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Proximate composition and phytoconstituents of *Justicia carnea* leaf meal as a potential livestock feed resource

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ABSTRACT: With growing interest in natural and sustainable livestock feed supplements and health solutions, this study evaluated the proximate composition and phytochemical constituents of *Justicia carnea* leaf meal to assess its potential for animal use. Fresh leaves of *Justicia carnea* were collected from Akwa Ibom State University, Obio Akpa campus, shade-dried at 23°C for 14 days, ground into leaf meal, and stored in dry, covered plastic containers prior to analysis. Proximate analysis and phytochemical screening were performed using ethanol and aqueous extracts after a 24-hour soak to determine the presence and concentration of various bioactive compounds. Quantitative analysis of phytoconstituents was carried out using standard laboratory methods. Proximate analysis showed a high crude protein content (27.00%), nitrogen-free extract (53.50%), and moderate levels of crude fibre (10.00%), ash (6.00%), and ether extract (3.50%). Phytochemical screening revealed the presence of alkaloids, polyphenols, flavonoids, tannins, glycosides, and saponins, with varying concentrations between ethanol and aqueous extracts. Alkaloids were the most abundant (44.00 mg), followed by polyphenols (3.00 mg) and glycosides (2.60 mg). Additionally, rabbits fed 200 g (T3) of *Justicia carnea* leaf meal showed significantly higher weight gain and better feed conversion ratios compared to those fed 0 g or 100 g, despite lower feed intake. The calculated energy value on a dry matter basis was 3535 kcal/kg. The results demonstrate that *Justicia carnea* leaf meal possesses significant nutritional properties, supporting its traditional use and highlighting its potential as a functional livestock feed ingredient. This study concludes that including 200 g of *Justicia carnea* leaf meal in rabbit diets is optimal for growth and recommends its use in rabbit and potentially other livestock production. Its high protein and energy content make it particularly suitable for livestock feed, while its phytochemical profile suggests broader pharmaceutical and nutraceutical applications.

Keyword: Proximate composition, phytoconstituents, *Justicia carnea*, leaf meal, feed resource.

INTRODUCTION

Plant parts (leaves, stems, seeds, roots, tubers, fruits) are consumed either cooked or raw, directly as vegetables or aqueous extracts as tonics for the treatment of various illnesses in humans. Animals consumed these plant parts by chewing, grinding, nibbling or selective feeding to obtain nutrients from them. Animal Nutritionists feed plants as fresh, dried, leafy green mix, hay or silage and supplements to provide specific nutrients to the animals (Christopher *et al*., 2024; Ekpo *et al.*, 2022; Christopher *et al*., 2019). One of such plant parts is *Justicia carnea* leaf, commonly called the gracious tonic plant in Akwa Ibom State. It belongs to the Acanthaceae family, and it is widely used in traditional medicine because of its medicinal properties. In Nigeria and other parts of West Africa, the leaves of *Justicia carnea* are commonly used for their known blood boosting effect (Oloruntola *et al*., 2022), which makes it well-known in the treatment of anaemia and related conditions.

Analysis of the proximate and phytochemical constituents of leaf meals, including that of *Justicia carnea,* is needed for validating their traditional uses and creating awareness of their potential nutritional uses in both human health and animal nutrition. According to Ukom (2018), proximate analysis of any feed resource offers information about its nutritional content, including moisture, ash, crude protein, crude fibre, crude fat, and nitrogen-free extract,

which are needed in assessing its dietary value. Meanwhile, phytochemical analysis, on the other hand, detects bioactive compounds such as alkaloids, flavonoids, tannins, saponins, and glycosides, which enhance the plant's medicinal properties (Ijoma *et al*., 2025; Ebana *et al*., 1995).

Recent studies have evaluated the nutrient profile of several tropical leaf meals. Oloruntola *et al*. (2022), N'guessan *et al*. (2010) reported that the *Justicia carnea* leaf meal contains significant levels of crude protein, crude fibre, and ash, indicating their potential as nutritious feed ingredients

According to Oloruntola *et al*. (2022), phytochemical analyses of some plants, such as *Justicia carnea* have revealed the presence of compounds such as alkaloids, saponins, tannins, flavonoids, cyanogenic glycosides, and phytates in their leaf meals, which are known to exhibit various pharmacological activities. Also, Onoja *et al*. (2017) reported the phytochemical analysis of *Justicia secunda* leaves and its effect on some biochemical parameters in Wistar albino rats.

There is an increasing interest in natural and sustainable health solutions of leaf meals, both for humans and livestock. A comprehensive evaluation of the proximate composition and phytoconstituents of *Justicia carnea* leaf meal is needed. Such an assessment will not only substantiate its ethno-medicinal applications but also explore its potential as a functional food ingredient or dietary supplement for livestock, thereby contributing to the diversification of nutritional resources and the promotion of health and well-being.

MATERIALS AND METHODS

Location of the experimental site

This study was conducted at Akwa Ibom State University (AKSU), Obio Akpa campus. This university campus is located between latitudes 4°30'N and 5°00'N and between longitudes 7°30'E and 8°50'E with an annual rainfall ranging from 3500 to 5000mm, an average monthly temperature of 25°C and relative humidity between 60 to 90% (AKSG, 2024).

Collection and processing of plant materials

Fresh leaves of *Justicia carnea* (Gracious Tonic) plants were harvested from the environment of Akwa Ibom State University, Obio Akpa Campus, Akwa Ibom State, Nigeria. The fresh leaves were shade-dried at 23°C for 14 days on slabs within the laboratory to reduce moisture content while maintaining their phytochemical constituents. The dried leaves were then ground into leaf meal using an electric blender (Kenwood brand). The *Justicia carnea* leaf meal was stored in a cool, dry plastic container until required for analysis and feed formulation.

Proximate composition analysis of *Justicia carnea* leaf meal

Proximate composition (crude protein, ether extract, crude fibre, ash, nitrogen-free extract (NFE), and moisture) was determined using established standard methods (AOAC, 2019). Crude protein, ether extract, ash and moisture contents were determined using the procedure outlined by (AOAC, 2019). Crude fibre analysis was done following the steps described by Van Soest (1994), while nitrogen-free extract was computed by subtracting the sum of crude protein, ether extract, crude fibre, and ash from 100% (Pearson, 1976).

Screening methods for phytochemical compounds in ethanol and aqueous extracts

Phytochemical screening was conducted using ethanol and aqueous extracts to detect the presence of bioactive compounds in *Justicia carnea* leaf extracts. The choice of solvent (ethanol and water) influences the solubility of different phytochemicals, which is reflected in the varying concentrations of the compounds detected in each extract after soaking for 24hours at room temperature. According to Harborne (1998) procedure the presence of alkaloids, tannins, and polyphenols was screened. The method of Trease and Evans (2002) was employed to screen glycosides, flavonoids, and phlobatannins. Saponins and reducing compounds such as flavonoids and phenolic acids were screened using the method of Sofowora (2008).

Quantitative analysis of phytochemical constituents of *Justicia carnea* leaf meal

Quantitative phytochemical analysis was carried out on *Justicia carnea* leaf meal to determine the concentration of various bioactive compounds. Alkaloid and tannin contents were determined following the method of Harborne (1998). Also, Polyphenols were extracted with 80% methanol and measured spectrophotometrically using the Folin-Ciocalteu method (Harborne, 1998). Glycosides, flavonoids, and phlobatannins were quantified using the procedure of Trease and Evans (2002), while saponins and reducing compounds, including flavonoids and phenolic acids, were analysed as described by Sofowora (2008). All concentrations were expressed as mg/100g of dry weight.

Feeding trial with weaner rabbits

Experimental diets

Three experimental diets were formulated using a concentrate mixture of common feed ingredients including

Table 1. Composition of concentrate diets fed to the weaner rabbits.

Ingredients	T_1 (0g) kg (%)	T_2 (100g)/kg (%)	T_3 (200g)/kg (%)
Maize	51.13	51.13	51.13
Soyabean	24.32	24.32	24.32
Wheat offal	15.00	15.00	15.00
Oyster shell	4.00	4.00	4.00
Bone meal	3.00	3.00	3.00
Plam oil	2.00	2.00	2.00
Salt	0.30	0.30	0.30
Premix	0.25	0.25	0.25
Total	100.00	100.00	100.00
Crude protein	18	18	18

maize, soyabean, wheat offal, etc (see Table 1) and varying levels of *Justicia carnea* leaf meal, fed alongside selected forages (*Calopogoinum mucunoides, Centrosema pubescens Luffa cylindrinca, Pennisetum purpurea and Panicum maximum*). Diet 1 served as the control (0% inclusion), while Diets 2 and 3 contained 100 g and 200 g of *Justicia carnea* leaf meal per kg of feed, respectively (Table 1).

Experimental animal, management and data collection

Twenty-seven weaner rabbits (Chinchilla × New Zealand White), aged 6–7 weeks, were acclimatised for one week, then randomly assigned into three treatment groups with three replicates each and managed under a completely randomised design. Data collected includes initial and weekly body weights, feed intake, body weight gain, and feed conversion ratio.

RESULTS AND DISCUSSIONS

Proximate analysis of *Justicia carnea* leaf meal

The proximate composition of *Justicia cornea* leaf meal, as shown in Table 2, provides insight into its nutritional significance and potential applications in food and pharmaceutical industries. The major proximate components analysed include crude protein, ether extract (fat), crude fibre, ash, nitrogen-free extract (NFE), and moisture content.

Crude protein

The crude protein content of *Justicia carnea* (27.00%) leaf meal was relatively high, indicating its potential as a protein-rich food source. (Younis *et al.,* 2016). The high protein content suggested that *Justicia carnea* leaf meal can be beneficial for dietary protein intake for humans and livestock, particularly in protein-deficient regions. Protein is essential for growth, enzymatic functions, and tissue repair.

Ether extract

The ether extract value of *Justicia carnea* leaf meal was 3.50%. Dietary fats enhance food palatability and the absorption of fat-soluble vitamins. However, excess fat consumption is associated with cardiovascular diseases (Agu *et al.*, 2023). The relatively low-fat content of *Justicia carnea* leaf meal makes it a suitable food ingredient for low-fat diets.

Crude fiber

The fibre content of *Justicia carnea* leaf meal was 10.00%, which is moderate and can be tolerated by young animals, especially ruminants and pseudo-ruminant animals. According to Fu *et al.* (2022), dietary fibre is known for its health benefits, including the reduction of cholesterol levels, improved digestion and decreased risk of diseases such as diabetes and hypertension.

Ash content

Ash content represents the total mineral composition in plant materials (Asaolu *et al*., 2012). In the present study, the ash content of *Justicia carnea* leaf meal was 6.00%. This indicates that *Justicia carnea* leaf meal contains a significant amount of essential minerals, which are vital for various metabolic functions.

Nitrogen-free extract (NFE)

The nitrogen-free extract of *Justicia cornea* (53.50%) represents the carbohydrate content, which is the largest proportion of the leaf meal. This value is comparable to *A sativum* (57.28%) (Ajayi et al., 2018). Carbohydrates are the primary energy source for most organisms, and *Justicia carnea* leaf meal can serve as an energy-rich food ingredient based on the high NFE content observed in the present study

Residual moisture content

The moisture content of *Justicia carnea* leaf meal (10.93%)

Table 2. Proximate analysis of J*usticia carnea* leaf meal (percentage of dry samples).

Proximate composition	Percentage composition (%)
Crude protein	27.00
Exther extract	3.50
Crude fibre	10.00
Ash	6.00
Nitrogen free extract	53.50
Residual moisture	10.93
Energy Kcal/Kg	3535

Table 3. Phytochemical composition of ethanol extract and aqueous extract.

Chemical constituents	Ethanol extract	Aqueous extract
Alkaloids	+++	++
Glycosides	+	++
Saponnin	-	++
Tannins	+	++
Flavonoids	++	-
Reducing compound	++	=
Polyphenol	++	+++
Phlobatanins	+	++

is relatively low. Lower moisture content is advantageous as it extends the shelf life of plant materials and reduces microbial spoilage (Aletor and Adeogun, 1995).

Phytochemical screening of *Justicia carnea* leaf extracts

Phytochemicals are bioactive compounds in plants that contribute to their medicinal and nutritional properties. The phytochemical screening of *Justicia carnea* leaf extracts (ethanol and aqueous) revealed the presence of several secondary metabolites with potential health benefits (Table 3).

Alkaloids

Alkaloids were strongly present (+++) in the ethanol extract but moderately present (++) in the aqueous extract. Alkaloids are known for their pharmacological properties, including antimicrobial, analgesic, and anti-inflammatory effects. These compounds are also reported to have a significant role in the treatment of chronic diseases such as hypertension and diabetes (Carneiro *et al.,* 2023).

Glycosides

Glycosides were detected in both extracts, but the aqueous extract showed a higher concentration (++). These bioactive compounds are affirmed to have cardio-protective and antioxidant properties, making them beneficial in managing heart-related ailments. Glycosides are also associated with anti-inflammatory and anticancer activities, further promoting their medicinal importance (Prasathkumar *et al*., 2021).

Saponins

Saponins were absent (-) in the ethanol extract but moderately present (++) in the aqueous extract. Saponins are known for their ability to reduce cholesterol levels and boost Immune responses. It also exhibits antimicrobial properties, making it useful in the pharmaceutical industry (Francis *et al*., 2002).

Tannins

Tannins were detected in both extracts, though at a lower concentration (+) in the ethanol extract and moderately present (++) in the aqueous extract. These polyphenolic compounds have strong antioxidant, antimicrobial, and astringent properties, making them beneficial in wound healing and gastrointestinal disorders. Their function in cancer curbing has also been highlighted in various studies (Kumari and Jain, 2012).

Flavonoids

Flavonoids were moderately present (++) in the ethanol extract but absent (-) in the aqueous extract. These compounds are known for their antioxidant properties, which help in abating oxidative stress and inflammation. Flavonoids have also been reported to contribute to cardiovascular preservation and improve cognitive function (Middleton *et al*., 2000).

Reducing compounds

Reducing compounds were moderately present (++) in the ethanol extract but absent (-) in the aqueous extract. As recorded in studies, these compounds help prevent oxidative damage by neutralising free radicals (Halliwell, 2012). Their presence in the ethanol extract suggests a potential antioxidant capacity, which is beneficial in reducing oxidative stress-related disorders.

Polyphenols

Polyphenols were present in both extracts, with a higher concentration (+++) in the aqueous extract compared to the ethanol extract (++). Polyphenols have been extensively reported to have antioxidant, anti-inflammatory, and anticancer activities. Their function in reducing the risk of chronic diseases such as cardiovascular ailments and diabetes has also been extensively studied (Manach *et al*., 2004; Scalbert *et al.,* 2005).

Phlobatannins

Phlobatannins were detected in both extracts, with a lower concentration (+) in the ethanol extract and a moderate concentration (++) in the aqueous extract. These compounds contribute to antimicrobial and antifungal activities, making them useful for treating infections. Their potential role in improving gut health by inhibiting harmful microbial growth has also been reported (Ijoma *et al.,* 2025).

Quantitative determination of phytochemical analysis

The quantitative phytochemical analysis of *Justicia carnea* leaf extract reveals a significant presence of various bioactive compounds. Among these, alkaloids have the highest concentration (44.00 mg), followed by polyphenols (3.00 mg), glycosides (2.60 mg), flavonoids (2.20 mg), tannins (2.00 mg), phlobatannins (1.80 mg), saponins (1.50 mg), and reducing compounds (1.40 mg) (Table 4). These phytochemicals contribute to the medicinal and therapeutic properties of *Justicia carnea* leaf extract. In the present study, their concentrations were all within the tolerated level of 50 mg/100 g, as reported by (Hossain *et al.,* 2025).

Table 4. Quantitative determination of phytochemical constituents of *Justicia carnea* leaf meal.

Chemical constituents	mg/100g
Alkaloids	44.00
Glycosides	2.60
Saponnin	1.50
Tannins	2.00
Flavonoids	2.20
Reducing compound	1.40
Polyphenol	3.00
Phlobatanins	1.80

Alkaloids

Alkaloids are the most abundant phytochemicals in *Justicia carnea* leaf extract (44.00 mg). These compounds are well known for their biological activities, including antimicrobial, analgesic, anti-hypertension and anti-inflammatory properties. Alkaloids have been reported to interfere with DNA replication in cancerous cells and exhibit antimalarial properties (Patil *et al.,* 2023).

Polyphenols

Polyphenols (3.00 mg) are another abundant class of phytochemicals present in *Justicia carnea* leaf. They possess antioxidant, cardioprotective, and neuroprotective functions. Polyphenols are also known for their role in reducing oxidative stress, which is one of the key factors in the progression of chronic diseases such as diabetes and cancer (Ayoka *et al.,* 2022).

Flavonoids

Flavonoids (2.20 mg) were obtained in this work, and they are known as secondary metabolites for their antioxidant, anti-diabetic and anti-inflammatory properties. They aid in reducing lipid peroxidation and enhancing cardiovascular health (Odukoya *et al*., 2021). The authors further stated that flavonoids in plants can also enhance immune responses and modulate cytokine production.

Tannins

Tannin quantity was moderate (2.00 mg), which is a polyphenolic compound that plays roles in wound healing, antimicrobial defence, and astringency. They have been found to inhibit bacterial adhesion to epithelial cells, making them useful in preventing infections (Cosme *et al.,* 2025).

Table 5. Growth performance of growers rabbits fed *Justicia carnea* leaf meal.

Parametres	T_1 (0g)kg	T_2 (100g)kg	T_3 (200g) kg	SEM
Initial weight(g)	563.33	563.66	563.33	1.17
Final body weight(g)	1069.33[b]	1105.66[b]	1352.66[a]	45.77
Body weights gain(g)	506.00[b]	542.00[b]	789.33[a]	43.00
Daily weight gain(g)	9.62[b]	9.68[b]	13.89 [a]	0.73
Total feed Intake (g)	2600.00[a]	2530.00[b]	2300.00[c]	49.18
Daily feed intake (g)	46.42[a]	45.17[b]	41.06 [c]	0.78
Feed conversion ratio (g)	4.84 [a]	4.67 [a]	2.91 [b]	0.32

Glycosides

Glycosides obtained were moderate (2.60 mg). They are secondary metabolites that exhibit cardio-protective and anti-diabetic properties. These compounds enhance heart function by inhibiting Na^+/K^+ ATPase, which is important in managing heart failure and arrhythmias (Oluwafemi *et al.,* 2020).

Saponins

Saponin content was low (1.50 mg) and is a bioactive compound known for its anti-inflammatory, cholesterol-lowering, and immune-boosting effects. They play a role in membrane permeability and may contribute to anticancer activity by inducing apoptosis in malignant cells (Timilsena *et al.*, 2024).

Phlobatannins

Phlobatannins, also low in content (1.80 mg), have been reported to exhibit antimicrobial, antioxidant, and hepatoprotective properties. These compounds are often linked to their ability to form complexes with proteins, thereby inhibiting bacterial growth and reducing inflammation (Mussa *et al.*, 2024)

Reducing compounds

Reducing compounds (1.40 mg) were also low and are essential in metabolic processes, particularly in maintaining redox balance in biological systems. They contribute to free radical scavenging and oxidative stress reduction, thereby preventing cellular damage (Mussa *et al.*, 2024)

Feeding trial with weaner rabbits

Body weight

The initial body weight was similar at the commencement of the experiment; however, the final body weight and body weight gain were significantly influenced by the inclusion levels of *Justicia carnea* leaf meal. The results (Table 5) indicate that rabbits fed Diet T3 (200 g/kg of *Justicia carnea* leaf meal) had significantly ($p<0.05$) higher final body weight (1352.66 g) and body weight gain (789.33 g), as well as increased daily weight gain (13.89 g/day), compared to those on Diets T1 and T2. From this study (Table 1), *Justicia carnea* leaf meal is shown to be notably rich in crude protein (27.00%), which is essential for muscle development and overall growth in rabbits. Its high nitrogen-free extract (53.50%) provides readily available carbohydrates, supplying the energy necessary for growth processes. Additionally, the presence of crude fibre (10.00%) supports digestive health, ensuring efficient nutrient absorption. The energy content of 3535 Kcal/kg further meets the energetic demands of growing rabbits. This improved performance aligns with previous findings by Christopher *et al*. (2024), who reported enhanced growth in rabbits fed diets supplemented with leafy vegetables due to increased protein and phytochemical content.

Feed intake

Moreover, the lowest feed intake and best feed conversion ratio (2.91) observed in T3 suggest improved feed efficiency (Table 5), likely due to the higher nutrient density and phytoconstituents of the *Justicia carnea* leaf meal-supplemented diet. The phytochemical profile of *Justicia carnea* leaf meal (Table 3) includes significant levels of alkaloids (44.00 mg), flavonoids (2.20 mg), tannins (2.00mg), and saponins (1.50 mg). Alkaloids are known for their antimicrobial properties, which likely enhance gut health by modulating the intestinal microbiota. Flavonoids and tannins possess antioxidant properties, reducing oxidative stress and potentially improving immune function for positive growth. Saponins may have enhanced nutrient absorption by increasing intestinal permeability and may also exhibit antimicrobial effects. Collectively, these phyto-chemicals contribute to improved growth performance and feed efficiency in rabbits. Similar trends were observed by Ekpo *et al.* (2022), who noted that incurporating high-quality forages into rabbit diets improved nutrient

utilisation and growth performance. The results from this study demonstrate that the inclusion of *Justicia carnea* leaf meal at 200 g/kg is optimal for growth and feed efficiency in grower rabbits, supporting its potential use in rabbit nutrition

Conclusion

The study on the proximate composition and phytoconstituent profile of *Justicia carnea* leaf meal highlights its nutritional and medicinal potentials. Phytochemical analysis confirms the presence of bioactive compounds such as alkaloids, polyphenols, flavonoids, tannins, glycosides, and saponins, all of which contribute to its pharmacological properties. These constituents are known to possess antioxidant, antimicrobial, anti-inflammatory, and immune-boosting effects, supporting the traditional use of *Justicia carnea* leaf meal in herbal medicine.

Proximate analysis revealed that *Justicia carnea* leaf meal is a rich source of crude protein, making it a valuable dietary supplement for enhancing protein intake. The high nitrogen-free extract indicates a significant carbohydrate content, providing energy for metabolic functions. Additionally, the moderate levels of crude fibre and ash content suggest the presence of essential minerals and digestive benefits.

Furthermore, the superior growth performance observed in rabbits fed the T3 diet can be attributed to the synergistic effects of the high-quality protein and energy content, along with the beneficial phytochemicals present in *Justicia carnea* leaf meal. These components work together to enhance nutrient utilisation, promote gut health, and support overall growth in weaner rabbits.

In conclusion, the findings of this study validate the nutritional importance of *Justicia carnea*, reinforcing its potential use in animal nutrition. Specifically, given its high protein and carbohydrate content, *Justicia carnea* leaf meal can be effectively incorporated into livestock feed formulations as a dietary supplement to boost animal growth performance.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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