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EFFECT OF DIFFERENT PROCESSING METHODS ON THE CHEMICAL COMPOSITION OF *Mangifera indica* LEAVES

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ABSTRACT

The study was conducted to assess the effect of different processing methods on the chemical composition of *Mangifera indica* leaves. The *M. indica* leaves were collected from the University Botanical Garden and Orchard of Kebbi State University of Science and Technology, Aliero and subjected to five different processing methods, designated as T1 (Air dried: control), T2 (Soaked in freshwater), T3 (Soaked in hot water), T4 (Fermented without yeast) and T5 (Fermented with yeast). Proximate composition of *M. indica* revealed that fermented leaf meal crude protein was significantly (T5: 13.15±1.2) higher ($P < 0.05$) than in other treatments. Analysis of anti-nutritional factors revealed that Cyanide, Nitrate, Tannin and Oxalate reduced significantly ($P<0.05$) after the processing of *M. indica* leaves meal. The mineral composition (Calcium, Magnesium, Potassium, Phosphorus, Nitrogen, and Sodium) recorded significantly ($P<0.05$) higher in fermented leaves than in other treatments. The results on the processing methods will serve as baseline information on the utilization of *M. indica* leaf meal for animal feed.

Keywords: *Mangifera indica* leaves; processing methods; proximate; anti-nutritional composition; minerals

INTRODUCTION

The mango tree (*Mangifera indica*, Linn Anacardiaceae) is one of the important fruits in the tropical and subtropical regions of the world. It is widely used as a source of food, medicines, timber and the trees are evergreen plants which withstand dry periods very efficiently. All the organs of the plants are rich in tannins and flavonoids (Nunez-Selles, 2005). Jhaumeer-Laulloo *et al*. (2018) reported that *M. indica* leaves is a good source of mineral elements since it has a high percentage of ash content, low crude fat while the crude protein was within the range required to support the growth of ruminants. The bark and leaves have astringent properties and are used in Nigeria as lotion to relieve toothache, sore gums, sore throat or as an infusion in malaria, diarrhoea and dysentery treatment (Adesegun and Coker, 2001).

The plant has feed ingredients that are included in the diets for animals contained anti-nutritional factors. These anti-nutritional factors interfere with the utilization of dietary nutrients in different ways including reducing protein digestibility, binding to various nutrients or damaging the gut wall and thereby reducing digestive efficiency (Karoly, 2011).

The presence of anti-nutritional factors may contribute to a decrease in their overall nutritional quality. The *M. indica* leaves have been reported to contain glucoside and mangiferin (Zakari *et al*., 2006). Santosh and Richard (2002) reported that physical and chemical methods employed to reduce or remove anti-nutritional factors including soaking, cooking, germination, fermentation, selective extraction, irradiation and enzymic treatment. An effective means of reducing phytic acid content in sesame seeds was suggested by Mukhopadyay and Ray (1999) who reported a substantial decrease in phytic acids content after bacterial fermentation with *Lactobacillus acidophilus* and also reduces amount of tannin in the seed. The present study is therefore aimed at providing information on the effect of different processing methods on chemical composition of *M. indica* leaves to assess its nutritional potentials of been utilized as a source of protein and energy in animal feeds.

MATERIALS AND METHODS

Study Area

This study was conducted in the fisheries laboratory of the Department of Forestry and Fisheries, Kebbi State University of Science and Technology Aliero, Kebbi State, Nigeria. Aliero is located in Southeast of Kebbi State at approximately latitudes $11^0$03'N to $12^0$47N and longitudes $3^0$6'E to $4^0$27'E (Singh, 2013). The town enjoys a tropical climate, which is characterized by dry and wet seasons. The annual temperature varies considerably but usually ranges between 26^0 and 37^0C while mean annual rainfall is 500 mm (SERC, 2000).

Collection of Leaf Samples

The leaves of *Mangifera indica* were obtained from the University Botanical Garden and Orchard in Kebbi State University of Science Technology, Aliero and authentication was carried out in the Department of Forestry and Fisheries, Kebbi State University of Science and Technology, Aliero.

Preparation of the Leaf Samples

The leaf samples were washed using tap water to remove the dust before different processing methods were employed to prepare the leaf meal and thereafter the proximate analysis, anti-nutritional and minerals content of the leaf samples were determined. The leaves were subjected to the following processing techniques, as described by Padmavathy and Shobha (1987) and used by Ibrahim *et al*. (2018).

i. The *M. indica* leaf weighing 1 kilogram was air-dried for a week.
ii. The *M. indica* leaf weighing 1 kilogram was soaked in freshwater at 1 kg leaf per 5 litre of water for 36 hours. The leaves were then collected by emptying the water and then air-dried for a week.
iii. The *M. indica* leaf weighing 1 kg was soaked in 60°C hot water and was allowed to cool down for 24 hours. The leaves were then collected by losing the water and air-dried for a week.
iv. The *M. indica* leaf weighing 1 kg was fermented in air-tight container for 72 hours. The leaves were then collected and air-dried for a week.

v. The *M. indica* leaf weighing 1 kilogram was fermented with yeast (*Saccharomyces cerevisiae*) of 2 kg in air tight container for 72 hours. The leaves were then collected and air-dried for a week.

The leaf samples were taken to Agric Chemical Laboratory, Faculty of Agriculture, Usmanu Danfodiyo University, Sokoto for Analysis. The proximate analysis of leaf meals was determined following methods described by the AOAC (1990). Proximate components such as moisture, crude protein, crude lipid and ash were analyzed. The anti-nutritional compounds were determined (tannin, phytate, nitrate and hydrocyanic acid) using colorimetric approach as described by AOAC (1990). The oxalate was determined as described by Krishna and Ranjhan (1980). Minerals were extracted from the sample by the wet digestion method (Vadivel and Janardhanan, 2000). The minerals such as calcium, magnesium, phosphorous, nitrogen, sodium, potassium were determined according to the method described by AOAC (1990).

Data Analysis

The data were subjected to analysis of variance (ANOVA) to test the significant difference among treatment means. Where there was significant difference, Duncan's Multiple Range Test (DMRT) was applied to rank treatment means (P<0.05). All statistical analyses were computed using SPSS (IBM) Statistical package Version 22 for Windows.

RESULTS AND DISCUSSION

Proximate Compositions of Processed *Mangifera indica* Leaf Meal

The proximate composition of processed *Mangifera indica* leaf meal is shown in Table 1. The moisture ranges from 1.36±0.18% to 2.16±0.16% while the crude protein percentages ranged from 5.34±0.10 to 13.15±1.20. The highest crude protein value (13.15±1.20%) was recorded in T5 and the lowest values (5.34±0.10%) was recorded in T2.. The ash content percentages ranged from 10.33±0.33 to 17.00±0.57.

Table 1: Proximate composition of processed *Mangifera indica* leaf meal

Parameters (%)	Leaf meal (±SE)				
	T_1	T_2	T_3	T_4	T_5
Moisture	$1.83±0.16^{ab}$	$1.66±0.16^{abc}$	$1.36±0.18^{bc}$	$1.16±0.16^{c}$	$2.16±0.16^{a}$
Ash	$11.00±0.57^{bc}$	$10.33±0.33^{c}$	$12.16±0.33^{b}$	$17.00±0.57^{a}$	$16.50±0.57^{a}$
Ether extract	$11.33±0.44^{a}$	$12.06±0.86^{a}$	$11.76±0.89^{a}$	$9.00±0.76^{b}$	$8.50±0.28^{b}$
Crude protein	$5.79±0.27^{c}$	$5.34±0.10^{c}$	$5.51±0.04^{c}$	$8.77±0.60^{b}$	$13.15±1.20^{a}$
Crude fibre	$15.50±0.76^{a}$	$11.50±0.28^{b}$	$11.43±0.57^{b}$	$7.03±0.51^{c}$	$5.50±0.86^{c}$
Nitrogen free extract	$54.54±0.62^{b}$	$59.38±0.54^{a}$	$57.98±0.50^{ab}$	$57.22±0.81^{ab}$	$54.51±1.88^{b}$

Mean with different superscript along row were significantly different (P<0.05).
T1 = Air-dried *M. indica* leaf meal, T2 = Soaked in freshwater *M. indica* leaf meal, T3 = Soaked in 60°C hot water *M. indica* leaf meal, T4 = Fermented in air-tight container *M. indica* leaf meal, T5 = Fermented with yeast *M. indica* leaf meal.

The proximate composition of air dried *Mangifera indica* leaf obtained from this work differs to that reported by Aborisade *et al*. (2017) where they examined the phytochemical and proximate analysis of some medicinal leaves obtained from a local farm in Esa Oke, Osun State, Nigeria. They reported the percentage proximate composition of *M. indica* leaves as 12.04%, 29.00%, 19.01%, 9.56% and 40.23% for ash content, crude protein, crude fibre, crude fat and carbohydrate respectively. The crude protein and ash content obtained in this study was lower than that reported by Aborisade *et al*. (2017), while the crude fibre recorded higher value. The differences observed in the proximate composition of air dried *M. indica* leaf from these two studies are probably as a result of factors, such as geographical location of the plant, soil and climatic conditions of cultured environment. FAO (2004) stated that these factors directly affect the composition of plant physiological and chemical composition. It could be observed that the crude protein of fermented *M. indica* leaf meal differed from that of the soaked in both freshwater and hot water. The observed difference may be attributed to leaching of soluble protein into water. This suggestion agrees with the observation of Ani (2008) which showed that Mucuna been seeds soaked in an aqueous solution of potassium bicarbonate at room temperature for 24 hours led to the solubilization and removal of some nitrogenous substance in the bean. The fermented *M. indica* leaf meal indicates a significant increase in the crude protein composition of the leaf meal. The increased level of crude protein is consistent with the findings of Ibrahim *et al*. (2018) who reported, an increase in protein value when Mucuna leaf was fermented with yeast. Fermentation could be attributed to net synthesis of protein by fermenting of the leaf, which might have resulted in the production of some amino acids during protein synthesis. Lipid content were found to be significantly lower in the fermented *M. indica* leaf meal. The decrease in lipid contents might be attributed to the increased activities of the lipolytic enzymes during fermentation which hydrolyses fat components into fatty acid and glycerol (Chinma *et al*., 2009).

Anti-nutritional Compounds of Processed *Mangifera indica* Leaf Meal

The anti-nutritional compounds such as tannin, oxalate, phytate, nitrate and cyanide as presented in Table 2 indicates that all the components determined were greatly reduced after processing methods of the leaf as there was significant difference (P<0.05) in the five treatments. In air dried and processed *M. indica* leaf meal, the values of phytate ranged from 1.10±0.10mg/100 to 2.23±0.28mg/100 while the tannin ranges from 0.55±0.03mg/100 to 1.33±0.33 mg/100.

Table 2: Anti-nutritional compounds of processed *Mangifera indica* leaf meal

Parameters	Leaf Meal (±S.E)				
	T_1 (mg/100)	T_2 (mg/100)	T_3 (mg/100)	T_4 (mg/100)	T_5 (mg/100)
Tannin	1.33±0.33^{a}	0.62±0.01^{b}	0.63±0.00^{b}	0.57±0.01^{b}	0.55±0.03^{b}
Oxalate	1.60±0.05^{a}	0.86±.0.03^{bc}	0.94±0.08^{b}	0.66±0.08^{c}	0.66±0.08^{c}
Phytate	2.23±0.28^{a}	1.63±0.08^{b}	1.56±0.28^{b}	1.10±0.10^{b}	1.16±0.03^{b}
Nitrate	0.01±0.00^{b}	0.01±0.00^{b}	0.01±0.00^{b}	1.51±0.00^{a}	1.67±0.11^{a}
Cyanide	2.44±0.33^{a}	0.31±0.00^{b}	0.32±0.00^{b}	0.25±0.00^{b}	0.22±0.00^{b}

Mean with different superscript along row were significantly different (P<0.05).
T1 = Air-dried *M. indica* leaf meal, T2 = Soaked in freshwater *M. indica* leaf meal, T3 = Soaked in 60°C hot water *M. indica* leaf meal, T4 = Fermented in air-tight container *M. indica* leaf meal, T5 = Fermented with yeast *M. indica* leaf meal.

The results of the anti-nutritional compounds of the air dried *M. indica* leaf obtained in this study show that tannin has lower value than that reported by Okwu and Ezenagu (2008), this could be as a result of difference in environment, probably being a determining factors of type of anti-nutritional compounds in plant and this may be as a result of plants absorbing substances from their environment. The anti-nutritional compounds of the processed *M. indica* leaf showed significant reduction. The significant reduction of the anti-nutritional compounds soaked in both freshwater and hot water, may be as result of efficacy of water leaching out anti-nutrients in the leaves as reported by Bichi and Ahmad (2010). The anti-nutritional compounds of the fermented *M. indica* leaf showed significant reduction, which is in concordant with the reports of Oseni and Ekperigin (2007) on reduction of phytate by fermentation, when pure strain of *Aspergillus niger* was used to ferment maize cobs, but contradicts the report of Oladele and Oshodi (2008) who observed an increase in phytate and tannin levels by fermentation; it is however possible that the mode of fermentation and the species of organisms involved play crucial roles in the fermentation processes.

Mineral Compositions of Processed *Mangifera indica* Leaf Meal

The mineral compositions of processed *Mangifera indica* leaf meal are presented in Table 3. The sodium value ranged from 25.33±0.88mg/kg to 45.33±0.66mg/kg, the T5 had significantly (P<0.05) higher value, while the least was recorded in T2. The value of calcium in air dried and processed *M. indica* leaf meal ranges from 1.76±0.03mg/kg to 4.93±0.52mg/kg while the magnesium ranged from 6.00±0.75mg/kg to 8.33±0.73mg/kg.

Table 3: Mineral compositions of processed *Mangifera indica* leaf meal

Parameters	Leaf Meal				
	T_1 (mg/kg) ±S.E	T_2 (mg/kg) ±S.E	T_3 (mg/kg) ±S.E	T_4 (mg/kg) ±S.E	T_5 (mg/kg) ±S.E
Sodium (Na)	$27.00±0.57^{d}$	$25.33±0.88^{d}$	$31.67±0.33^{c}$	$40.67±0.88^{b}$	$45.33±0.66^{a}$
Potassium (K)	$46.67±0.88^{b}$	$44.33±066^{b}$	$14.33±1.20^{c}$	$51.67±0.66^{a}$	$53.67±0.88^{a}$
Calcium (Ca)	$2.03±0.06^{c}$	$3.23±0.03^{b}$	$1.76±0.03^{c}$	$4.40±0.60^{a}$	$4.93±0.52^{a}$
Magnesium(Mg)	$7.30±0.05^{ab}$	$6.73±0.06^{ab}$	$6.00±0.75^{b}$	$8.33±0.73^{a}$	$8.06±0.40^{a}$
Phosphorous (P)	$0.45±0.00^{c}$	$0.39±0.00^{d}$	$0.38±0.00^{e}$	$0.46±0.00^{b}$	$0.49±0.00^{a}$
Nitrogen (N)	$0.87±0.01^{b}$	$0.84±0.00^{b}$	$0.88±0.00^{b}$	$1.59±0.32^{a}$	$2.21±0.32^{a}$

Mean with different superscript along row were significantly different (P<0.05).
T1 = Air-dried *M. indica* leaf meal, T2 = Soaked in freshwater *M. indica* leaf meal, T3 = Soaked in 60°C hot water *M. indica* leaf meal, T4 = Fermented in air-tight container *M. indica* leaf meal, T5 = Fermented with yeast *M. indica* leaf meal.

The values of magnesium, potassium and sodium in air dried *M. indica* leaf meal were found to be higher than that reported by Okwu and Ezenagu (2008) while the calcium and phosphorous obtained in this study had lower values. The differences from these two studies observed, may be attributed to the different in geographical location of the plant. There was significant reduction of the mineral composition of *M. indica* leaf meal soaked in both freshwater and hot water. The reduction may be as a result of minerals leaching out from the leaves into the water. The fermented *M. indica* leaf meal indicates a significant increase in the mineral composition of the leaf. The increased level of minerals composition may be due to activities of micro-organism during fermentations.

CONCLUSION

The results on the effect of different processing methods will serve as baseline information on the utilization of *Mangifera indica* leaf meal for animal feeds. The fermentation of *M. indica* leaf significantly improved the crude protein and reduced crude fibre. The anti-nutritional compounds reduced significantly ($P<0.05$) by the processing methods employed. It is therefore, concluded that fermented *M. indica* leaf meal has a potential to be utilized as a source of energy in the animal feeds.

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