International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 5, July-August 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Composition and Feeding Values of Mango Seed Kernel (MSK) as Supplement in Lactating Ruminant Diets

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ABSTRACT

Mango Seed Kernel (MSK) as supplement in lactating ruminant diets was investigated. Rotten mango fruits was gathered at 4 settlements around Ogbomoso in Oyo State, Nigeria, to represent 4 treatments; TI, T2, T3 and T4, respectively. Samples were washed, soaked for 48 hours and sundried. Dried samples were milled and bottled for laboratory analysis for chemical composition, mineral analysis (Calcium -Ca, Magnesium – Mg, Sodium – Na, Potassium – K, Iron – Fe, Zinc – Zn and Copper -Cu), amino acids (Methionine, Lysine, Isoleucine, and Phenylalanine) and Anti-nutritional factors (Tannin, Phytic acid and Oxalate). The results were significantly different (P<0.05). The crude protein values ranged from 7.00% (T1) to 10.95% (T3). There was no significant difference (P>0.05) between T1 and T2 for crude fibre. Ash values ranged from 4.31% (T4) to 6.05% (T3). Mineral composition were significantly different(P<0.05). T3 (mg/100g) recorded highest values of 48.75, 182.50, 315.00 , 780.00, 0.90, 5.85, and 0.80, for Ca, Mg, Na, K, Fe, Zn and Cu, respectively. Amino acid was significantly different (P<0.05). Methionine (g/100g protein) varied from 1.65 (T4) to 2.00 (T3), Lysine (g/100g protein) varied from 3.00 (T2 and T4) to 3.85(T3). Isoleucine differed significantly(P<0.05) as T3 had highest value (4.25g/100g protein). Phenylalanine showed no significant different (P>0.05) for TI and T2 as well as T3 and T4. Tannin value was significant (P<0.05) at T1 (2.62 mg/100g/DM). Oxalate(mg/100g/DM) differed significantly (P<0.05), with values range of 1.66(T4) and 1.92 (T3). This study therefore presents MSK as good supplement in ruminant nutrition for meat and milk production purpose.

KEYWORDS: *Mango seed kernel, chemical composition, mineral analysis, supplement, ruminant*

How to cite this paper: Okunlola D. O | Olatunji O. O | Shittu M. D | Amuda A. J | Olaniyan O. S | Fasola A. A | Olateju B. O | Alao A. J "Composition and Feeding Values of Mango Seed Kernel (MSK) as Supplement in Lactating Ruminant Diets" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-5, August 2021, pp.2439-2444, URL: www.ijtsrd.com/papers/ijtsrd47751.pdf

IJTSRD47751

Description of Problem

Problems of ruminants raised in the tropics largely depend on seasonal feed resources and diseases. Tropical feeds are imbalanced as they are deficient in essential nutrients and are poorly digestible especially in the dry season . Consequently, intake, digestibility and productivity becomes low (Bababyemi, 2007). The search for alternative tropical energy feed resource as supplement especially non-conventional feed materials and crop wastes for sustainable ruminant production is a step in right direction. However, researchers have carried out studies on the utilization of various materials such as baobab fruit (Okunlola *et. al.,* 2015), cassava peel (Salami *et. al.,* 2003), mango seed kernel meal (Odunsi and Farinu, 1997). Incidentally, aside cassava peel, most of these studies were carried out on monogastrics, especially poultry.

Mango *(Mangifera indica)* is one of the most important tropical fruits. It has a world-wide popularity and has gained increasing relevance in the European market (Rafiu, 2011)). In Nigeria, it is one of the most commonly consumed fruits. Large quantities are transported across state borders while mango tree itself grows on different soil types especially in the humid tropical zone (Farinu *et. al.,* 1999). Unfortunately, poor storage facilities and marketing of Agricultural produce makes mango wastes a serious environmental pollutant via rottenness; giving rise to flies transmitted diseases outbreak at the peak of its harvest.

Mango seed kernel is a good and rich source of carbohydrate (Maria *et. al.,* 2019). It contains 78.62% NFE and metabolizable energy value of 3.17Kcal/g (Pausenga, 1985). The mango seed kernel's fat is a promising source of edible oil and may also be used as a source of natural anti-oxidants (Maria *et. al.,* 2019).

Therefore, the need for alternative feed resource to improve the performance of ruminants necessitates the utilization of nutrient rich unconventional feed material as supplement in ruminant animal's ration. This study therefore, seeks to examine the potentials of mango seed kernel as feed supplement in ruminant nutrition.

Materials and methods

Rotten mango fruits were gathered randomly from markets at rural communities in Ogbomoso on longitude 4^{o}5' east of the Greenwich Meridian and latitude 8^{o}7' North of the Equator in the derived savannah zone of Nigeria. Usually, heaps of rotten mango fruits are commonly found around less city areas of Ogbomoso. The locations visited include Ikoyi-Ile, Iresaapa, Odo-oba and Ajaawa. The rotten mango fruits gathered from these locations were washed, sun dried separately and thereafter; milled. Samples were taken on location basis and stored in a covered plastic container for laboratory analysis. Chemical composition of mango seed kernel was carried out according to the procedure of (AOAC 2003).Crude fibre determination was carried out using trichloroacetic acid (TCA) method. Hemicellulose was calculated as the difference between NDF and ADF and cellulose as the difference between ADL and ADF.Analysis of selected minerals of interest was determined by wet digestion of samples using Atomic Absorption Spectro-photometer (AAS). Data obtained were subjected to analysis of variance (ANOVA) using the procedure of (SAS 2003) package to determine the effect of dietary treatments on the various parameters studied. Significant means were separated using Duncan multiple range test of the same software.

Results and Discussion

Table 1 presents the chemical composition of mango seed kernel in the derived savannah zone of Nigeria. The dry matter content of MSK varied at different location. The value ranged from 81.05% to 84.07%. The samples from Odo-Oba (T3) recorded the highest value, while samples from Iresaapa (T2) had the lowest value. The CP value was also higher in T3(10.95%) ahead of T1, T2 and T4. The value of CP in the study was higher than 5.59% recorded by (Asma 2017) and 6.0% (12) in a research on composition of mango seed kernel. But lower than 17.30% CP reported of Baobab seed (Okunlola *et. al.,* 2015). The CP range recorded in this study is an indication that mango seed kernel is more of energy feed than protein feed. This makes it more appropriate as supplement in ruminant nutrition because ruminant requires more of energy feed, compared to poultry which thrives better on feed of high protein value. The crude fibre (CF) content of all treatments are in agreement with the findings of (Elegbede *et. al*., 1995) who reported 2.00% CF on a study on mango kernel. The proximate composition values recorded in this study aligned with findings from (Odunsi 2005, Diara *et.al*., 2011 and Dakare *et. al*., 2012) in various studies carried out on mango seed kernel. The result affirms MSK as good supplement for ruminant animals.

The recorded values for macro and micro minerals in the samples investigated in Table 2 shows great potentials for its utilization as feed resource not for ruminants alone but livestock in general. Ca value ranged from 42.33 to 48.75mg/100g, Mg;; 173.75 to 182.50 mg/100g, Na; 310.75 to 315.00 mg/100g, K; 755.50 to780.00 mg/100g, Fe; 0.76 to 0.90 mg/100g, Zn; 4.85 to 5.85mg/100g and Cu; 0.60 to 0.80 mg/100g, respectively, in significant order of. T2<T1<T4<T3. The Iron (Fe) content of the samples investigated especially T3 shows great potential for adequate erythropoiesis in ruminant. Mango fruit has a high nutritional value and health benefits due to its attributes as revealed in this study. The mineral contents of the samples in this study are in agreement with the findings of (Asma 2017), though, slightly higher. The variation in the values recorded in this study was due to edaphic factors of the locations and species of the mango tree and fruits; through which kernels were gotten. The specie of parent trees that produced the kernel used in this study is generally adjudged unique in Southwest Nigeria due to its sweetness, flavor and juiciness. It is popularly

referred to as 'Ogbomoso mango'. These sensory attributes will in addition make mango seed kernel acceptable to ruminants when fed as supplement. The superiority of T3(Odo-Oba) above other treatments was due to its location; being a popular market where mango fruits sellers from neighboring villages converge to sell their produce; and wastes heaped on incinerators around, thereby making rotten mangoes and mango kernel there; a mixture of all samples from various locations.

Essential amino acids investigated in this study includes. Methionine, Lysine, Isoleucine and Phenylalanine (Table 3) They are basically essential amino acids. These amino acids were selected for investigation in MSK because of their vital role in body system, both in human and livestock alike. Methionine plays an important role in metabolism and detoxification. It's also necessary for tissue growth and the absorption of trace minerals such as zinc and selenium that are vital to good body function. Lysine plays major roles in protein synthesis, production of hormone, enzymes and energy and the absorption of calcium as well as immune function. Isoleucine is involved in muscle metabolism and is heavily concentrated in muscle tissue. It's also important for immune function, hemoglobin production and energy regulation while Phenylalanine plays an integral role in the structure and function of proteins and enzymes and the production of other amino acids. The findings from this study, put methionine value of MSK in the derived savannah area of Nigeria within the range of 1.25g/100g protein (T2) to 2.00 g/100g protein (T3), Lysine, 3.00g/100g protein (T2 and T4) to 3.85g/100g protein (T3), Isoleucine, 3.33g/100g protein (T1) to 4.25g/100g protein (T3) and phenylalanine, 4.35g/100g protein (T1) to 4.50g/100g protein (T3). These value agrees with existing reports on amino acid content of Mango seed kernel (Fowomola, 2010, Asoush and Gadallah, 2011 and Kittiphoom, 2012), though with variation in values. The values variation could be traced to species on mango seed kernel investigated, age of harvest and processing methods. T3 results in this study seems richer than values recorded for T1,T2 and T4. This could be linked to the source of T4. A central market where mango fruits from farm from many locations are marketed and after-sales (rotten mangoes) are heaped. Results from this study confirms MSK as rich supplement in the diets of lactating ruminant.

Table 4 presents anti-nutritional factors (mg/100gDM) in mango seed kernel (MSK) in the derived savannah area of Nigeria. Plant secondary metabolites are generally known for the inhibitive roles they play on bioavailability of nutrients to livestock. Ruminants however has ability to tolerate and utilize low-quality fibrous feed that cannot be utilized to any appreciable extent by simple stomach animals. Thus the poor quality substrates are converted into high-quality product (Greathead, 2003). Fibrous feeds such as crop residues, agro-industrial by-products and native grass with low digestibility takes a larger percentage of feeds available to most ruminants under small scale production system in the developing countries (Wanapat, *et al.*, 2009). Therefore, various improvements such as chemical, heat and biological treatments aiming at improving these fibrous feeds to improve their digestibility should be exploited.

Although, tannin has been reported to have inhibiting effects on microbial and intestinal functions (Brooker *et al.,* 1999), ruminants can consume substantial amounts of condensed tannin without apparently reducing the flow of microbial protein to the small intestines. Tannins can be fed at concentrations which protect dietary protein from wasteful degradation in the rumen without significantly affecting the efficiency of microbial digestion. However, the benefits of digestible by-pass protein are probably a function of the binding characteristics of the particular forage tannin with endogenous protein. In some cases, protection of protein in the rumen by tannins may reduce rumen ammonia levels below levels that are critical for efficient digestion of roughage diets. According to Ramirez-Restrepo and Barry (2005) and Waghorn (2008), methane emission decreased when ruminants are fed tannin-rich forages. But feed resource containing hydrolysable tannin is preferred by ruminants to condensed tannin rich feed (Derix, 2017). Several reports have been made on the ability of ruminants to tolerate tannin containing diets up to 30-50% inclusion level without negative effect (Arjona-Alcocer et al., 2012; Ruz-Ruiz et al., 2013). Therefore, tannin content of MSK in this study (2.62 mg/100gDM – 3.48 mg/100gDM) is tolerable to ruminants raised for either or dual purpose of milk and meat production.

Phytic acid is found mainly in form of phosphorus in seeds, grains and legumes. Phytate reduces the absorption of minerals from a meal. These include iron, zinc, magnesium and calcium. High concentrations of calcium (Ca) increase the anti-nutritive effect of phytic acid on mineral and trace element bioavailability and thus impede the action of phytase. This effect can in part be compensated by an increased supply of vitamin D for the animals. Also, researches which involves the use of secondary plant metabolites such as saponin and oxalates from various sources indicate a possibility of the effect of these compounds in manipulating the process of methanogenesis in the rumen (Ningrat *et al.,* 2002; Śliwiński *et al.,* 2002a; Hess *et al.*, 2003a, 2006; García-González *et al*., 2008, 2010; Wang and Chen, 2009). Processing methods goes a long way to reduce to bearable levels, the anti-nutrition factors in MSK. (Ravindran and Sivakanesan, 1996 and Diarra *et al.*, 2011) in an experiment on MSK reported that, soaking and boiling significantly reduced the anti-nutritional contents and increase the metabolizable energy content of MSK.

Ruminants readily digest phytate, due to the phytase produced by rumen microorganisms. This natural ability to digest phytate makes MSK a good feed supplement to ruminants. Anti-nutrition factors in ruminant diet has protective property on their immunity. Since antibiotics are found to have residual effects in the aftermath of their use in animal feed; reason for its ban by the European Union (Hussen E and Fasil N, 2020), these compounds (secondary plant metabolites) has better opportunity to raise healthy animals by their protective tendency. Therefore, Mango seed Kernel meal has potentials as feed supplement and immune-booster to ruminants. The mineral content and amino acid profile is a pointer to better performance in livestock production. Hence, it is recommended as supplement in ruminants diets for good meat and milk production.

Conclusion and Application

The results from this study showed mango seed kernel as profitable supplement in ruminant nutrition. The nutrient composition is capable of supplying nutritional needs of ruminants, whether for meat or milk purpose. Its use as supplement in ruminant production and management will reduce cost of production because of its availability, during mango season, (April-June). At this period, it could be gathered from various locations, processed and milled for use all year round, especially in dry season when grasses and forages are scarce and low in quality. In addition, environmental pollution, smell and disease outbreak in locations where mango wastes are heaped will be controlled since the MSK which is usually a waste would have been harnessed into animal feed. Further studies should be encouraged to ascertain MSK tolerable level for optimum performance. Since amino acids are precursors to spermatogenesis in male animals, having established their presence in MSK in this study; especially the essential amino acids, it is recommended that MSK be fed to male ruminants to investigate its effects on sperm production and quality.

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Table 1: Chemical composition of Mango Seed Kernel (MSK) in the Derived Savannah zone of Nigeria

Parameters (%)	Ikoyi Ile (T1)	Iresaapa (T2)	Odo-Oba (T3)	Ajaawa (T4)	SEM
Dry matter	83.12	81.05	84.07	82.00	0.55
Crude protein	7.60^{ab}	7.00^{c}	10.95^{a}	8.56^{ab}	0.07
Crude fibre	2.00^{b}	2.00^{b}	2.50^{a}	$2.22b^{c}$	0.08
Ether extract	10.00^{ab}	9.00^{abc}	10.51^{a}	9.20^{abc}	0.10
Ash	5.50^{b}	4.60^{c}	6.05^{a}	4.31^{cd}	0.10
Moisture	16.88^{b}	18.95^{a}	15.93^{c}	18.00^{a}	0.08
Nitrogen free extract	68.95	72.38	66.94	71.73	-
Neutral detergent fibre	52.70^{b}	46.08^{d}	55.00^{a}	48.00^{c}	1.05
Acid detergent fibre	28.55^{b}	30.05^{a}	26.65^{c}	30.00^{a}	0.95
Acid detergent lignin	12.00^{c}	14.65^{a}	10.80^{d}	13.50^{b}	1.00
Hemicellulose	24.15	16.03	28.35	18.00	-
Cellulose	16.55	15.40	15.85	16.50	-
Gross Energy(kcal/kg)	3419.50^{bc}	3425.10^{c}	3850.50^{a}	3460.45^{b}	10.05

[abcd] *Means within each row/column with different superscripts are significantly different (p<0.05)*

Table 2: Mineral composition of Mango Seed Kernel (MSK) Derived Savannah zone of Nigeria

Samples/ Location	Macro nutrients (mg/100g)				Micro nutrients (mg/100g)		
	Ca	Mg	Na	K	Fe	Zn	Cu
T1	45.50 ± 1.30^{b}	175.00 ± 2.50^{c}	310.25 ± 5.55^{b}	765.00 ± 5.00^{b}	0.78 ± 0.05^{c}	4.90 ± 0.05^{c}	0.65 ± 0.01^{c}
T2	42.33 ± 2.00^{c}	173.75 ± 4.55^{c}	310.75 ± 3.50^{b}	755.50 ± 1.00^{c}	0.76 ± 0.02^{d}	4.85 ± 0.05^{c}	0.60 ± 0.03^{d}
T3	48.75 ± 1.50^{a}	182.50 ± 3.50^{a}	315.00 ± 4.20^{a}	780.00 ± 2.25^{a}	0.90 ± 0.05^{a}	5.85 ± 0.10^{a}	0.80 ± 0.05^{a}
T4	46.05 ± 1.50^{ab}	180.25 ± 1.55^{b}	312.50 ± 3.75^{ab}	750.80 ± 3.50^{d}	0.80 ± 0.01^{b}	5.40 ± 0.08^{b}	0.75 ± 0.01^{b}

[abcd] *Means within each row/column with different superscripts are significantly different (p<0.05)*

Table 3: Selected essential amino acid profile of mango seed kernel (MSK) in the Derived Savannah Area of Nigeria

Parameters/Location (g/100g protein)	Ikoyi Ile (T1)	Iresaapa (T2)	Odo-Oba (T3)	Ajaawa (T4)	SEM
Methionine	1.85^{a}	1.25^{c}	2.00^{a}	1.65^{b}	0.02
Lysine	3.42^{b}	3.00^{c}	3.85^{a}	3.00^{c}	0.05
Isoleucine	3.33^{d}	3.45^{c}	4.25^{a}	3.88^{b}	0.03
Phenylalanine	4.35^{b}	4.42^{b}	4.50^{a}	4.47^{a}	0.10

[abcd] *Means within each row/column with different superscripts are significantly different (p<0.05)*

Table 4: Anti-nutritional factors (mg/100gDM) in Mango Seed Kernel (MSK) in the Derived Savannah Area of Nigeria

Parameters/Location (mg/100gDM)	Ikoyi Ile (T1)	Iresaapa (T2)	Odo-Oba (T3)	Ajaawa (T4)	SEM
Tannin	2.62^{ab}	3.00^{a}	3.48^{a}	3.25^{a}	0.05
Phytic acid	1.30	1.12	1.00	1.12	0.01
Oxalate	1.80^{b}	1.85^{a}	1.92^{a}	1.66^{c}	0.01