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DIGESTIBILITY AND NUTRIENTS INTAKE TRIALS ON NEW ZEALAND WHITE RABBIT AND THEIR CROSSES FED GROUPED AMOUNTS OF TIGERNUT (*Cyperus esculentus*)

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ABSTRACT

The study was carried out to determine the feed intake and nutrients digestibility of tigernut meal fed to New Zealand White rabbit and their crosses. Twenty four (24) bucks with a mean body weight of 523g were used within the period of twelve (12) weeks. Experimental bucks were allotted into three dietary treatments using 2×3 factorial in a Completely Randomized Design (CRD). The treatments are; T1 (control 0% tigernut), T2 (3% tigernut) and T3 (6% tigernut). The results revealed that an increase in the level of tigernut inclusion significantly increases the dietary protein (CP). T3 had the highest mean value (35.08) for Crude fibre (CF), and Ash values (6.53) whereas T2 recorded the highest mean value (9.60) for Ether extract (EE). T1 had the highest mean value for Dry Matter (DM), (94.80), Crude Protein (CP) and nitrogen free extract (NFE). T1 had the highest mean values (10.67) for CP Content. The CP intake value was significantly higher in T3 compared to other treatments. The digestibility result revealed significant difference on DM (with T2 having highest mean value of 85.85), CF (T2 having the highest mean value of 66.17), EE (With T1 having the highest mean value of 54.77), while no significant difference was observed on CP and Ash. It could be concluded from these results that tigernut can be used as energy and protein sources in the diet of New Zealand white and crosses rabbit. More trials should be conducted to further elucidate the replacement value of tigernut as feed ingredient.

Keyword: Feed intake; Digestibility; Tigernut; Proximate analysis; New Zealand white rabbit

INTRODUCTION

Protein deficiency continues to be the major problems of the developing countries. Likewise the Nigerian population also, was marked by inadequate intake of protein both in the quality and quantity (De Vries-Ten Have *et al.*, 2020). The average daily protein intake is still far less than 35g per adult per day as recommended by (FAO, 2021). Animals protein source have the nutritional advantage of being rich in amino acid which were useful to human body than those of plant origin (Beski *et al.*, 2015).This resulted in high demand of protein from animal source, and makes it more expensive than the protein sourced from the plants. Therefore efforts are being directed towards exploring all reasonable options to meet the recommended level at an affordable price (Ojebiyi *et al.*, 2006). This made it vital to avail cheaper and faster ways of attaining necessary required for normal body growth and functions.

To encounter the recommended level of animal protein supply in Nigeria, rabbit should be intensively produced because of the high price of beef, mutton, pork, and chicken. Bamgbose *et al.* (2004) Also supports the necessity of exploring other unusual but prospective animal protein sources like rabbits. The advantages projected in rabbit production include high quality nutritious meat, high feed conversion rate, lest production cost, short gestation period, rapid maturity, and low dependence on humans food (Gebremedhin, 1991). Colin and Lebas (1996) Reported that rabbit production is relatively important to the economy of some developing countries including Nigeria. Furthermore, the meat of rabbit prevents vascular diseases due to its low content of sodium and cholesterol; this makes the meat a good animal protein source for people on low sodium diet and chronic heart patients (Rasinska *et al.*, 2018). Intensive rabbit production however, was faced with many difficulties like feed shortage, expensive feed ingredients, particularly the conventional protein and energy ingredient like Groundnut cake and Soybean cake (Khan *et al.*, 2016). This has been blamed on the competition between man and livestock for conventional feedstuff. This has necessitated scientist to explore ways of replacement of such costly feed ingredients with cheaply available feed ingredients. Consequently, more attention should be paid to uncommon unconventional feedstuff like tigernut (*Cyperus esculentus*). Tigernut was described as noxious, invasive and injurious weed in the tropic and temperate zones (Asare *et al.*, 2020).

The nuts (of tigernut) was highly bestowed with an exceptional nutritional qualities having a fat content like that of olive oil (Ezeh *et al.*, 2014). The nuts were as well highly rich in minerals such as potassium and phosphorus (Gambo and Da'u, 2014). They added that nutritive content of tigernut varies greatly among species, cultivars within species, and growth among the cultivar. The yellow variety was favored over others due to its superior qualities among which were; fleshier body, attractive color and big size. Henceforth, this variety contained more protein, more milk during extraction, low fat and more importantly less anti-nutritional factor (Ayo *et al.,* 2016). Recent studies indicated that residue or the whole plant is high in energy, fair in amino acids composition with little or no-tolerable allergens and serves as a useful ingredient in livestock feeds (Belewu and Abodunrin, 2008). Bamgbose *et al.* (2003) Reported better carcass yield and low cost of feed consumed when 33.3% of tigernut was used to replace maize in the diet of cockerel. (Belewu *et al.,* 2007) also discovered that the West African dwarf goats gain more weight in tigernut seed meal diet than those on control. The effect of tigernut meal on rabbit feeds was only evaluated by (Ekpenyong *et al.,* 2020) who uses high percentage of about 40% which according to (Elkin *et al.,* 1991) reduce growth rate of livestock due to reduce protein and specific amino acids utilization. Thus, the high potential of the tigernut as rabbits feed, its availability all year round at low cost and the gap left by the researchers inspired this study. The aim of the current study was to determine the nutrient digestibility and feed intake of New Zealand white rabbit and Crosses rabbit fed varying levels of tigernut diet.

MATERIALS AND METHODS

Experimental Area.

The study was conducted at the University Teaching and Research Farm of Department of Animal Science, Faculty of Agriculture, Bayero University, Kano, New site. Kano State was located $11^0 99^1$N latitude, and $8^0 51^1$E longitude. The annual temperature ranges between 38^0C to 43^0C whereas relative humidity lies between the ranges of 40% to 52% (Muhammad *et al.,* 2020).The area experienced the tropical wet and dry climate. Yearly precipitation ranges from 787mm – 960mm (Kawo, 2012). Rainy season begins from May and lasted till September while dry season starts on October and ends in April.

Experimental animals and Management.

The bucks were purchased from the National Animal Production Research Institutes (NAPRI), Shika, ABU, Zaria, Kaduna State. Twenty four bucks with a mean weight of 523g were used throughout the study. The bucks were caged, antibiotics prophylaxis was given using *Keproceryl*®. Dewormed using Albendazole at the dose rate of 7.5mg/kg body weight. The bucks were quarantine for two weeks prior to the commencement of the experiment. House sanitation was also carried out on daily basis during the course of the experimental period. Feeders and drinkers were thoroughly washed and clean everyday all over the experimental period. The Bucks were injected with Ivermectin at (0.2ml/kg body weight) subcutaneously against Ecto and Endo parasite. The animals were fed with the formulated diet every morning. Water was given to the animals *ad libitum*. The rabbits were aged between two to three months. The experiment lasted for about 12 weeks. The rabbits were individually housed in a wire cage, of size 38cm length × 33cm breath × 45cm height. The cages were raised 45cm above the ground to facilitate easy cleaning. Each cell of the cage was equipped with plastic drinkers and metal feeding trough. A trough was placed under each cage to collect feces and urine of each individual rabbit.

Experimental Design and treatment.

Two different breeds of rabbits (New Zealand white and Crosses rabbit) were used for this study and considered as Factor A and B. Experimental animals were assigned into three dietary treatments using 2x 3 factorial experiment in a completely randomized design (CRD). There were two breeds of rabbits (New Zealand white rabbit (n=12), crosses rabbit (n=12)) fed with 3 different feeds with graded levels of tigernut inclusion 0%, 3%, and 6%. Hence 2×3 factorial experiment. New Zealand white rabbit and crosses rabbit were divided in to 3 treatments each with four animals (Replications) each per treatment.

Digestibility trial.

Digestibility study was performed at the finale of the trial. Sample from each treatment were used for the digestibility study. Fecal samples were collected for a period of 7 days using polythene bags and dried under shade. At the end of the collection period, samples from each treatments were bulked thoroughly; mixed and 5% of the total fecal was collected and used for chemical analysis in the laboratory.

Feed intake.

Experimental animals were given the diet in the morning at 8:00am and basal diet was given *ad-libitum* throughout the experimental period, leftover feed was measured on daily basis. The animals were served with 100g of the formulated feeds accordingly, and daily feed intake was determined by reducing the leftover feed from 100g and the data generated was subjected to analysis. Table 1 below shows the composition of the experimental diet.

Table 1 Composition of the experimental diet (%)

Ingredients	T1	T2	T3
Tigernut meal	0%	3%	6%
Soya bean meal	17	18	18
Wheat offal	23	20	20
Maize bran	28.75	29.75	29.75
Rice bran	30	28	25
Bone meal	0.30	0.30	0.30
Premix	0.25	0.25	0.25
Salt	0.30	0.30	0.30
Methionine	0.25	0.25	0.25
Lysine	0.15	0.15	0.15
Total	100	100	100
Cal Energy cal/Kg	2097	2072	2034
Cp (%)	16.00	16.10	16.20

Chemical analysis.
The 5% of the dried fecal sample was taken to the laboratory to determine the Dry matter, Crude protein, and Crude fiber, Ether Extract, Nitrogen Free Extract, ADF, ADL, HC and C according to the procedure described by (AOAC, 2012).

Data analysis.

The Data was subjected to analysis of variance (ANOVA) using the SAS package (2002), where significant difference observed means were separated using least significant difference (LSD).

RESULT AND DISCUSSION
The result of proximate composition of tigernut was presented on Table 2. The result depicted that tigernut contained 90.50% dry matter, 8.37% crude protein, 12.28% crude fibre. 65.43% nitrogen free extract, 9.35% ether extract and 4.58% ash. Table 3 Present the proximate composition of the experimental diets, fed to two rabbits breeds. The variable was Dry matter, Crude protein, Ash and Nitrogen free extract Significant ($P < 0.05$) different was observed among the treatments. Treatment three had the highest mean value (35.08) for Crude fibre, and ash values (6.53) whereas Treatment two recorded the highest mean value (9.60) for Ether extract. Treatment one had the highest mean value (94.80) for dry matter, crude protein and nitrogen free extract. Treatment one had the highest mean values (10.67) for CP Content whereas Treatment two mean values (10.17) and treatment three recorded the least mean values (7.11). The result revealed decreasing dry matter and crude protein contents as the inclusion levels of tigernut meal increased in the diets while crude protein increased across the treatments. 3.3. Performance of two breeds of rabbits fed tigernut diet.

The growth performance of two breeds of rabbits fed tigernut diet results are presented on Table 4. The results revealed that there was no significant ($P > 0.05$) difference among the treatments observed. Significant difference was observed among the treatments of the nutrient digestibility of New Zealand white rabbit and Crosses rabbit fed graded levels of tigernut diet. Dry matter digestibility (DMD) was significantly higher ($P <0.05$) in Treatment two (85.85) whereas treatment three having the lowest mean value (77.33). There is no significant difference in crude protein digestibility among the treatments. The highest CP value was obtained in treatment two (63.18). Crude fibre digestibility was significantly differed among the treatments. Treatment two recorded the highest value (66.17) for CF whereas treatment one had the lowest mean value (46.8). Ether Extract digestibility was also significant ($P > 0.05$) difference was observed among the treatment. Treatment one has the highest mean value (54.77) whereas treatment two and three had the lowest mean value (50.48). No significant ($P > 0.05$) difference was observed among the treatment two and three for Ash digestibility. Treatment one had the lowest mean value (49.17) for Ash digestibility while treatment two had the highest mean value (74.74) which was significantly higher ($P < 0.05$) as compared to other treatments. Treatment one is had the lowest mean value (55.67) for NFE.

The result obtained for proximate composition of tigernut meal differed significantly ($P < 0.05$) among the treatments observed. The result was contrary to the finding of (Oderinde and Tairu, 1988) who reported the lowest mean values for moisture, crude protein, crude fibre and Nitrogen free extract when compared to values obtained in the present study. Similarly the values reported by

(Oderinde and Tairu, 1988) for ether extract was significantly higher than the values reported in the present study. The disparities could probably be due to location of study, inherent error, variety used in the study, type of tigernut used (dried or fresh one). The current result point out that inclusion of tigernut at 6% improved the crude protein intake as compared to other levels of inclusion.

Crude protein content could be a single nutrient that could determine the quality of feed as reported by (McDonald *et al.,* 2010). The higher level of crude fibre (66.17) obtained in treatment two of this study was probably due to the crude fibre content of the maize offal used, while lower value in the rest of the treatment was probably due to the inclusion of tigernut meal base diet. This is in contrast with the report of (Sánchez-Zapata *et al.,* 2009) who reported that inclusion of tigernut in rabbit diet increased the fibre content and contributed to bulkiness of the feed. The variation in Ash content from 67.11% in treatment two to 49.17% in treatment one could be attributed to the higher proportion of tigernut, a tuber rich in mineral content (Oderinde and Tairu, 1988).

The crude protein digestibility obtained fell within the range reported by (Belewu and Abodunrin, 2008) whose values range between 76% and 80.96%. The dry matter digestibility value obtained in the present research, 85.85% - 65.37% was in agreement with earlier report of 78% to 80% by (Wallace, 1994). Result from present study reveals that crude fibre digestibility decrease with increase in crude fibre content which is in agreement with (Cheeke *et al.,* 1986) that reported that high fibre content inhibited digestibility. The ash and ether extract digestibility value obtained were within the range reported by (Aduku and Olukosi, 1990). The disparities observed in this research may be due to breed and age variation. Likewise climatic condition might be a contributing factor as reported by (Eberhart, 1980).

Table 2 Proximate composition of tigernut meal

Parameters	Proportion (%)
Dry matter	90.50
Crude protein	8.37
Crude fiber	12.28
Nitrogen free extract	65.43
Ether extract	9.35
Ash	4.5

Table 3 proximate composition of the experimental diet (%).

Parameters	Treatments			
	T1	T2	T3	SEM
Dry matter	94.80^{a}	94.60^{a}	93.51^{b}	2.58
Crude protein	10.67^{a}	10.17^{a}	7.11^{b}	5.17
Crude fibre	12.08^{c}	21.58^{b}	35.08^{a}	2.77
Ether extract	8.55^{b}	9.60^{a}	7.40^{c}	2.70
NFE	63.34^{c}	52.85^{b}	43.89^{a}	1.01
Ash	5.38^{a}	5.80^{b}	6.53^{c}	6.45

^{abc}= Means with different superscripts differ significantly (P< 0.05). SEM = Standard error of means

Table 4 Nutrient digestibility of New Zealand white and crosses rabbit fed graded level of tigernut meal

Parameters	Treatments			
	T1	T2	T3	SEM
Dry matter	65.37^{c}	85.85^{a}	77.33^{b}	1.23
Crude protein	53.52^{b}	63.18^{b}	53.24^{b}	3.06
Crude fibre	46.80^{c}	66.17^{b}	58.29^{a}	2.02
Ether extract	54.77^{b}	50.48^{a}	50.48^{c}	2.62
Ash	49.17^{b}	67.11^{a}	67.11^{a}	0.87
NFE	55.67^{c}	74.74^{a}	66.08^{b}	1.18

^{abc}= Means with different superscripts differ significantly (P < 0.05) different. SEM = Standard error of means

CONCLUSION

The result obtained from this study shows that tigernut could supply good protein and increase bulkiness of the feed when fed as complete diet to New Zealand white rabbit and crosses rabbit without deleterious effects on growth performance. The result of the study showed that animals in treatment three had higher feed intake compared to other treatments. The study shows that tigernut is highly palatable and acceptable to enhance the performance of the rabbits.

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