COMPREHENSIVE EVALUATION OF NUTRITIONAL AND PHYTOCHEMICAL QUALITIES OF TURMERIC (*CURCUMA LONGA* LINN) LEAVES

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***Received** August 7, 2023; **Revised** September 06, 2023; **Accepted** September 11, 2023*

ABSTRACT

Turmeric (Curcuma longa L.), is a member of the family zingiberaceae, which grow in tropical climate. The matured leaves used in this study were source from Obio Akpa, Oruk Anam Local Government Area of Akwa Ibom State, Nigeria. Sample of the leaves were analyzed in the laboratory for proximate, gross energy, minerals, vitamins, and photochemical compositions. Values obtained for the proximate analysis of C. longa leaf were; dry matter (88.13 ± 3.26%), crude protein (25.22 ± 1.67%), ether extract (4.03 ± 0.35%), crude fibre (16.73 ± 1.00%), ash (9.65 ± 0.62%), and nitrogen free extract (32.49 ± 1.40%) respectively. The gross energy value was 4110.00 ± 0.10 kcal/kg. Mineral and vitamin composition analysis of the leaves of C. longa gave the following values; calcium (0.26 ± 0.04%), phosphorus (0.38 ± 0.10%), potassium (0.89 ± 0.10%), magnesium (0.28 ± 0.00%), sodium (0.19 ± 0.10%), iodine (7.30 ± 0.54 mg/kg), zinc (48.74 ± 1.21 mg/kg), cobalt (0.41 ± 0.11 mg/kg), manganese (36.17 ± 1.04 mg/kg), vitamin E (31.38 ± 1.00 mg/100g), vitamin A (254.80 ± 2.80 mg/100g), vitamin B6 (1.27 ± 0.20 mg/100g) and vitamin B12 (0.07 ± 0.01 mg/100) respectively. Phytochemical compositions were, curcumin (0.006 ± 0.01%), demethoxycurcumin (0.004 ± 0.00%), bisdemethoxycurcumin (0.003 ± 0.00%), tannin (0.04 ± 0.01%), saponin (0.22 ± 0.02%), alkaloids (0.32 ± 0.10%) and flavonoid (0.01 ± 0.00%) respectively. The results of the current study indicated that turmeric leaf meal will be a good ingredient for livestock feed production.

Keywords: Turmeric leaf meal, Proximate composition, Gross energy, Phytochemical composition, Minerals, Vitamins

INTRODUCTION

The livestock sector plays a significant economic role in most developing countries, and essential for the food security of populations (Herrero *et al.*, 2013). The productivity of farmed animals in most tropical countries is generally low, mainly due to poor quality and inadequacy of available feeds (IAEA, 2006; Oosting *et al.*, 2022). Moreover, conventional feed resources (grains, cereals, legumes, etc.) for animal production are scarce and highly expensive in many parts of the world. To solve these challenges, interests have been shifted to the search for cheaper, available and nutritionally viable feedstuffs with some phytogenic properties to enhance livestock production. Some leaf meals of tropical origin as potential alternative feedstuffs have been reported (Jiwuba, 2018; Jiwuba *et al.*, 2020; Amad and Zentek, 2023) to yield relatively higher levels of crude protein, dry matter and moderately crude fibre levels than most tropical forages.

Turmeric (*Curcuma longa* Linn) belongs to the family of Zingiberaceae (Asagwara *et al.*, 2018), and its' leave is locally called *Atale pupa* in Yoruba, *Gangamaw* in Hausa, *Nwandumo* in Ebonyi, *Ohu boboch* in Nkanu East, Enugu, *Gigir* in Tiv, *Magina* in Kaduna, *Turi* in Niger State, *Onjonigho* by Meo tribe of Cross River and *Aden-Unen* by the Ibibios of Akwa Ibom (Asagwara *et al.*, 2018). The plant is found primarily grown in tropical regions of Bangladesh, China, Thailand, Cambodia, Malaysia, Indonesia, Philippines and Nigeria. Turmeric leaves are small to medium in size and are oblong or lanceolate in shape, averaging 80 – 115 centimetres in length and 30 – 38 centimetres in width (Specialty Produce, 2023). Turmeric leaves have a neutral aroma when fresh and once they are cut, pounded, or chewed, they release a distinctive tart flavour with notes of grass and mint (Specialty Produce, 2023). Turmeric leaves produces a specific bioactive compound called curcumin, a polyphenolic phytochemical with anti-oxidant, anti-bacterial, anti-hyperglycemic, anti-hyperlipidemic anti-carcinogenic as well hypocholesterolemic activities (Selvam *et al.*, 1995; Ramırez-Tortosa *et al.*, 1999; Sukandar *et al.*, 2010; Gouda and Bhandary, 2018; Chanda and Ramachandra, 2019; Khatun *et al.*, 2021). Turmeric leaves is cheaply available and without competitive utilization. Given the interest and benefits from using phytobiotics, previous research work have been conducted and reported on the proximate composition, mineral composition and phytochemical content of Turmeric leaves (Asagwara *et al.*, 2018; Ahaotu and Lawal, 2019). Thus, the need arose to evaluate this feed resource for its optimum utilization in feeding livestock animals. Thus, the need arose to evaluate this feed resource for its optimum utilization in feeding livestock animals. The study reported here was conducted to determine the chemical component, minerals, vitamins and phytochemical composition of turmeric leaf meal (TLM).

MATERIALS AND METHODS

Experimental Location: Fresh turmeric leaves were harvested between May and July 2023 from fallow lands in Obio Akpa, Oruk Anam L.G.A of Akwa Ibom State. Obio Akpa is in the rain forest zone of Nigeria. It is located between latitude $5^0 17^1$N and $5^0 27^1$N and between longitude $7^0 27^1$N and $7^0 58^1$E with an annual rainfall ranging between 3500 – 5000 mm and average monthly temperature of 25 ± 4^0C, and relative humidity between 60 – 90% (Udo *et al.*, 2020).

Processing of Experimental Materials: Turmeric leave was identified (Cronquist, 1981) and authenticated by a plant taxonomist in the Department of Crop Science, Faculty of Agriculture, Akwa Ibom State University, Obio Akpa Campus, Akwa Ibom State, Nigeria and voucher specimen (No. 3016-2) was kept in the herbarium. The leaves were washed to remove debris, sliced and oven dried at 50^0C for two days. The dried sample was blended using Eberbach Heavy Duty Lab Blender (E8430.HD, Eberbach Corporation, Germany) to powder in preparation for laboratory analyses. Triplicate samples were later taken for laboratory analysis at International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State.

Analytical Procedure: The proximate composition of TLM was assayed using AOAC (2005). The sample was also analysed for gross energy composition (McDonald *et al.*, 2010). Calcium (Ca), sodium (Na) and potassium (K) were determined by flame photometry using Jenway Digital Flame Photometer (PFPT model). Zinc (Zn), cobalt (Co), magnesium (Mg), manganese (Mn) and iodine (I) were determined using Atomic Absorption Spectrophotometry (Buck 211VGP) (AOAC, 2005). Total phosphorus was determined using vanadomolybdate colorimeter (Raun *et al.*, 1987). Vitamin A, E, C, B_6 and B_{12} were assayed using the methods of AOAC (2005) and Eitenmiller *et al.* (2008) respectively. Quantitative assay of curcumin, demethoxycurcumin, bisdemethoxycurcumin, tannin, saponin, alkaloids and flavonoids levels in TLM were done according to the methods of AOAC (2005), Harborne (1998) and Jayaprakasha *et al.* (2002) respectively.

Statistical Analysis: Data obtained were subjected to descriptive statistics using the general statistical package (Genstat Version 22) (Baird *et al*., 2022).

RESULTS AND DISCUSSION

The crude protein value derived from the proximate analysis of TLM was 25.22 ± 1.67% on dry matters basis (Table 1).

Table 1: Proximate composition of turmeric leaf meal prepared from turmeric leaves harvested from Obio Akpa, Akwa Ibom State, Nigeria

Parameters (%)	Levels
Ash	9.65 ± 0.62
Crude fibre	16.73 ± 1.00
Crude protein	25.22 ± 1.67
Dry mater	88.13 ± 3.26
Ether extract	4.03 ± 0.35
Nitrogen free extract (NFE)	32.49 ± 1.40
Gross energy (kcal/kg)	4110.00 ± 0.10

The value obtained was higher than the value (17.87 ± 0.10) reported by earlier workers (Asagwara *et al*., 2018. The variation in crude protein composition may be due to species diversity, difference in stages at which the plant was harvested, difference in soil nutrients and acidity. The crude protein content reported in this study when compared with other leaf meals was lower than that of Mulberry leaves (*Broussonetia papyrifera*) (26.10%) (Tu *et al*., 2009) and *Moringa* leaves (*Moringa oleifera*) (26.8 – 30.30%) (Amad and Zentek*,* 2023). In the present study, the crude protein level reported may support the production of monogastric species on a supplemental basis. However, this level was above the 7% CP requirements for ruminants which will provide ammonia required by rumen microorganisms to support optimum microbial activity (Njidda, 2010).

The ether extract content of 4.03 ± 0.35% (Table 1) observed in this study did not agreed with the levels (2.41 ± 0.01%) obtained by Asagwara *et al.* (2018). The level reported in the study was low when compared with other leaf meal sources, especially paper mulberry (5.2%) and *M. oleifera* (8.65%) (Tu *et al*., 2009; Sanchez-Machado *et al.,* 2010). The low level of ether extract reported in this study supports the use of turmeric leave as hypocholesterolemic agents, which inhibits the accumulation of lipid droplets in fat cells (Lee *et al*., 2021).

The crude fibre content (16.73 ± 1.00%) (Table 1) were higher when compare with crude fibre from other sources such as wheat bran (10.8%), maize bran (11.7%), etc. (INRAE-CIRAD-AFZ, 2023), for provision of bulk in feeds. Fibre has some nutritional and health benefits in humans and livestock nutrition especially in gastro-intestinal tract by reducing gastric emptying time in the small intestine, enhancing bile salt and cholesterol excretion, increasing faecal bulk and faecal transit time through the bowl (Amadi *et al.,* 2018). Furthermore, fibre intake has been associated with improved intestinal microbiome, management in metabolic diseases (obesity and diabetes), neurological disorder, cardiovascular diseases, autoimmune diseases and cancer prevention (Ioniță-Mîndrican *et al*., 2022). The values of fibre obtained in the present study tend to be of advantage to ruminant animals than monogastric animals especially poultry, knowing fully that they have low ability to handle fibrous materials (Amadi *et al*., 2018).

Ash components are the inorganic materials left after the extraction of organic matter which serves as the mineral sources in the feed (McClements, 2023). The reported ash content in this study of 9.65 ± 0.62% did not agree with the value (11.37 ± 0.04%) previously reported (Asagwara *et al*., 2018). Geographical location, age stage of maturity and soil type may be the cause of the ash content variations. In a young leaf the ash may constitute approximately 5% of the dry weight while in the mature leaf it may be 15% (Oduntan *et al*., 2012).

The nitrogen free extracts (NFE) content of 32.49 ± 1.40% is comparable with the acceptable range values for legumes (20 – 60%) (Nwafor *et al.,* 2017). The NFE which represents the readily available carbohydrates which is mostly sugars, starches and also some of the more soluble hemicelluloses in TLM serves as an indication of energy source.

TLM gross energy stands at 4110.00 ± 0.10 kcal/kg. This value was comparable to 3.85 kcal/g reported by Kinati *et al.* (2022) for turmeric powder. This value also compared favorably with those of some alternative plant sources such as coelocaryon plant (4010.00 kcal/kg), lima beans (4120.00 kcal/kg) and *Canavialia* spp. (4480.00 kcal/kg) (Odoemelam and Ahamefule, 2006; Ibeabuchi *et al.*, 2019; Akpan *et al.*, 2022). This suggests that TLM is a good energy supplement.

Values obtained for minerals (Table 2) indicated that for macro minerals, potassium was the most abundant element in the leaf meal of the plant with a concentration of 0.89 ± 0.01%., other macro minerals such as phosphorous (0.38 ± 0.10%), magnesium (0.28 ± 0.00%) and calcium (026 ± 0.4%) were defected in higher concentration when compared to sodium (0.19 ± 0.10%).

Table 2: Mineral composition of turmeric leaf meal prepared from turmeric leaves harvested from Obio Akpa, Akwa Ibom State, Nigeria

Minerals	Levels
Macro Minerals (%)	
Calcium	0.26 ± 0.04
Magnesium	0.28 ± 0.00
Phosphorus	0.38 ± 0.10
Potassium	0.89 ± 0.10
Sodium	1.19 ± 0.10
Micro Minerals (mg/kg)	
Cobalt	0.41 ± 0.11
Iodine	7.30 ± 0.54
Manganese	36.17 ± 1.04
Zinc	48.74 ± 1.21

Micro mineral values revealed that zinc content (48.74 ± 1.21 mg/kg) was the most abundant followed by manganese (36.17 ± 1.04 mg/kg), and iodine (7.30 ± 0.54 mg/kg), while cobalt was the least detectable micro mineral with a value of 0.41 ± 0.11 mg/kg. The results of the present study on the mineral contents of TLM where higher than the values obtained for turmeric leave by Ahaotu and Lawal (2019). Ahaotu and Lawal (2019) analyzed the mineral contents of turmeric leave source from National Root Crop Research Institute, Umudike and found lower calcium (0.02%), magnesium (0.05%), potassium (0.42%), sodium (0.01%) and phosphorous (0.03%) contents when compared with the result of the present study. Variations in these mineral content can be attributed to differences in the locations from where the plant materials were sourced. Minerals are beneficial to health and their deficiencies have been linked to many ailments/diseases (Awuchi *et al.*, 2020).

Calcium and phosphorus are major constituents of none in addition calcium play major functions in blood clothing, membrane permeability, muscle contraction; nerve function and energy activity. Adequate levels of calcium for lactating goats are necessary to prevent parturient paresis (milk fever) (Pugh, 2022). Phosphorous is essential for growth, energy utilization, and acid base balance, and is required by rumen microbes for optimal growth and activity (Radke, 2021). Phosphorous deficiency results in slowed growth and an unthrifty appearance. Sodium and potassium function in maintaining adequate fluid balance in the body, lowers the rate of oxidation, thereby enhancing the body's antioxidant protection (Prasad and Aggarwal, 2011). Magnesium primary function is in carbohydrate and fat metabolism and its deficiency is associated with grass tetany in cows (Schonewille, 2013)). TLM also contained substantial amount of micro elements. This implies that the use of TLM in the diets of livestock animals would enhance immune response, and adequate protein synthesis because of high value of zinc (Recharla *et al.*, 2021) enhance iodine promotion in the synthesis of thyroid hormones to prevent goitrogenic conditions (Radke, 2021), enhance the synthesis of vitamin Bs because of the present of cobalt (Pugh, 2022) and promotes manganese in immune system functioning and structural development in animals (Recharla *et al.*, 2021). The presences of these numerals in appreciable amounts enhance the nutritional value of TLM.

Table 3 showed the vitamin constituents of TLM. The vitamin content showed the presence of Vitamin E, Vitamin A, Vitamin C, Vitamin B6 and vitamin B12 in the following proportions 31.38 ± 1.00 mg/100 g, 1.27 ± 0.20 mg/100 g and 0.07 ± 0.01 mg/100 g respectively.

Table 3: Vitamin Composition (mg/100g) of turmeric leaf meal prepared from turmeric leaves harvested from Obio Akpa, Akwa Ibom State, Nigeria

Vitamins	Levels
A	254.8 ± 2.80
B_6	1.27 ± 0.20
B_{12}	0.07 ± 0.01
C	18.74 ± 1.00
E	31.38 ± 1.00

Vitamins are known to have positive effects on health. The high contents of vitamins A, C and E obtained in the present study indicated that TLM is a good source of these vitamins. Vitamin play vital role in the functioning of nervous system, aid in the formation of red blood cells and helps to helps to build tissues (Lebas, 2000). Vitamins A and E are known as antioxidant vitamins because they possess free radical scavenging potentials, this suggests that they may play important roles in curbing the incidence of oxidative stress in humans and animals (McDonald *et al*., 2010; Banerjee, 2018). In livestock production especially ruminants, the main benefits of synthesizing water soluble vitamin such as vitamin B6 (pyridoxine) and B12 (cyanocobalamin) is to achieve amino acid metabolism and the metabolism of propionic acid into succinic acid (McDonald *et al*., 2010; Banerjee, 2018). These B-complex vitamins are necessary in ruminants for maintenance and normal production.

Bioactive compounds such as curcumin, demethoxycurcumin and bisdemethoxycurcumin were found in TLM are as shown in Table 4.

Table 4: Bioactive compounds of turmeric leaf meal prepared from turmeric leaves harvested from Obio Akpa, Akwa Ibom State, Nigeria

Bioactive compounds (%)	Levels
Bisdemethoxycurcumin	0.003 ± 0.00
Curcumin	0.006 ± 0.01
Demethoxycurcumin	0.004 ± 0.00

The more abundant bioactive compound found in turmeric is the phenolic compound known as curcumin (70 – 75%) (Kocaadam and Şanlier, 2017) followed by demethoxycurcumin (10 – 25%), and bisdemethoxycurcumin (5 – 10%). The findings of this study were in agreement with the findings of Kocaadam and Şanlier (2017). According to Asagwara *et al.* (2018), Verma *et al.* (2018), Chanda and Ramachandra (2019) and Jyotirmayee and Mahalik (2022), these bioactive substances has wide range of important pharmacological applications such as an antioxidant, anti-inflammatory, anti-bacterial, anti-fungal, and anti-lipidemic properties when utilized as feed additive. These authors also reported that these phenolic compounds present anti-oxidant activity by scavenging of oxygen free radicals. This anti-oxidant property also protects haemoglobin from oxidation. Banerjee *et al.* (2015) reported that curcumin and its derivatives can significantly inhibit the generation of reactive oxygen species (ROS), like superoxide anions hydrogen peroxides (H_2O_2) and nitrite radical generation by activated macrophages, which play an important role in inflammation. Verma *et al.* (2018) reported that (curcumin suppress growth of several bacteria like *Streptococcus, Staphylococcus, Lactobacillus*, etc. Dalal *et al.* (2018) revealed in their study that the antimicrobial properties of turmeric limits the growth and colonization of numerous pathogenic and non-pathogenic species of bacteria in chicken gut, thus resulting in balanced gut microbial ecosystems which enhance better feed utilization. In another study, Jiang *et al.* (2019) reported that dietary curcumin supplementation (450 and 900 mg/sheep daily) promoted lipid metabolism, antioxidant capacity, and immune response as well as testicular development in Hu sheep, thus providing more evidences on the protective roles of curcumin against heat stress in sheep.

Results of anti-nutritional factors in TLM are presented in Table 5. Anti-nutritional factors such as tannin and saponin values in TLM fell below the range of 2 – 4% for tannin (Njidda, 2010) and 1.72 – 2.62% for saponin (Cheeke, 1995) allowed in the diets of ruminant animals. However, phenolic substances such as alkaloids and flavonoids content in TLM were present in high quantities above the level recommended in the diets of ruminant animals for alkaloids (>2 – 3 ppm) (Klotz, 2015) and of flavonoids (60 mg/kg BW) (Zhang *et al*., 2017).

Table 5: Anti-nutritional factors of turmeric leaf meal prepared from turmeric leaves harvested from Obio Akpa, Akwa Ibom State, Nigeria

Parameters (%)	Levels
Alkaloids	0.32 ± 0.10
Flavonoid	0.01 ± 0.00
Saponin	0.22 ± 0.02
Tannin	0.04 ± 0.01

According to Klotz (2015) and Kalantar (2018), alkaloids and flavonoids are important bioactive constituents of natural products and help in maintaining human and animal health and sometimes possessing remarkable therapeutic potentials. However, in the present study, these compounds present themselves as anti-nutritional factors. Alkaloids are considered to be anti-nutrients because of their action on the nervous systems, disrupting or inappropriately augmenting electrochemical transmission (Klotz, 2015; Tadele, 2015). These authors also reported that high alkaloid content in the diets of young growing animals may cause rapid heartbeat, paralysis and in fatal case, lead to death. According to Oskoueian *et al.* (2013) and Zhang *et al.* (2017), flavonoids possess chelating properties which may bind nutrition and make it less available and also disturb acid/base balance.

Conclusion: The results of this study showed that TLM is a promising source of rich nutritional and photochemical agents. The leaves of *C. longa* have high content of crude protein, and nitrogen free extract which will provoke adequate growth and performance of farm animals. The rich mineral elements and vitamins are essential in animal nutrition. The presence of bioactive and phenolic compounds suggests high pharmacological activities of the leaf meal. Conclusively, based on the above findings, this study recommends the use of TLM as feed additive in feeding trials.

ACKNOWLEDGEMENTS

The authors are grateful to the technical staff of the Department of Animal Science, Akwa Ibom State University, and International Institute of Tropical Agriculture (IITA), Ibadan for their various contributions.

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