of the crops but also underscore the importance of tailored organic manure application for specific crops to meet the nutritional needs of both crops and the livestock in the region. This approach aligns with the principles of sustainable agriculture and contributes to improved food security. The promotion of such targeted organic farming practices can have positive implications on the environment, local economies, and the overall well-being of the population. It is essential for farmers in the region to consider these findings and implement these recommendations to enhance agricultural productivity, address nutritional needs, and contribute to the sustainability of farming practices in the coastal rainforest region.

Acknowledgement

The authors thank the Almighty God, the giver of wisdom and understanding for his help throughout this research, as well as the Akwa Ibom State University, for providing the necessary facilities for this research.

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