Effects of processed jackfruit seed based diet on nutrient intake, digestibility and nutrition in West African dwarf goats

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Abstract

In spite of the major role of providing meat and dairy products amongst other attributes, low animal protein intake still remains a nutritional challenge. Against this background, the effect of processed jackfruit seed meal (JFSM) as a source of protein on nutrient intake, digestibility and nitrogen balance by West African dwarf goats was investigated. The seeds were processed as raw, soaked and toasted with 5% JFSM in each processing method, incorporated in feed and designated as diets B, C and D, while diet A devoid of JFSM served as the control. Four animals were randomly assigned to the diets in a 4x4 Latin square design experiment. The goats were each housed in a metabolic cage. Data was collected on nutrient intake, digestibility and nitrogen balance. Significant ($P < 0.05$) differences were observed in nitrogen intake (g/d), nitrogen absorbed (g/d) and nitrogen balance (g/d); 7.37, 7.45, 7.40, 7.55g/d, 3.05, 3.15, 3.23, 3.40g/d and 3.66, 3.75, 3.83, 4.02g/d respectively. Similarly, apparent digestibility coefficient also showed significant difference ($P < 0.05$) in crude protein, crude fibre, ether extract and energy. Metabolic faecal nitrogen (MFN) ($\text{g}^{-1} 100\text{gDM}$) values were 1.38, 0.93, 0.38 and 1.75 for diets A, B, C and D respectively while digestible crude protein (DCP) $\text{g}^{-1} \text{d}^{-1} \text{Wkg}^{0.75}$ values were 2.13, 5.39, 2.00 and 2.45 for diets A, B, C and D respectively. This shows that the diet enhanced nutrient intake, digestibility and nitrogen utilization, thus promoting positive nitrogen balance and maintenance in goats.

Keywords: Jackfruit seed meal, processing methods, WAD goats, digestibility, nitrogen balance.

Les Effets de l'alimentation de graines de jacquier transformées sur les nutriments consommés, la digestibilité et la nutrition chez les chèvres naines d'Afrique de l'Ouest

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Résumé

Malgré le rôle majeur de fournir de viande et de produits laitiers, entre autres attributs, la faible consommation de protéines animales reste un défi nutritionnel. Dans ce contexte, l'effet de la farine de graines de jacquier transformée en tant que source de protéines sur les nutriments consommés, la digestibilité et le bilan azoté des chèvres naines d'Afrique de l'Ouest a été étudié. Les graines ont été traitées comme crues, trempées et grillées avec 5% de la farine de graines de jacquier transformée dans chaque méthode de traitement, incorporées dans les aliments pour animaux et désignées sous le nom de régimes B, C et D, tandis que le régime A dépourvu de la farine de graines de jacquier transformée a servi de témoin. Quatre animaux ont été assignés au hasard aux régimes dans une expérience de conception en carré latin 4x4. Les chèvres étaient logées chacune dans une cage métabolique. Des données ont été recueillies sur l'apport en éléments nutritifs, la digestibilité et le bilan azoté. Des différences significatives ($P < 0,05$) ont été observées dans l'apport d'azote (g/j), l'azote absorbé (g/j) et le bilan azoté (g/j) ; 7,37, 7,45, 7,40, 7,55 g/j, 3,05, 3,15, 3,23, 3,40 g/j et

3,66, 3,75, 3,83, 4,02 g/j respectivement. De même, le coefficient de digestibilité apparente a également montré une différence significative ($P < 0,05$) dans les protéines brutes, les fibres brutes, l'extrait d'éther et l'énergie. Les valeurs d'azote fécal métabolique (NPF) (g-1100gDM) étaient respectivement de 1,38, 0,93, 0,38 et 1,75 pour les régimes A, B, C et D, tandis que les valeurs de protéine brute digestible (DCP) g-1d-1Wkg 0,75 étaient de 2,13, 5,39, 2,00 et 2,45 pour les régimes A, B, C et D respectivement. Cela montre que le régime a amélioré l'apport en nutriments, la digestibilité et l'utilisation de l'azote, favorisant ainsi l'équilibre et le maintien positifs de l'azote chez les chèvres.

Mots clés : farine de graines de jacquier, méthodes de transformation, chèvres WAD, digestibilité, bilan azoté.

Introduction

Goat production is a veritable way of alleviating animal protein deficiency in Nigeria. It constitutes an important part of the livelihood of livestock farmers besides offering the cheapest source of meat Tsado *et al.* (2009) in the tropics when compared to cattle. In spite of the major role of providing meat and dairy products amongst other attributes, low animal protein intake still remains a nutritional challenge. The main constraint to goat and other livestock production is feeding (Eyoh, 2016). Feeding accounts for up to 70% of the total cost of production. Many researchers' data have pointed out that low productivity of goats is associated with problems of meeting their nutritional requirements (Babayemi and Bamikole, 2006; Aye and Adegun, 2010; Eyoh and Ayuk, 2019). The concentrate feed made from cereal grains are becoming expensive. An alternative source of ingredients which encourages a shift to those with less competition could be used especially when there are seasonal fluctuations that affects the nutritive quality of forages and their availability during scarcity periods. Thus, the use of non-conventional feed ingredients has been known to contribute in the nutrition of ruminants thereby ensuring availability of feed at critical times. Jackfruit tree which bears jack seeds grows naturally in the wild and sometimes planted as ornamental trees around homes. Despite the nutritional potential of jackfruit, there is dearth of

convincing information on its utilization for West African Dwarf WAD goats. Therefore, this study evaluates nutrient intake and digestibility in WAD goats fed differently processed jackfruit seed based diets.

Materials and methods

Location of the experiment

The research was conducted at Teaching and Research Farm of the Department of Animal Science, Akwa Ibom State University, Obio Akpa Campus. Obio Akpa is located between latitudes 5° 17'N and 5° 27'N and between longitude 7° 27'N and 7° 58'E with an annual rainfall ranging from 3500mm – 5000mm and average monthly temperature of 25°C with relative humidity between 60 – 90%. It is in the tropical rainforest zone of Nigeria (SLUS-AK, 1989).

Experimental animals and their management

Four West African dwarf bucks 6 – 9 months were used for the experiment. The animals were purchased from a reputable sheep and goat farm in Abak village and quarantined for two weeks in the farm; dewormed with Albendazole and also treated against ecto-parasites. The animals were managed intensively before confirmed to individual metabolic crates.

Experimental feed and design

The diets consisted of processed jackfruit seeds (raw, soaked and toasted); in addition to other feed ingredients. The fresh jackfruit seeds were manually removed from the

Pods and divided into three groups for processing.

Processing

For raw; 1kg of the jackfruit seed was sun dried for 60 minutes. Soaking; 1kg of the seed was soaked in 2 litres of water for 60 minutes on a hot plate was also carried out. All the groups were milled (5% each) and used for formulation (Table 1) with group A (Control) with 0% JFS. Digestibility and nitrogen balance studies were carried out in a 4x4 Latin square arrangement with 4 periods each of 10 days of adjustment periods and 5 days for collection of samples. The animals were weighed and housed individually in a clean disinfected metabolism cages which is ideal for faecal and urine collection. The diets designated A

– D, were offered daily to the animals at 3% of their body weight. Water was provided *ad libitum*. At the expiration of 10-day adjustment to the new environment, measurements were taken for a period of five consecutive days. Left over was weighed and recorded daily before morning feeding.

Total faecal output collected daily in the morning for 5 days was weighed, mixed thoroughly, bulked and sub-sampled. Further bacterial activity was prevented by adding twenty (20%) formaldehyde and then stored at -4°C. Total urine output for 24 hours was collected in plastic containers containing 10mls 0.1NH₂SO₄ which were placed under the metabolic crates. Ten percent (10%) of daily urine output taken

Table 1: Composition of experimental diets

Ingredients	A(control)	B(raw)	C(soaked)	D(toasted)
Brewer's spent grain	20.00	15.00	15.00	15.00
Rice meal	20.00	20.00	20.00	20.00
Palm kernel cake	20.00	20.00	20.00	20.00
Cocoyam	0.00	5.00	5.00	5.00
Rice bran	36.00	36.00	36.00	36.00
Oyster shell	2.00	2.00	2.00	2.00
Limestone	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50
Total	100	100	100	100
Calculated composition:				
Protein (%)	13.82	14.20	14.12	14.05
Energy (kcal/kg)	2037.6	3746.4	2712.5	2589.6
Dry matter (%)	89.71	89.78	89.47	89.58
Crude protein (%)	15.73	15.64	15.84	15.53
Ether extract (%)	3.78	3.86	4.02	3.74
Crude fibre (%)	9.66	9.77	9.57	10.14
Ash(%)	8.91	9.48	8.68	8.81
NFE(%)	51.65	51.25	51.36	51.37
G.E(kcal/kg)	3.98	3.99	3.97	3.99

Table 2: Proximate composition of experimental diets, *Andropogon tectorum*

Parameters	A(control)	B(raw)	C(soaked)	D(toasted)	<i>Andropogon tectorum</i>
Dry matter (%)	89.85	89.96	90.06	90.10	94.00
Crude protein (%)	15.44	15.64	15.52	15.84	11.20
Ether extract (%)	3.84	3.95	4.06	4.10	25.00
Crude fibre (%)	9.51	9.44	9.60	9.37	3.20
Ash (%)	5.27	5.21	5.36	5.24	12.50
Nitrogen free extract	55.80	55.73	5.36	5.24	12.50
Gross energy (kcal/kg)	4.02	4.03	4.01	4.03	18.4

from each buck was stored in a refrigerator for analysis.

Proximate analysis

Feed samples were oven-dried at 70°C for 48 hours and milled through a 2.5mm sieve. Dry matter content of the dried feed samples and faeces were determined by drying at 60 °C for 48 hours. Nitrogen content of the feed samples and urine were determined using AOAC (2000) procedures. Similarly, ether extract and crude fibre of the samples were analyzed according to AOAC (2000) procedure, while the other samples were charred in muffle furnace at 500 °C for about 3 hours.

Statistical analysis

Data collected during feeding and digestibility were subjected to a one-way analysis of variance (ANOVA) procedure (AOAC, 2000). Duncan's Multiple Range Test (DMRT) was used to compare treatment means where there were significant differences (Duncan, 1955).

Results and discussion

The dry matter intake, nitrogen intake, digestibility and nitrogen balance by WAD goats fed processed jackfruit seed meal are presented in Table 3. There were significant ($P<0.05$) differences observed in all the parameters except for final weight. The values for dry matter intake (DMI) were 63.75, 69.17, 54.17 and 52.97g/day. The least value (52.97g/day) was obtained in diet D (toasted). Dry matter intake (DMI) is an important factor determining the utilization of feed in ruminants which simply referred to critical determinant of energy intake (Devendra, 1997). Feed intake on the other, is a measure of diet appreciation, collection and consumption by an animal (Masafu, 2006). Processing methods may also affect intake as observed in this study where the DMI showed no consistent trend but recorded the least in

diet D (toasted). However, the crude protein intake increased with the processing methods which is in line with observation of Hwangbo *et al.* (2009) that increasing or decreasing crude protein intake levels had no significant effect on dry matter intake. Nitrogen intake values showed a consistent trend as they increased across the treatments for processing as compared to the control group. The values were 7.37, 7.45, 7.40 and 7.55 for diets A – D respectively. These values were however lower than 13.28 – 15.68 reported for WAD goats fed mucuna seed meal (Ukpabi, 2007). It was evident from the result of this study that the processing method employed to reduce the anti-nutritional factors of jackfruit seed was effective, hence enhanced nutrient intake. Nitrogen in faeces for the processing methods were comparable with the control diet. The highest faecal nitrogen obtained in goats on diet B (raw) could probably be due to the crude protein content that was not well utilized and thus excreted. This conforms with the report of Kerchegessner *et al.* (2001) that nitrogen consumed in excess of animal requirement was excreted in urine and faeces. The N-urine value (g per day) obtained in this study ranged from 0.59g/day – 0.61g/day. The N-urine values were also comparable across the treatment groups. This may have been due to a reflection of nitrogen in the rumen that depends on the quality and solubility of the diets, which might have been lost from the rumen as ammonia and converted to urea before being excreted as urine. The N-balance and N-absorbed followed a similar trend of increase across the treatment groups. The values ranged from 3.05 – 3.40g/day and 3.66 – 4.02g/day

respectively. The highest values (3.40g/day and 4.02g/day) were recorded in toasted processing method respectively. Nitrogen absorbed is the proportion of nitrogen utilized by farm animals for body process from nitrogen intake hence more nitrogen consumed and digested also results in more nitrogen being absorbed. Okeniyi *et al.* (2010) reported that this observation might have been as a result of the amount of nitrogen used in protein deposition and nitrogen utilization in the rumen. The relationship between faecal nitrogen (gK^{-1}DM) and N-intake (gday^{-1}) is shown in Table 4. Except for diet C which was not

significant, other jackfruit seed meal processing methods had higher coefficient of correlation than diet A and were also significant. The intercept of the line relating faecal nitrogen to N-intake gave the nitrogen excreted in faeces for each diet when the nitrogen intake was hypothetically zero, i.e. the (MFN) metabolic faecal nitrogen. The mean MFN value of $1.10 \pm 0.1\text{g}100\text{g}^{-1}\text{DM}$ obtained in this study for jackfruit seed meal based diets is slightly higher than $0.97 \pm 0.88\text{gN}^{-1}100\text{g DM}$ reported by these researchers (Akinsonyinu, 1974; Odoemelum *et al.*, 2005; Ukpabi, 2007).

Table 3: Dry matter intake and nutrient digestibility of WAD goats fed processed jackfruit seed meal

Parameters	A	B	C	D	SEM
Final weight (kg)	7.20	7.40	7.20	7.87	1.10
Finale weight ($\text{kg}^{0.75}$)	4.90	4.47	4.39	4.68	0.05
DMI (g/day)	63.75 ^b	69.17 ^a	54.17	52.97 ^c	1.20
DMI ($\text{W/kg}^{0.75}$)	22.56 ^b	23.65 ^a	19.97 ^c	19.63 ^c	0.04
CP intake (g/d)	54.47 ^d	55.90 ^c	57.00 ^b	59.70 ^a	0.46
N-intake (g/d)	7.37 ^c	7.45 ^b	7.40 ^c	7.55 ^a	0.02
N-faeces (g/d)	3.71 ^a	3.69 ^a	3.57 ^b	3.53 ^c	0.00
N-urine (g/d)	0.61 ^a	0.60 ^b	0.59 ^b	0.61 ^a	0.43
N-absorbed (g/d)	3.05 ^d	3.15 ^c	3.23 ^b	3.40 ^a	0.03
N-balance (g/d)	3.66 ^d	3.75 ^c	3.83 ^b	4.02 ^a	0.03
N-balance ($\text{g/d/Wkg}^{0.75}$)	2.31 ^c	1.37 ^c	2.41 ^b	2.51 ^a	0.02
N-intake ($\text{g/d/Wkg}^{0.75}$)	4.47 ^b	4.51 ^a	4.49 ^b	4.55 ^c	0.01
N-absorbed ($\text{g/d/Wkg}^{0.75}$)	2.65 ^d	2.70 ^c	2.74 ^b	2.83 ^a	0.02
Apparent digestibility %	49.68 ^c	50.38 ^c	51.67 ^b	53.22 ^a	0.44

^{a, b, c} means in a row with different superscripts are significantly ($P < 0.05$) different.

SEM: Standard Error of Mean

Table 4: Regression equation between faecal-N(g/d) (Y) and N-intake (g/d) (X) in WAD goats fed processed jackfruit seed meal

Diets	Regression equation	Correlation coefficient ®	Standard error (SE)	Faecal –N at zero N-intake	MFN ($\text{g}/100\text{gDM}$)
A	$Y = 13.79 - 1.37X$	0.923*	0.010	13.79	1.38
B	$Y = 1.75X - 9.34$	0.986*	0.004	9.34	0.93
C	$Y = 100X - 3.83$	1.000 ^{NS}	0.000	3.83	0.38
D	$Y = 2.76X - 17.32$	0.974*	0.011	17.32	1.75

MFN: Metabolic faecal nitrogen, ^{NS} = not significant.

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The relationship between urinary-N ($\text{g/day Wkg}^{0.75}$) is presented in Table 5. The two parameters considered here in this study were positively correlated except for diet C. The coefficients of correlation were 0.986, 0.143, 1.000 and 0.974 for diets A – D respectively. Similarly, the endogenous urinary nitrogen (EUN) values were 4.08, 3.08, 3.13 and 1.81 for diets A, B, C and D respectively. The intercepts on the urinary-N axis gave the urinary-N at zero N-absorption which is the EUN. Akinsonyinu (1974) reported that variation in the value of EUN observed within the breed may be due to urea recycling effect and this is also suggested by previous authors (Onwuka *et al.*, 1985; Eyoh, 2016). Indicated in Table 6 is the relationship between balance (g^{-1}day

$\text{Wkg}^{0.75}$) and absorbed nitrogen. There was high correlation in the two parameters for all the diets with diets B and D being significant. The gradient of line relating N-balance to absorbed nitrogen showed the biological value (BV) while the absorbed N at zero N-balance multiplied by a factor 6.25, gave the digestible crude protein (DCP) requirement Mba *et al.* (1975) for maintenance. The comparable biological values recorded in this study is indicative of better utilization of N across treatments. Meanwhile, the mean value of DCP $2.99\text{g DCP}^{-1} \text{Wkg}^{0.75}$ obtained in this study is higher than $1.7\text{g DCP}^{-1} \text{Wkg}^{0.75}$ Hadjipanayiotou (1988) and $0.51\text{gday}^{-1} \text{Wkg}^{0.75}$ Onwuka *et al.* (1985) for WAD goats.

Table 5: Regression and correlation coefficients between urinary nitrogen (g/d(Y)) and absorbed nitrogen ($\text{g/d/Wkg}^{0.75}\text{(X)}$) in WAD goats fed processed jackfruit seed meal

Diets	Regression equation	Correlation coefficient ®	Standard error (SE)	Faecal –N at zero N-intake	MFN (g/100gDM)
A	$Y = 4.08 - 3.5X$	0.986*	0.004	4.08	4.08
B	$Y = 3.08 - 1.0X$	-0.143*	0.020	3.08	3.08
C	$Y = 3.13 - 1.0X$	1.000 ^{NS}	0.000	3.13	3.13
D	$Y = 1.81 + 2.5X$	0.974*	0.004	1.81	1.81

EUN = Endogenous urinary nitrogen; ^{NS}= not significant

Table 6: Regression analysis and correlation coefficients between nitrogen balance ($\text{g/d/Wkg}^{0.75}\text{(Y)}$) and absorbed nitrogen ($\text{g/d/Wkg}^{0.75}\text{(X)}$) in WAD goats fed processed jackfruit seed meal

Diets	Regression equation	Correlation coefficient (r)	Standard error	N – absorbed at zero - N balance	Biological value (BV)	DCP for maintenance ($\text{g/d/Wkg}^{0.75}$)
A	$Y = 0.340 + 1.00X$	1.000 ^{NS}	0.000	0.340	0.96	2.13
B	$Y = 1.50X - 0.862$	0.929*	0.004	0.862	0.96	5.39
C	$Y = 0.320 + 1.00X$	1.000 ^{NS}	0.000	0.320	0.96	2.00
D	$Y = 0.392 + 0.974X$	0.896*	0.008	0.392	0.97	2.45

DCP = Digestible crude protein, ^{NS} = not significant

Table 7 reveals the dry matter (DM) and nutrient digestibilities of WAD goats fed processed jackfruit seed meal based diets. There were significant ($P < 0.05$) differences in the apparent digestibility of dietary CP, CF, EE and Gross energy except for DM and NFE. The dry matter digestibility though not significantly

different were comparable among the treatment groups with the highest (87.63%) value obtained in diet D (toasted). This may have been that toasting enhanced palatability of the meal hence increase in intake. Dry matter digestibility is negatively correlated with dry matter intake (McDonald *et al.*, 1995). The values for

crude protein digestibility were 48.33, 47.11, 49.95 and 50.08 for diets A, B, C and D respectively. The result reveals that jackfruit seed meal based diets had better crude protein digestibility than diet A except for diet B. The highest crude protein digestibility coefficient (50.08%) was obtained in diet D. This implies that jackfruit seed meal enhanced digestibility

of crude protein. Crude fibre digestibility and ether extract digestibility followed a consistent trend. The values were 50.80, 50.28, 50.01, 52.72 and 55.10, 57.39, 57.28 and 56.64 for diets A – D respectively. Crude fibre is a component of dry matter, hence any factor affecting the dry matter also affects the crude fibre of that same feed (Ahamefule, 2005; Eyoh, 2016).

Table 7: Apparent Digestibility coefficient (%) of WAD goats fed processed jackfruit seed meal

Diets	A(Control)	B(Raw)	C(Soaked)	D(Toasted)	SEM
Dry matter	75.65	75.66	81.23	87.63	5.50
Crude Protein	48.33 ^b	47.11 ^c	49.95 ^a	50.08 ^a	0.22
Crude fibre	50.80 ^b	50.28 ^b	50.01 ^b	52.72 ^a	0.60
Ether extract	55.10 ^b	57.39 ^a	57.28 ^a	56.64 ^a	0.40
NFE	74.08	74.07	74.08	74.16	0.20
Energy	69.32 ^c	69.28 ^c	69.55 ^b	69.85 ^a	0.03

^{-a, b, c,} means on the same row with different superscripts differ significantly (P<0.05)

SEM: Standard Error of Mean

Nitrogen free extract (NFE) digestibility values which did not differ (P<0.05) significantly were 74.08, 74.07, 74.08 and 74.16% for diets A, B, C and D respectively. The comparable NFE digestibility values in this study suggests that there was proper utilization and digestion by the animals across all the treatment groups. However, the values reported in this work contradicts with the reports of these researchers; (Onwuka and Akinsoyinu, 1985; Lamidi *et al.* (2010). Energy digestibility co-efficient of the diets were significant and comparable among the treatment groups. The values were 69.32, 69.28, 69.55 and 69.85 for diets A, B, C and D respectively. The highest 69.85kcal/kg was obtained in diet D.

The values for apparent N-digestibility (%) (Table 3) were 49.68, 50.38, 51.67, 53.22 for diets A, B, C and D respectively. The result shows that jackfruit seed based diet gave better apparent digestibility than the control diet which is plausible reason for better utilization.

Conclusion

The study showed that processed jackfruit

seed meal can be included in feeding West African dwarf goats as it enhanced nutrient intake, digestibility and nitrogen utilization.

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