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Meat attribute of rabbit fed inclusion of sunflower (*Tithonia diversifolia*) in their diet

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Abstract

Rabbit consumption and production in Nigeria cannot be compared with poultry and beef consumption and production. Inclusion of rabbit meat in our diet could help to solve the problem of shortage of protein consumption by alternating Sunflower (*Tithonia diversifolia)* in rabbit diet. Thirty – two male growing (weaners) rabbit at 6 weeks old of 9.5 -10kg were reared for 10 weeks. They were randomly allocated to four treatments containing; T1 (100% tridax), T2 (100% compounded feed), T3 (50% compounded feed and 50% *Tithonia diversifolia)* and T4 (100% *Tithonia diversifola),* to evaluate for proximate, minerals and palatability status in a completely randomized design. Results shows that T3 had the highest protein content (36.54%) and least significant moisture content (52.80%) ($p<0.05$) than T1, T2 and T4, for proximate composition. Mineral composition had no significant difference ($p>0.05$) for all the treatment evaluated. When the shoulder and the thigh nutrients are compared, the shoulder was observed to have the higher protein content of 33.68%, ash content of 1.11% and lower moisture content of 51.55% than the thigh with, 32.67% protein content, 0.97% ash content and highest ($p<0.05$) 58.21% moisture content. When samples were processed, grilled products had the highest protein content of (45.50%), ash (1.54%) and ether extract (9.69%) with least moisture content of (36.17%) compared with the fresh and boiled samples significantly, ($p<0.05$). For acceptability, the panellists rated T1 for both boiled and grilled products highest, followed by T3 for both products and T2 for only grilled product, significantly and also rated boiled (6.03) to grilled products (5.79). Rabbit fed 50% inclusion of *Tithonia diversifolia* in their diets performed better in proximate composition and palatability status.

Key words: *Tithonia diversifolia*, *shoulder muscle*, *thigh muscle*, boiled and grilled products

1. Introduction

In order to bridge the gap of dismally low protein intake in developing countries, some steps should be taken. One of such necessary steps is the utilization of micro livestock like rabbit. This is because it can supply high quality animal protein and attracts low costs of production, has small size, ability to utilize forage, short gestation interval, high facundity and rapid growth rate.

There is need to improve rabbit production in Nigeria for increased supply of animal protein due to high cost of chicken, pork and beef, exploring other forms of meat like quail, snail, and rabbits, can increase consumer's protein intake. Bamgbose *et al.* (2004) supports the necessity of exploring other less common but potential sources of animal protein such as rabbits. Rabbit meat production has been on the increase in Nigeria in recent years. The rabbit (*Oryctolagus cuniculus*) is one of the most productive meat producing among all domesticated animals. The feeding habits offer no appreciable competition with man, and this is because it can substitute on green as basal diets. The combinations of these characteristics are unique. In addition to this, rabbits have a number of other characteristics that might be advantageous to subsistence farming system, such as their small body size, short generation interval, with a relatively short gestation period average of 30 - 31 days. The daily weight gain is high in proportion to the body weight which gives them a rapid growth rate, and sexual maturity is early. Rabbit reaches the weight of a sexually mature animal 30% faster than other animals (Ajayi *et al.* 2005) and also make rabbits suitable as meat producing small livestock in developing countries (Arijeniwa *et al*. 2000).

One reason for the acute shortage of animal protein in the diets of most Nigerians is inadequate supply and exorbitant cost of conventional feed ingredient leading to high cost of meat and animal products such as beef, mutton, goat meat, poultry eggs and milk. Rabbits have been recommended as having the best productive advantages to bridge the protein deficiency gap (Taiwo *et al.* 2005). Similarly, Iyeghe – Erakpotobor *et al.* (2002) reported that increased rabbit production is one sure way of meeting the animal protein requirements of the populace. Akinmutimi & Ezea, (2006) stated that conventional feeds account for about 70% of the total cost

of rabbit production making them expensive to most farmers. And so, alternating other cheap foliage plants in rabbit feed to reduce feed cost and to build up rabbit muscle so as to affect consumer protein intake positively.

But alternating rabbit feed with other available non- human competitive foliage's with little or no cost implication could help reduce cost of feeds and also have a positive impact in the meat attributes and rabbit production as a whole. Studies have reported on the effect of feeding the sunflower to rabbits, the leaves of tropical grasses and forage legumes are excellent sources of protein, vitamin and xanthophyll's. Sunflower is of high nutritional value, containing all the known essential amino acid and also is rich in minerals and vitamins especially the B-complex vitamin (Day1954).

The enormous potential of rabbits in alleviating animal protein inadequacy in developing economies is hinged on its attributes. These include; ability to thrive well on forages, high reproductive potential with short gestation period, early maturity, highly prolificacy and ability to re–breed shortly after kindling (Odimba 2006). Egbo *et al.* (2000) reported that rabbits are efficient converters of feed to meat and utilize up to 30% fibre as against 10% by most poultry species. Thus, the daily weight gain of rabbit is high in proportion to the body weight which gives them a rapid growth rate before sexual maturity. Nutritionally, rabbit meat is high in protein but low in fat and cholesterol, and highly digestible with dressed weight of 82 to 85% (Yusuf *et al.* 2011). The potential of forages as feed for rabbit is of particular significance because of their availability and ability of rabbits to effectively digest leaf protein (Bello 2003).
This study will therefore determine rabbit meat qualities fed *Tithonia diversifolia* as inclusion in their diet.

2. Materials and Methods

2.2 Experimental Animal
Thirty-two (32) male weaners of New Zealand rabbit were used for this study. They were given vitamins on arrival at the Teaching and Research farm, Department of Animal Science, Ejigbo Campus, Osun State University, Osogbo Nigeria. The initial weight of the animals was obtained and the animals were acclimatized for two weeks before the commencement of the experiment for additional 8weeks. The animals were managed intensively and daily routine management was carried out.

2.3 Feeding of experimental animals
The animals were kept in individual ventilation cages measuring 57 x 53 x 60cm in the Departmental rabbit house. The cages were identified by rabbit treatment and replicate number. The animals were randomly allocated to four dietary treatments groups.

T1- 100% *Tridax* only (Control).
T2- 100% *Tithonia diversifolia* only.
T3- 50% Finished feed and 50% *Tithonia diversifolia* .
T4- 100% *Tithonia diversifolia*.
There were four (8) rabbits per treatment, and individual initial body weights of the experimental rabbits were recorded by weighing them using a digital weighing scale before allocating them to the experimental diet. Feeding was done twice per day at 0800 hr and 1500 hr

Table 1: Composition of the compounded feed

INGREDIENTS	PERCENTAGE
Maize	30.00
Soya Bean Meal	16.00
Wheat bran	18.15
Bone meal	2.00
Periwinkle shell	1.00
Premix	1.00
Salt	0.35
Palm Kernel Cake	31.50
TOTAL	100.00
Crude protein	19.00
Energy (ME Kcal/kg)	2450.00
Methionine/ cysteine(%)	0.68

Lysine 1.04

2.3 Slaughter procedure

Twenty - four (24) rabbits, 6 per treatment were selected randomly for slaughtering. The animals were slaughtered at the end of the 10th weeks of the experiment. Before slaughter, both feed was withheld for twenty - four hours. Animals were slaughtered by dislocating the neck and bleeding by severing the jugular veins and carotid arteries using a sharp knife. The skin was then pulled out. Evisceration was done by slitting the abdominal wall of the skinned animal longitudinally using a sharp knife.

2.4 Processing method

The thigh muscles and shoulder muscles of the four {4} treatments were removed from the replicates and each was weighed before dividing it into three (3). i.e the muscles for fresh, boiled and grilled. Samples were boiled at 100 ^{0}C, for 20 minutes while grilled samples were carried out using the grilled machine at 105 ^{0}C for 20 minutes

2.5 Proximate Analysis

Samples were analysed chemically according to the official methods of analysis described by the Association of Official Analytical Chemist (AOAC.18TH EDITION 1999). To analysed for the protein, the ash, the ether extract and the moisture content.

2.6 Palatability Parameters

40 trained staffs and students of the Department who were known for their past records in evaluating sensory test were used. Boiled and grilled meat samples were presented sequentially to the panellists on clean odourless saucers under a white florescent light and each meat sample was evaluated independently. The panellists were provided unsalted biscuits and clean water to erase the previous sample judgement from the next sample, using a 9-point hedonic scale on the colour, flavour, juiciness, texture and acceptability status for each sample evaluated.

2.7 Determination of Mg, P, and Fe.

The digest of the ash of each sample above as obtained in calcium and potassium determination was washed into 100ml volumetric flask with deionised or distilled water and made up to mark. This diluent was aspirated into the Buck 200 Atomic Absorption Spectrophotometer (AAS) through the suction tube. Each of the trace mineral elements was read at their respective wavelengths with their respective hollow cathode lamps using appropriate fuel and oxidant combination.

Ppm or mg/kg (any of the elements = Meter reading x Slope or Gradient x dilution factor.

$$\%\ (any\ of\ the\ elements) = ppm\ or\ mg/kg\ divided\ by\ 10000$$

2.8 Statistical Analysis and Design

Data obtained were subjected to analysis of variance (ANOVA) and significant means will be separated by Tukey HSD test using the procedure of SAS (1995). The experimental design for this study is Complete Randomized Design (CRD).

3. Results and Discussion.

Table 2 shows the proximate composition of the experimental diet. T4 was observed with higher values in crude protein, crude fibre and ether extract, ($p<0.05$) than others, though T1, T3 and T4 had same crude protein significantly, however the ether extract values was higher in T2 with (63.20%), followed by T3 (55.64%), then T1 (51.85%) and T4 (40.03%). The results here were not in line with the reported by (Olabamyi *et al*. 2007 and Ajayi *et al*. 2007). T4 the treatment with *Tithonia diversifolia* has the choice nutrients in the composition measured, for crude protein, fibre and ash content.

Table 3 shows the proximate and mineral composition of rabbit muscles fed sunflower inclusion in their diet. T1 had the highest significant ($p<0.05$) protein content value with (36.54%) followed by T2 (34.07%), while T4 had the least value (32.08%). Ash and ether extract content had no significant difference ($p>0.05$) T3 had lower moisture content and higher dry matter values than T1, T2 and T4. The mineral measured in this table were Magnesium, Iron and Phosphorous, there were no significant difference ($p>0.05$) among them. The values obtained for protein content were lower than (37.19 – 37.72%) reported by Olabamji *et al*. (2007) when they fed

different level of wild sunflower leaf blood meal mixture to rabbit. But greater that (19.4 – 20.2 %) reported by Duwa *et al*. (2014) when weaners rabbit was fed graded levels of roasted Sunflower seed meal. The composition shows that rabbit that fed with T3 performed best than other treatments, this may be due to the fact that they eat balanced diet, meaning concentrate feed and foliage. T2 also was high in protein content due to the fact that rabbit on that diet consume only concentrate feed. The mineral composition obtained in table 2 indicate that the treatments T1 – T4 has no effect on rabbit meat, since magnesium, iron and phosphorus has same significant values.

Table 4 shows the proximate and mineral composition for the thigh and shoulder muscles. Significant differences ($p<0.05$) were observed in all parameters measured except in crude fiber ($p>0.05$). The shoulder had higher significant values ($p<0.05$) for crude protein content (33.68 %), ash content (1.11 %), ether extract (8.85 %) and dry matter content (48.46 %), for proximate composition. And for minerals composition, rabbit shoulder muscles had no significant difference in their values. When the thigh and the shoulder muscles were evaluated, it was observed that the shoulder part of the rabbit irrespective of the diet fed with, had a higher nutrients quality than the thigh muscles. This is significant when compared to other domestic animals who usually had more of their nutrient at the thigh muscles. The value obtained in this table are higher than the values reported by Malik *et al*. (2011) when they compared the nutritional and organoleptic assessment of the meat of giant African land snail with other livestock meat, and that of Moniello & Nizza, (2000), who worked on the meat quality and caeca characteristic of rabbit according to dietary content and botanical origin of starch. The mineral content is the same in both the shoulder and the thigh muscles, meaning that the diets consumed had no effect on the content of the minerals present in the muscles of rabbit.

Table 5 compared the nutrients in the fresh muscles and when they are processed into boiled and grilled meat. There were significant differences observed in all the parameters measured except for fiber. Grilled products had the highest significant valves in protein, ash, ether extract, and dry matter except for moisture content, then the boiled and fresh samples. The higher values in grilled meat is more than times two of the fresh muscles. As the moisture decreases through meat processing the nutrients in the meat increases, which is also affected by how long or how much moisture was removed from the meat. The results in this Table was in line with the report of Apata & Akinfemi (2010), who work on effect of different cooking methods on the proximate composition and eating quality of rabbit meat. However, the higher values observed for moisture content in fresh meat, was because it was not subjected to any processing methods.

Table 6 and 7, shows the palatability status of processed rabbit meat fed sunflower in their diet. T1 that serves as the control had the highest significant ($p<0.05$) values for colour, grilled flavor, boiled juiceness, boiled texture and total acceptability followed by T2 (control), which was later followed by T3. T4 had the least significant values compared to all other diets. Total acceptability higher values were also observed in grilled sample (6.13) for T2 and (6.66) for boiled sample and (6.00) for grilled samples for T3 respectively. Looking at Table 7, which summarized the total summation of palatability status according to their diet irrespective of the process used. It shows that, T1 values were rated highest significantly ($p<0.05$) by the panelist accept in flavor while the least values were observed in T. for total acceptability, T1 was highly accepted followed by T3, then T2 and T4 had the least acceptability. It could also be denoted that T3 was accepted after T1 due to the fact that, the diet they consumed which was 50 % compounded feed and 50 % *Tithonia diversifolia* was a balance diet, since T2 diet (100 % concentrate) added more fat accumulation to the muscle, which resulted in the highest value obtained for flavor, tenderness and texture but lowered the acceptability due to the perception of the panelists.

T3 produces more lean meat like T1, with more juiciness that T2 and so increases the influence on the panelists score. However, the results in this Table are similar to that reported by Apata &Akinfemi, (2010). who worked on effect of different cooking methods on the proximate composition and eating quality of rabbit meat and Lafuente and Lopez (2000), who worked on the effect of stunning methods on some instrumental and sensory qualities of rabbit meat. But were different in values with the report of Malik et al. (2011), when they compared the nutritional and organoleptic assessment of the meat of giant African land snail with other livestock meat. In Table 6, it also appeared that the panelists rated boiled meat higher than grilled meat, and this could be as a result of the higher value in colour and tenderness of boiled meat than grilled meat. Rabbit could tolerate and improved in production with 50% inclusion of *Tithonia diversifolia* in their diet.

Table 2: Proximate Composition of Experimental Diet.

Constituents	T1 *Tridax*	T2 Grower's mash	T3 Grower's mash +*Tithonia diversifolia*	T4 *Tithonia diversifolia*	SEM
DRY MATTER (%)	92.10^{ab}	95.15^{a}	93.50^{ab}	90.12^{b}	0.249
CRUDE PROTEIN (%)	23.98^{a}	20.25^{c}	23.05^{a}	23.35^{a}	0.341
CRUDE FIBRE (%)	5.47^{c}	4.55^{c}	7.32^{b}	12.69^{a}	0.336
ASH (%)	3.20^{d}	5.70^{c}	10.40^{b}	15.80^{a}	0.190
ETHER EXTRACT (%)	5.12^{a}	5.48^{a}	3.49^{b}	2.11^{c}	0.275
NITROGEN FREE EXTRACT (%)	51.85^{c}	63.20^{a}	55.64^{b}	40.03^{d}	1.97

^{abcd} means on the same row with different superscripts are significantly different (P<0.05)
SEM-Standard error of mean

Table 3: Proximate and minerals composition of rabbit muscles fed sunflower inclusion in their diets (%)

	Experimental diets				
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**
Protein (%)	30.01^{d}	34.07^{ab}	36.54^{a}	32.08^{c}	2.34
Ash (%)	1.07	1.02	1.05	1.02	0.08
Ether extract (%)	8.33	8.42	8.46	8.76	0.25
Crude fiber (%)	0.01	0.01	0.01	0.01	0.00
Moisture content (%)	58.31^{a}	54.44^{b}	52.80^{c}	53.96^{c}	3.23
Dry matter (%)	41.69^{c}	45.56^{ab}	47.36^{a}	46.04^{a}	3.23
Magnesium (mg/100g)	24.85	25.66	24.83	24.13	0.25
Iron (mg/100g)	5.03	4.87	5.05	4.73	0.08
Phosphorus (mg/100g)	2.34	2.36	2.34	2.35	0.66

^{abcd} means on the same row with different superscripts are significantly different (P<0.05)

Table 4: Proximate and mineral composition of the shoulder and thigh muscles of rabbit fed *Tithonia diversifolia* in their diet.

Parameters	**Thigh**	**Shoulder**	**SEM**
Crude protein (%)	32.67^{b}	33.68^{a}	2.34
Ash (%)	0.97^{b}	1.11^{a}	0.08
Ether extract (%)	8.14^{b}	8.85^{a}	0.25
Crude fiber (%)	0.01	0.01	0.00
Moisture content (%)	58.21^{a}	51.55^{b}	3.23
Dry matter (%)	41.88^{b}	48.46^{a}	3.23
Magnesium (mg/100g)	24.84	24.90	0.25
Iron (mg/100g)	4.96	4.88	0.08
Phosphorous (mg/100g)	2.34	2.36	0.66

^{ab} Means on the same row with different superscripts are significantly different (p≤0.05)

Table 5: Proximate composition of the fresh, boiled and grilled meat of rabbit fed *Tithonia Diversifolia* in their diet (%).

Parameters	**Fresh**	**Boiled**	**Grilled**	**SEM**
Protein	19.43^{c}	34.60^{b}	45.50^{a}	0.78
Ash	0.69^{c}	0.89^{b}	1.54^{a}	0.03
Ether extract	7.62^{c}	8.17^{b}	9.69^{a}	0.08
Fiber	0.01	0.01	0.01	0.00
Moisture content	69.88^{a}	58.56^{b}	36.19^{c}	1.08
Dry matter	30.24^{c}	41.45^{b}	63.81^{a}	1.08

^{abc} Mean on the same row with different superscript are significantly different (p<0.05)

Table 6: Palatability status of boiled and grilled rabbit meat fed *tithonia diversifola* in their diet (%) Experimental diets

Parameters		T1	T2	T3	T4	±SEM
Colour	Boiled	7.61^{a}	6.91^{ab}	6.81^{b}	4.49^{c}	0.70
	Grilled	7.00^{a}	6.83^{b}	6.40^{b}	3.41^{c}	0.70
Flavor	Boiled	4.81^{c}	7.21^{a}	5.20^{b}	4.69^{c}	0.36
	Grilled	7.00^{a}	4.80^{b}	5.40^{ab}	3.51^{c}	0.36
Tenderness	Boiled	6.81^{b}	7.01^{a}	5.60^{b}	5.99^{c}	0.15
	Grilled	6.60^{a}	5.35^{b}	5.28^{c}	3.31^{c}	0.15
Juiciness	Boiled	7.01^{a}	5.61^{b}	5.13^{b}	5.89^{b}	0.22
	Grilled	6.40^{a}	4.25^{c}	5.00^{b}	3.51^{d}	0.22
Texture	Boiled	7.41^{a}	6.41^{b}	5.20^{c}	4.99^{d}	0.44
	Grilled	6.00^{a}	4.60^{b}	5.00^{b}	3.21^{c}	0.44
Acceptability	Boiled	7.01^{a}	5.11^{c}	6.66^{b}	5.39^{c}	0.73
	Grilled	7.40^{a}	6.13^{b}	6.00^{b}	4.61^{c}	0.73

^{abcdef} Mean on the same row different superscripts are significantly different

Table 7: Total summation of mean palatability status of rabbit meat in respect to the experimental diets (%).Experimental diets

Parameters	T1	T2	T3	T4	SEM
Colour	7.30^{a}	6.87^{b}	6.61^{b}	3.95^{d}	0.05
Flavor	5.90^{b}	6.01^{a}	5.30^{b}	4.10^{c}	0.26
Tenderness	6.70^{a}	6.18^{b}	5.44^{d}	4.65^{c}	0.11
Juiciness	6.70^{a}	4.93^{b}	5.07^{b}	4.70^{b}	0.15
Texture	6.70^{a}	5.51^{ab}	5.10^{bc}	4.10^{c}	0.31
Acceptability	7.20^{a}	5.62^{b}	6.33^{ab}	5.00^{b}	0.52

^{a,b,c} Means on the same row different superscripts are significantly different

4. Conclusion

T3 and shoulder muscle performed better in proximate composition and had better values for palatability after T1 which stand as the control. Nutrients in grilled samples are more than boiled samples but the panellists preferred the boiled meat better than the grilled rabbit meat.

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