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Performance and carcass characteristics of weaner rabbits fed wild sunflower (*Tithoniadiversifolia*) inclusion in their diet

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Abstract

Inclusion of alternative cheap non-utilized foliage in rabbit production to improve its performance and thereby increase protein intake is the focus of this study. Ten-weeks study was carried out to determine the effect of *Tithonia diversifolia* inclusion on the nutrient digestibility, growth performance, organs and carcass characteristics of weaner rabbits. In a completely randomized design, forty (8 weeks old of 11 -12kg) rabbits were randomly distributed into four dietary treatments. Treatment 1: *Tridax procumbens*, Treatment 2 :100% concentrates, Treatment 3: 50% *Tithoniadiversifolia* + 50% concentrates, Treatment 4: 100% *Tithonia diversifolia*. Results shows that, T2 (433.33g) and T3 (416.67g) had the highest significant (P<0.05) weight gain followed by T1 (167.67g) while T4 (-200) had a negative and the lowest value. Feed intake was higher (P<0.05) in T1 followed by T2, T3 and then T4 respectively. T3 (6.82) had the best feed conversion ratio (P<0.05) while T1 (12.36) had the lowest significantly, for performance characteristic. Apparent digestibility of nutrient records T3 with the highest significant (P<0.06) crude protein and either extract while T4 had the lowest vales. The carcass and organ evaluation, T2 and T3 performed best than T1 and T4 respectively. T3 at 50% *Tithoniadiversifolia inclusion* could enhances good performance, nutrient digestibility, and increases the weight of organs and muscles of rabbit, when fed.

Keywords: Rabbit; Tithonia Diversifolia; Performance; Carcass; Organ

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1. Introduction

The reduction on the reliance of importation of livestock feed in Nigeria has increased the demand and cost of conventional feedstuff (Togun et al., 2006). Therefore, there is the need, to explore the use of non-conventional feed sources that have the capacity to yield the same output as conventional feeds, and perhaps at cheaper cost. The recommended policy is to identify and use locally available feed resources to formulate diets that are as balanced as possible (Guèye and Branckaert, 2002). This strategy could help reduce the cost of production, and ensure cheaper meat production thereby making available the major crops for human consumption. The economization of feed cost using cheaper and unconventional feed resources is an important aspect of commercial rabbit production (Bhatt and Sharma, 2001; Muriu et al., 2002).

Rabbits are efficient converters of feed to meat and can utilize 30 % fibre as against 10 % by most poultry species (Egbo et al., 2001). The enormous potential of Rabbits as a good source of animal protein is hinged on its attributes to thrive well on forages such as *Tridax procumbens, Tithonia diversifolia* also have high reproductive potential with short gestation period, early maturing, its proficiency, and ability to rebreed shortly after kindling (Odimba, 2006; Taiwo et al., 2004).

Nutritionally, Rabbit meat has high protein content, low in fat, cholesterol, and highly digestible, (Yusuf et al., 2011). But the question often asked, is why the production of rabbit is still in small scale production and not in commercial scale like poultry and beef production. Rabbits can utilize unconventional feeds like sunflower, which has no cost effective and has high protein content of about 18 % (Olayeni et al., 2006). Reasons why attention is being shifted to rabbit production with the use of cheap feedstuffs such as *Tithonia diversifolia* is to raise the level of protein available for the populace. *Tithonia diversifolia* belongs to the shrub family Astaracea. It is of high nutritional value containing all the known essential amino acids and also rich in minerals and vitamins especially the B-complex vitamins (Day and Levin,1954).

This study is designed to investigate the effect of feeding *Tithonia diversifolia* on the growth performance, digestibility status, organs and carcass characteristics of weaned rabbits.

2. Materials and methods

2.1. Experimental site

The experiment was carried out at the Rabbitry unit of Osun State University, Teaching and Research Farm, College of Agriculture, Ejigbo campus, Ejigbo, Osun State.

2.2. Preparation of test ingredients

Tithonia diversifolia was harvested at its first inflorescence. The sunflower leaf meal was prepared by chopping the leaves into smaller units, air dried on a concrete floor of a well ventilated roofed house to preserve its nutritive value as much as possible. The dried leaves were fed as inclusion according to the experimental diet / treatment.

2.3. Experimental animals and management

Forty (40) weaned New Zealand male Rabbits were purchased from a reputable source. On arrival, the initial weight of the animals was obtained, vitamins were also administered on arrival. The animals were randomly allocated to four dietary treatments with five replicates per treatments. The animals were managed intensively and housed in hutches. Daily routine management was carried out which includes cleaning, provision of water and feeding twice daily. The animals were acclimatized for two weeks after which the experiment proper lasted eight weeks.

2.4. Experimental diet

Four experimental diets which consist of;

Treatment1: 100% Tridax *procumbens*

Treatment 2: 100% Grower's mash

Treatment 3: 50% *Tithonia diversifoia* + 50% Grower's mash

Treatment 4: 100% *Tithonia diversifolia*

Table 1. Gross Composition of Grower's Mash

INGREDIENT	**Percentage composition**
Maize	47.7
Soya bean	20
Wheat offal	17
P.K.C	3.0
Bone meal	5.0
Oyster shell	6.5
Methionine	0.1
Lysine	0.1
Premix	0.5
Salt	0.1
	100
Calculated crude protein (%)	*16.6*
Metabolizable Energy (kcal/mg)	*2600*

2.5. Performance characteristics

The initial weight of the Rabbits was taken before allocating them into treatments, thereafter, data on their initial body weight, weekly feed consumed; changes in the body weight were collected. The weight gain and feed efficiency were determined on a weekly basis as follows:

2.5.1. Feed intake (g)

A known quantity of feed given to the rabbits and left over was measured to determine both the daily and weekly feed intake.

Feed intake = feed supplied - left over

2.5.2. Weight gain (g)

The initial body weight of the rabbits and also subsequent changes of weight on weekly basis were taken.

Weight gain = final weight - initial weight

2.5.3. Feed conversion ratio (FCR)

The FCR of the rabbits was determined by calculating the ratio of the feed intake to the ratio of the weight gain

$$FCR = \frac{Feed\ intake\ (g)}{Body\ weight\ gain\ (g)}$$

2.6. Digestibility study

After the 8th week of the experiment, feacal samples were collected for five days. A known quantity of feed was supplied and the feaces collected afterwards. The feacal samples were dried at 65 ^{0}C for a 24 hours' period. The dried feaces from each treatment were analyzed for proximate constituent and the results were used for proximate analysis for crude protein, crude fibre, ether extract, ash and dry matter using AOAC (2005).

Digestibility of the nutrients was determined by the formula:

$$Dry\ matter\ digestibility = \frac{Feed\ intake\ (g/dm) - Feacal\ output\ (g/dm)}{Feed\ intake(g/dm)}\ x\ 100$$

$$\%\ Nutrient\ digestibility = \frac{Nutrient\ in\ feed - Nutrient\ in\ feaces}{Nutrient\ in\ feed}\ x\ 100$$

2.7. Chemical analysis

Samples were analyzed chemically for its crude protein, crude fibre, ash, ether extract and dry matter content according to the methods of A.O.A.C, 18th edition (2005)

2.8. Carcass and organ evaluation

The rabbits were tagged and fasted overnight. 5 rabbit each were randomly selected from each treatment and slaughtered, fur was removed by skinning and the carcass weight was determined after slaughtering. Blood was drained, then reweighed. Evisceration was carried out immediately. The bled weight, weight of the carcass, head and internal organs which includes the liver, heart and lungs were measured using a weighing balance.

2.9. Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) and the significant differences were separated using Tukey HSD (Highest Significant Difference) of the same Analytical software (XLStat,2014).

3. Results and discussion

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(%)	90.10^{ab}	93.15^{a}	91.50^{ab}	88.12^{b}	0.249
CRUDE PROTEIN(%)	22.98^{a}	19.25^{c}	22.05^{a}	22.35^{a}	0.341
CRUDE FIBRE(%)	5.46^{c}	4.54^{c}	7.30^{b}	12.70^{a}	0.336
ASH(%)	3.10^{d}	5.50^{c}	10.30^{b}	15.70^{a}	0.190
ETHER EXTRACT(%)	5.10^{a}	5.50^{a}	3.50^{b}	2.11^{c}	0.275
NITROGEN FREE EXTRACT(%)	53.86^{c}	65.21^{a}	56.85^{b}	41.14^{d}	1.98

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

Table 3. Performance Characteristics of Rabbits Fed Sunflower Inclusion in Their Diet

PARAMETER	T1	T2	T3	T4	SEM
Initial Weight(g)	1083.00	950	1033.00	1150	55.28
Final weight(g)	1250.00^{b}	1383.33^{a}	1450.00^{a}	950.00^{c}	46.39
Weight gain(g)	167.67^{b}	433.33^{a}	416.67^{a}	-200.00^{c}	76.37
Daily Weight gain (g)	4.66^{b}	10.32^{a}	9.92^{a}	-4.72^{c}	1.56
Average Feed Intake(g)	94.89^{a}	76.32^{b}	67.66^{c}	46.05^{d}	10.13
Feed conversion Ratio (g)	12.36^{a}	7.40^{c}	6.82^{d}	9.67^{b}	1.26

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

Table 4. Nutrients Digestibility of Rabbits fed Sunflower Inclusion in their Diets

CONSTITIUENTS	T1	T2	T3	T4	SEM
DRY MATTER (%)	88.07	89.58	90.05	90.06	1.05
CRUDE PROTEIN(%)	67.30^{b}	69.76^{b}	74.83^{a}	55.34^{c}	4.13
CRUDE FIBRE(%)	71.96^{b}	62.49^{d}	54.52^{c}	79.85^{a}	5.52
ETHER EXTRACT	55.02^{c}	61.86^{b}	72.07^{a}	55.74^{c}	3.94
NITROGEN FREE EXTRACT(%)	55.86^{ab}	55.90^{a}	42.98^{a}	39.87^{a}	0.98

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

Table 5. Carcass characteristics of Rabbits fed sunflower Inclusion (g)

PARAMETER (g)	T1	T2	T3	T4	SEM
LIVE WEIGHT	1250[b]	1383.33[ab]	1450[a]	950[c]	54.67
SLAUGHTER WEIGHT	1133[b]	1353[ab]	1420[a]	880[c]	44.57
DRAINED WEIGHT	976.7	1193.33	1293.33	767.41	64.70
RIGHT THIGH	83.37[b]	91.67[ab]	101.2[a]	48.73[b]	5.19
LEFT THIGH	77.40[b]	91.47[ab]	98.23[a]	52.10[c]	4.07
RIGHT SHOULDER	45.43[ab]	41.00[ab]	52.17[a]	32.37[b]	2.82
LEFT SHOULDER	48.36[a]	44.03[ab]	50.33[a]	32.97[b]	3.23
HEAD	124.7[ab]	139.00[a]	93.07[c]	116.2[b]	23.34
BACK	154.7[b]	200.53[a]	214.03[a]	98.03[c]	16.21
CHEST	121.17[ab]	156.17[a]	148.27[a]	89.23[b]	12.99
LEFT LEG	16.27	16.70	16.77	18.63	1.71
RIGHT LEG	17.57	17.30	16.10	16.90	1.12
SKIN	111.67[b]	133.33[a]	133.33[a]	81.67[c]	22.33

[abc] :means on the same row with different superscripts are significantly different (p<0.05)

Table 6. Organ characteristics of Rabbits fed sunflower Inclusion (g)

LUNG	8.10 b	13.20a	10.80ab	6.83b	1.21
HEART	2.80	3.37	3.07	2.63	0.30
LIVER	28.7b	47.4a	49.4a	20.9b	3.80
FULL GIT	198.8	239.80	256.17	187.23	18.50
KIDNEY	6.87b	9.97a	9.97a	7.60b	0.46

abc: means on the same row with different superscripts are significantly different (p<0.05)

Table 2 shows the proximate composition of the experimental diet, T2 had the greatest dry matter while T4 had the least dry matter significantly. The crude protein was lowest in T2 with (19.25%) value ($p<0.05$) while T1, T3 and T4 had same significant values ($p<0.05$) of (22.98%, 22.05% and 22.35%) respectively. Crude fibre had the highest valve in T4 (12.70%) while the least was observed in T1 and T2 (5.46% and 4.54% ($p<0.05$). Ash content was significantly highest in T4 (15.70%) while T1 had the least (3.10%) ($p<0.05$). Ether extract was highest in (5.10% and 5.50%) in T1 and T2 while T4 had the least ($p<0.05$) value (2.11%). The nitrogen free extract followed same trend as in dry matter.

The least crude protein gotten in Table 2 (19.25%) which was slightly higher than the value reported by Togun et al. (2006), who reported 18.4% when wild sunflower was fed to Isa cock, while the other values derived for T1, T3 and T4 were (22.98%, 22.05% and 22.35%) which were higher than 21.21% reported by Olabanji et al. (2007), when Wild Sunflower meal was fed as a whole meal to weaner rabbits. The differences in the values of crude protein could be attributed to the differences in the soil type in which the plants were grown, method of preparation, as well as the stage of growth as at the time of harvest. Ash content describe the mineral content of the feed, muscle or whatever content it is addressed with, in Table 2, the highest ash content 15.70% was found in T4 which was higher than 14%, reported by Amao et al. (2012) when graded

wild sunflower meal was fed to weaner Rabbits. Ether extract fell within the values gotten by Amao et al., (2006) and Nadiatu (2013) they reported (2.11%, 5% and 10% respectively for sunflower inclusion in the diet of rabbit. The differences in values obtained by different authors could be as a result of the way ash content was analyzed, since some analysis may involve excessive heating which may leads to loss of volatile minerals.

The crude fibre values, which ranges (4.54 - 12.50%) fell in line with the values (12.0%) reported by Ajayi et al. (2007), for feeding graded levels of wild sunflower meal in replacement of maize at pre – puberty age, negatively impacts on growth and morphometric characteristic of the genetic of Anak 2000 broilers cock at the puberty age. Also Togun et al. (2006) gave 5.0 and 6.2% for performance evaluation of male weaner rabbits fed diets containing graded levels of blood wild sunflower leaf meal moisture. Difference in valves obtained could be attributed to the stage of growth of the plant and method of processing sunflower meal.

Table 3 shows the performance characteristics of rabbits fed sunflower inclusion in their diet. There were no significant differences in the initial weight obtained for T1 – T4. T2 and T3 had (1383.33g and 1450g) ($p<0.05$) higher valves for final weight, while T4 had the least final weight with a negative value (-200g). The weight gain and daily weight gain, followed the same trend as the final weight. Average feed intake had the highest significant value ($p<0.05$) (94.89g) while T3 had the least value (67.66g). The feed conversion ratio was highest in T1 (12.36) while the least was obtained in T3 (6.82).

The initial weight gain range between (950g-1083g) and this reflects no difference as a result of homogeneity. The weight gain obtained in this study (-200g – 433.33g) were lower than (940 -1019.91) when graded level of roasted sunflower seed meal on weaners rabbits, Duma et al. (2014) and Ajayi et al. (2007) reported (671.18 – 1149.79g) when male weaners rabbit was fed diet containing graded level of blood – Wild Sunflower leaf meal mixture. The valves of -200g in this study seems very low, which may be due to the taste of *Tithonia diversifolia* since the rabbit that was fed with whole sunflower T4 often have a lot of leftover than T1-T3, also the poor feed intake may be due to the non-palatability and anti-nutrients in *Tithonia diversifolia* as reported by Dutta et al. (2003) that animals feed consumption reduces with the presence of anti-nutrients present in feed meal as well as the non-palatability of the feed ingredients affecting the valves of feed intake.

The daily weight gain in this study (- 4.72 – 10.32g) were very lower except for T2 and T3 with (10.32 and 9.92g) T4 had negative value, as this is a bad indicator, describing that sunflower plant can't be taken as a whole by rabbit animals and since the feed intake was at negative value, the resulting weight gain also will be negative. However, the values obtained in this study were lower than (12g) reported by Omole and Ajayi (1976) who fed dried brewer's grain to rabbit and also lower than (17.65-18.80g) reported by Agunbiade et al. (1999) on cassava leaf and peel meal. They were much lower than, (11.20 – 12.08g), values observed by Ajayi et al. (2007), who fed graded level of blood –wild sunflower leaf meal mixture to male weaners rabbit. And 10.65g and 18.25g of (Duwa et al., 2014) who fed graded level of roasted sunflower seed meal on weaners rabbits. But the results obtained was similar to the observations reported by Togun et al. (2006) when *Tithonia diversifolia* was fed to Isa cocks, they noted that the level of Wild Sunflower inclusion increased in the diet, the weight gain decreases. The marked decrease in weight gain especially in T4, (-

4.23g) may be attributed to that reported by Tangendjaja et al. (1990) they noted that there is often poor digestibility of leaf meal and which tends to suppress the overall nutrient digestibility, if it constitutes a greater proportion of the diet.

The feed conversion ration ranges from (6.82 - 12.36) T3 had the least, showing the best conversion rate than other direct. The values here fell within the values of (5.17 -11.32g), Obiba (2011) who fed graded level of soybean seed meal in the diet of weaners rabbit. Rabbit on T3 performed best with little feed intake and increased weight gain. From Table 3, T3 had the choice diet considering the better weight gain, good feed intake and having the least feed conversion ratio when comparing with other treatment. This may be due to fact that when leaf meal is added as inclusion in the meal of animals, they tend to do better because of their inherent nutrients. This performance was in line with the report of Ajayi et al. (2007) who worked with African wild sunflower leaf-blood mixture to feed broiler cock and Olabanji et al. (2007) who reported better growth of Rabbits when fed Wild Sunflower leaf based diet. This may be due to fact that when leaf meal is included in the meal of animals they tend to do well because of the inherent nutrients.

Table 4 shows the nutrient digestibility of the Rabbits fed inclusion of sunflower in their diet. There were significant differences ($P<0.05$) for crude protein, crude fibre and ether extract across the treatments. Rabbits on T3 recorded the highest digestibility (74.83%) for CP while T4 had the least with (55.34%) significantly ($p<0.05$). T4 had the highest digestible crude fiber (79.85%) while T3 had the lowest (54.52%) ($P<0.05$) for ether extract T3 had the highest digestibility value (72.07%) followed by T2 (61.86%), then T1 and T4 with (55.02% and 55.74%) significantly. T3 respond to the reported by Ajayi et al. (2007), who said that, there is increased protein digestion of African Wild sunflower when incorporated into other feed materials.

The diet of T3, is a good diet choice since, it marked improvement in the digestibility of nutrient. The valves gotten for crude protein (55.34 – 74.83%) was lower than (76.32 – 84.39%) by Duma et al. (2014) who fed graded levels of roasted sunflower seed meal on weaner rabbits. The values for crude fibre and ether extract fell within the values reported by (Duwa et al., 2014; Ajayi et al., 2007). The digestibility values of the nutrients obtained for *Tithonia diversifolia* in this study when included in the compounded feed, was lower than that recorded by Ajayi et al. (2007), when rabbits were fed Wild Sunflower leaf-blood mixture. The differences could be as a result of blood protein present in the mixture

The higher crude fibre value in T4 could suggest the cause of depression in its crude protein digestibility. T4 recorded the least digestibility for CP and EE but highest digestibility for fibre. Which could be as a result of poor digestibility of leaf meal which tends to suppress the overall nutrient digestibility, since it was give whole to the experimental rabbit. Tangendjaja, (1990) reported that poor digestibility could also be due to increased fibre digestion which tends to increase the rate of digesta in the gut, (Mc Donald, 1995), thereby making the nutrients unavailable for use by the animals.

Table 5 shows the carcass characteristic of rabbits fed sunflower inclusion in their diet. The results show significant difference ($P<0.05$) in all parameters measured except in right and left legs. Treatment 3 recorded the highest values in live, slaughter and drained weight, right and left thigh, right and left shoulder, back and skin. Though T2 also appears less high than T1 and T4, T4 had the least significant values than other

treatments ($p<0.05$). This observation in their carcass weight is probably due to the type of diet they are fed with. As rabbit in T3 responded best in meaty areas, the right and left thigh and shoulder, which was followed by T2, T1 and lastly by T4. The differences in the values obtained may be due to the various treatments the animals were subjected to as well as the differences in the feed intake of the animals. The reduction in values of T4 for all parameters may be due to the live weight of the Rabbits in this treatment as compared to other Rabbits across the other treatments which had higher live weight since rabbit in T4 did not appreciate in weight addition due to the type of diet they were exposed to. T3 increased well in meaty part of the rabbit and so, increasing its diet by 50% inclusion of sunflower could help increase the thigh and shoulder muscle weight, thereby increasing the protein intake of the consumers.

Table 6 shows the organs characteristics of rabbits fed sunflower inclusion in their diet. Significant differences ($p<0.05$) were observed in all parameters measured except the heart organ ($p>0,05$). T2 and T3 had the highest significant valves in all parameters measured followed by while T4 had the least values. The values recorded for the lungs, liver, heart, and kidney for T2 and T3 was similar to the values reported by Togun et al. (2006) when *Tithonia diversifolia* was fed at 20% inclusion to male Rabbits. However, the results obtained for T4 was lower than to that reported by Akinola (2007) when mango based diet was fed to weaners rabbit. The differences in values obtained may be due to the varying level of inclusion of *Tithonia diversifolia* which may indicate that as the inclusion level increases the availability of anti-nutritional factors which may cause reduction in organ weight increases, (Togun et al., 2006)

4. Conclusion

Inclusion of *Tithonia diversifolia* at 50% enhances growth performance, nutrient digestibility, organ and carcass characteristics of rabbit. Further study on the anti-nutritional factors of *Tithonia diversifolia* is recommended.

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