# Growth performance and carcass characteristics of weaned rabbits fed tomato fruit waste meal based diets

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## Abstract

An eight week feeding trial was conducted to examine the effect of tomato fruit waste meal (TFWM) based-diets on the performance and carcass characteristics of weaned rabbits. Twenty eight (28) weaned rabbits were used. Seven rabbits were randomly assigned to each dietary treatment with each rabbit serving as replicate using a Completely Randomized Design (CRD). Four dietary treatments were formulated such that TFWM was included at 0, 5, 10, and 15% levels in $T_1$, $T_2$, $T_3$, and $T_4$, respectively. Water and feed were provided *ad libitum*. Growth performance characteristics were evaluated. At the end of the feeding trial, three (3) rabbits from each treatment were randomly selected for carcass evaluation. Results showed that growth performance parameters were not significantly (P>0.05) affected by dietary treatments except the final weight gain and feed conversion ratio. Rabbits fed 5% TFWM diet had the best final weight (1317.00g/rabbit) followed by those fed 10% TFWM (1300.00g/rabbit). The result on growth performance showed that inclusion of TFWM at 5% level improved the FCR (1.05). All carcass parameters and internal organs were also not significantly (P>0.05) affected by dietary treatments except the kidney, visceral fat and spleen. Based on the results of this study, inclusion of tomato fruit waste meal up to 10% in rabbit diets is nutritionally adequate for adoption by farmers for better growth performance and carcass yield.
***Keywords****:* carcass yield, rabbit meat, tomato fruit wastes, feed resources

## Introduction

The shortage of major conventional feedstuffs such as maize and soybean for the livestock industry has resulted in a continuous increase in the cost of production, causing a phenomenal rise in the unit cost of livestock products. These products have become too expensive and beyond the reach of most households. In developing countries, increases in population practically erodes increase of food production leaving no hope of ever having surplus grains to compound economically viable livestock feeds (Syed *et al.*, 2009).

The processing of many fruit and vegetable products generate wastes which could contribute to environmental pollution. The tomato processing industry serves as an excellent example. The total waste generated from tomato processing from world production estimates is about 11 million tons/year (FAO, 2011). Tomato fruit waste is a mixture of tomato skin, pulp and crushed seeds that remain after the processing of tomato for juice, paste and ketchup. This by-product is rich in protein, energy and crude fibre (Syed *et al.*, 2009). In addition, it contains more essential amino acids for rabbits as compared to alfalfa meal of good quality

(Gippert *et al*., 1989). Tomato protein contains approximately 13% more lysine than soy-protein, which would allow it to be used in fortifying low lysine foods (Bordowski and Geisman, 1980). Tomato fruit waste is a good source of protein but may be limited in energy due to its high fibre content (Elloitt *et al*., 1981).

Due to its high fibre content (more than 31%), it is recommended for cattle and dairy cow feeds due to the ability of these animals to digest fibre while for poultry, using tomato waste is restricted to not more than 15% in the diet (Syed *et al*., 2009). Rabbits have the ability to digest higher levels of crude fibre due to their microbial digestion. Extant literature revealed that tomato waste does not have a harmful effect on rabbit performance (Khadr and Abdel-fattah, 2008) and therefore it is recommended as feed for the small animal. Tackling the problem of high cost of feed, unavailability of feed resources for livestock, food for human consumption and raw materials for industries, brings rabbit production into focus.

Rabbitry, the science and occupation of raising rabbits for food, can be regarded as a new practice of animal farming in Nigeria with its potentialities, opportunities and challenges. The potentialities of rabbit rearing are that the cooked meat has a high nutritional value with high protein (20.8%), low fat (10 2%), and low in cholesterol, sodium and calories (8%) and contain 28% phosphorus, 13% iron, 16% zinc, 14% riboflavin, 6% thiamin, 35% B12 and 48% niacin, making it ideal meat for hypertensive patients (Amaefule and Obioha, 2005). Also, rabbit production requires comparatively low level of capital to set up; requires little space and is well-adapted to domestic rearing. In Nigeria, low protein intake has remained a major nutritional problem, especially for the low income and non-wage earners (Amaefule and Obioha, 2005). There is therefore an urgent need to develop rabbit (*Oryctolagus cuniculus*) production as a cheap source of animal protein to bridge the wide gap existing between animal protein supply and consumption. It is well understood that rapid increase in meat consumption is not attainable with large animals in view of their long gestation period, but may however be met with short breeding cycle animals like the rabbit (Aduku and Olukos, 1990). Rabbits are monogastric herbivores, fast growing animals. They have short gestation period with the ability to rebreed shortly after parturition, highly prolific and have the ability to efficiently convert noncompetitive feed sources to meat and do not require a hatchery for continuous production (Aduku and Olukosi, 1990). The most notable characteristic of rabbit meat is its tenderness. In addition the meat is of fine quality, highly proteinuos (20.8%) and low in fat content (10.2%) (Eshiett *et al*., 1979).

Rabbits have been observed to excel compared to other livestock such as cattle, sheep and goats, but rank close to chicken in respect of growth rate, feed conversion efficiency (FCE) and meat quality (Onifiade *et al*., 1999). Of all the livestock species, rabbit is the most efficient converter of feed to flesh (Agunbiade *et al*., 2001). Rabbit as a micro livestock is part of value chain development in the Agricultural Transformation Agenda (ATA) of the Federal Government of Nigeria (Udofia, 2004). This is because of the huge potentials of rabbit production in supplying the much needed animal protein intake. Other potentials include: low capital outlay, good converter of feed and prolificacy. Furthermore, their characteristic small body size, rapid growth and ability to live on forages have made rabbit production lucrative especially in some parts of Nigeria where the meat is receiving an encouraging patronage. Rabbit skin also has some commercial value. The skin may be dressed, dyed and made into fur, garments. Most domestic rabbits are raised for meat production while some are for other purposes (Loosh, 1997). Bolaji (2005) reported that rabbit manure is high in nitrogen and phosphorus and can be useful in improving soil fertility. The prolific nature of rabbits coupled with their short gestation period and generation interval, make them animals of choice for multiplication and serve as a short way of increasing animal protein intake (Egbo *et al*., 2001). Rabbit productions thus have enormous potentials in alleviating the problem of animal protein intake supply in developing countries (Ezea, 2004).

The optimum exploitation of rabbit prolificacy and performance can be achieved through proper feeding (Iheukwumere *et al.*, 2005). Dried tomato fruit waste could be utilized efficiently by rabbits but its effect on performance and carcass characteristics needs to be fully investigated, hence the need to evaluate the nutritional potential of tomato fruit waste meal on the growth performance and carcass characteristics of weaned rabbits.

The high cost of conventional feedstuffs is militating against the increased productivity of farm animals which results in low animal protein intake by consumers. The prices of animal products have increased, making them expensive for the common man. To tackle these problems, efforts are geared towards the use of alternative feed resources such as tomato fruit waste which could also be considered an environmental nuisance but can be utilized by animals because it is easily available, natural and non-toxic. Tomato is rich in protein and other antioxidant compounds such as carotenoids and ascorbic acid. The tomato skin contains a high dietary fibre content and the seeds are rich in oil. Therefore, significant amount of some of these valuable nutrients and oxidation-resistant compounds, are potentially present in the tomato waste which is being discarded during the processing of tomatoes. These ingredients could be harnessed into useful feed for rabbits. It would reduce feed cost as well as prevent environmental pollution from careless discarding of tomato waste from our numerous grocery outlets.

## Materials and methods

### Location of study

This study was conducted at the Rabbitry Unit of the Department of Animals Science Teaching and Research Farm, University of Calabar, Calabar, Nigeria. Calabar is located in south-south region of Nigeria at Latitude 4$^{o}$N57′N of the equator and Longitude 8$^{o}$19′E of the Greenwich meridian with annual rainfall ranging from 1260-1280 mm, annual temperature from 25-30$^{o}$C with relative humidity of 70-90% and at elevation of 98 meters above sea level (NMA, 2018).

### Sources of tomato fruit waste (TFW) and preparation

The tomato fruit waste was gathered from Watt and Marian markets within the Calabar Metropolis. The tomato fruits were sliced into pieces of about 4-5 mm thick for quick drying. The tomato fruits waste consisted mainly of skins, seeds, and hard tissues of the whole tomatoes. The tomato fruit waste was sun-dried following the method of Grant (2004). The process took up to twelve (12) days to dry to constant weight. Large quantities were dried, stored in large bags before being milled and used in compounding the experimental diets.

### Experimental diets

Four experimental diets were formulated to satisfy the nutrient requirements for weaned rabbits. The level of inclusion of tomato waste meal was at varied percentage (%) by weight of 0, 5, 10 and 15 %, respectively for diet treatments, $T_1$, $T_2$, $T_3$ and $T_4$. Thus, treatment diet T1, with no tomato waste meal inclusion served as the control treatment diet. The composition of experimental diets is presented in Table 1.

**Experimental design:**

The experiment was fitted into a Completely Randomized Design (CRD).Twenty eight (28) weaned rabbits were used. Seven rabbits were randomly assigned to each dietary treatment with each rabbit serving as replicate..

**Experimental animals and management**

Twenty eight (28) weaned rabbits were purchased from a reputable Rabbitry within Calabar Metropolis and used for the study. On arrival, the rabbits were given vitalite in drinking water to ease stress. The animals were dewormed against ecto-parasitic organisms using ivermectin administered subcutaneously at 0.02 ml/rabbit and fed the control diet for a period of two weeks for acclimatization. The initial weights of the rabbits were taken. The animals were then randomly assigned to the four dietary groups of seven (7) animals each, after weight equalization and assigned to each of the four treatments containing 0, 5, 10 and 15% Tomato Fruit Waste Meal (TFWM) represented as $T_1$, $T_2$, $T_3$ and $T_4$ respectively.

All rabbits were housed intensively using wooden hutches. Fresh and clean water was made available at all times. This was followed by daily cleaning of the hutches/cells, washing of troughs and feeding the animals accordingly. The feeding trial lasted for 60 days.

**Determination of growth performance characteristics**

Initial weights of the rabbits were determined at the inception of the experiment, while live weight was subsequently measured on a weekly basis to evaluate weight changes. The weight at the end of the experiment was measured as the final weight. Feed intake was measured by subtracting the feed remaining from that supplied the previous day on a daily basis. Data was collected on weight gain by subtracting the initial weight from the finals weight. Feed conversion ratio (FCR) was obtained by dividing the average feed intake (kg) by average weight gain (kg).

$$FCR = \frac{\text{Total feed intake}}{\text{Total weight gain}}$$

**Determination of carcass characteristics**

At the end of the feeding trial (60$^{th}$ day), three (3) rabbits from each treatment whose weight were close or similar to the mean weight-per rabbit were selected and slaughtered after fasting for 12 hours. After complete bleeding (within 30 minutes), the rabbits were eviscerated and weighed. The dressing percentage was determined. The carcass of each rabbit was dismembered into major cuts according to the procedure of Ozung *et al.* (2011) into the shoulder, fore limbs, rack, cut, loin and thigh/hind limbs. While the visceral/organs like liver, heart, spleen, lungs, left and right kidneys, left and right adrenals, gall bladder and visceral fat were removed and weighed accordingly.

**Dressing percentage**

This was calculated as:

$$\text{Dressing \%} = \frac{\text{Dressed weight}}{\text{Live weight}} \times \frac{100}{1}$$

**Statistical analysis**

The data obtained in this study were subjected to one-way analysis of variance (ANOVA) using General Statistics. Gen-Stat version 17.1 of 2017. Significant means were compared using Duncan's Multiple Range Test (Duncan, 1995).

**Results and discussion**

**Results**

**Growth performance characteristics of weaned rabbits fed tomato fruits waste meal (TFWM) based-diets**

The result of growth performance characteristics of weaned rabbits fed tomato fruit waste meal based-diets is presented in Table 2. The final body weight and feed conversion ratio were significantly ($P<0.05$) influenced by dietary treatments. Results for final body weight revealed that $T_2$ (5% TFWM) had the highest value (1317.00g/rabbit) followed by $T_3$ (10% TFWM) (1300.00g/rabbit) and $T_1$ (0% TFWM) (1133.00 g/rabbit) while $T_4$ (15% TFWM) had the least (983.00 g/rabbit). Feed conversion ratio values were high for rabbits fed $T_4$ (15%) (1.32) followed by $T_1$ (0%) (1.17) and $T_3$ (1.13) while $T_2$ (5%) had the lowest and best (1.05). Total feed intake, daily weight gain, daily feed intake and total weight gain were not significantly (P>0.05) influenced by dietary treatments. Results for total feed intake revealed that values were higher for rabbits fed $T_3$ (10%) (499.71 g/rabbits) followed by $T_2$ (5%) (477.34 g/rabbit) and $T_4$ (15%) (474.34 g/rabbit) while $T_1$ (0%) (8.08 g/rabbit) had the least (469.42 g/rabbit). Daily weight gain values were higher for rabbits fed $T_2$ (5%) (8.08 g/rabbit) followed by $T_3$ (10%) (7.91 g/rabbit) and $T_1$ (0%) (7.14 g/rabbit) while $T_4$ (15%) recorded the least (6.43 g/rabbit). Results for daily feed intake revealed that $T_3$ (10%) had the highest value (8.92 g/rabbit) followed by $T_2$ (5%) (8.52 g/rabbit) and $T_4$ (15%) (8.47 g/rabbit) while $T_1$ (0%) had the least (8.38 g/rabbit). The highest value recorded for total weight gain was for rabbit fed $T_2$ (5%) (452.39 g/rabbit) followed by $T_3$ (10%) (442.86 g/rabbit) and $T_1$ (0%) (400 g/rabbit) while least was $T_4$ (15%) (360.00 g/rabbit).

**Carcass characteristics of weaned rabbits fed tomato fruit waste meal (TFWM) based-diets**

The carcass characteristics of weaned rabbits fed tomato fruit waste meal based-diets are represented in Table 3. Results showed no significant (P>0.05) differences in live weights of rabbits between treatments. Results revealed that $T_2$ (5%) (1250.00g/rabbit) had the highest value followed by $T_3$ (10%) (1116.00g/ rabbit) and T1 (0%) (1100.00g/ rabbit), while $T_4$ (15%) (1083.00 g/rabbit) had the lowest value.

Dressed weight was not significantly (P>0.05) influenced by dietary treatments. Rabbits fed $T_2$ (5%) TFWM had higher dressed weight (1033.33g/rabbit), followed by T3 (10%) (750.00g/rabbit) although these values were similar to those obtained for rabbits on $T_4$ (15%) (716.00g/rabbit) and $T_1$ (0%) (700.00g/rabbit) dressed weight. Dressing percentage was not significantly (P>0.05) influenced by dietary treatments but rabbits fed $T_2$ (5%) had numerically higher value (82.67%) followed by those fed $T_3$ (10%) (67.17%), $T_4$ (15%) (66.15 %) and the least was $T_1$ (0%) (63 64%).

The relative weight of rabbit head was not significantly (P>0.05) influenced by dietary treatments. The highest weight was obtained from $T_4$ (15%) (11.55 %) followed by those fed $T_3$ (10%) (11.34%). Forelimb was not significantly (P>005) different among treatments statistically although rabbits fed $T_4$ (15%) diets had numerically higher values (7.71%), followed by $T_2$ (5%) and $T_3$ (10%) with the same values (6.81%) respectively, and $T_1$ (0%) with (6.41%). Relative weight of back cut was not significantly (P>0 05) different among dietary treatments but the highest value was recorded for rabbits fed $T_4$ (15% ) (18 80%). followed by $T_3$ (10%) (16.90%) and $T_1$ (0%) (16.60 %), the least was recorded for $T_2$ (5%) (15 30%).

The highest weight of hind limb in this study was recorded for rabbits fed $T_2$ (5%) (20.23%), followed by $T_3$ (10%) (19.85%) and $T_4$ (15%) (19.71%) while the least was recorded for $T_1$ (0%) (19.22%). Intestine was not significantly (P>0.05) influenced by dietary treatments. The highest value was recorded for rabbits fed $T_3$ (10%) (27.11%), followed by $T_1$ (0%) (26.72%), $T_4$ (15%) and $T_2$ (5%) had the least 22.43 and 22.41%) respectively. Jejunum although was not significantly (P>0.05) different among dietary treatments, have numerically higher value for rabbits fed $T_1$ (0%) (0.28%) and $T_4$ (15%) (0.25%) while $T_3$ (10%) and $T_2$ (5%) had the least (0.21 and 0.13%). Ileum recorded higher value (3.19%) for rabbits fed $T_4$ (15%) followed by $T_1$ (0%) (3.13%) and $T_3$ (10%) (3.10%), $T_2$ (5%) had the least (2.87%) but was not significantly (P>0.05) influenced by dietary treatments. Colon though not significantly (P>.0.05) different had higher value for rabbits fed control diet $T_1$ (0%) (3.62%) and $T_2$ (5%) (3.17%) while $T_4$ (15%) and $T_3$ (10%) had the least (2.89 and 2.73%). Caecum was not significantly (P>0.05) different among dietary treatments but the highest value was recorded for rabbits fed $T_1$ (0%) (12.05%) followed by $T_3$ (10%) (10.73%) and $T_2$ (5%) (8.82%) and the least was $T_4$ (15%) (8.21%).

Appendix in this study was not significantly (P>0.05) influenced, $T_2$ (5%) had the highest value (0.59%) followed by $T_1$ (0%) (0.51%), $T_4$ (15%) and $T_3$ (10%) had the least (0.46 and 0.33%). Esophagus was observed to have higher value in $T_3$ (10%) (0.90%) although not significantly (P>0.05) different among dietary treatments, followed by T2 (5%) (0.31%) while $T_1$ (0%) and $T_4$ (15%) had the same values (0.09%) each. The range of 4.56-8.08% was obtained in this study for relative weight of Loin. Rabbits fed $T_3$ (10%) had 8.08% followed by $T_4$ (15%) (6.92%) and $T_2$ (5%) (5.89%), while those fed $T_1$ (0%) had the least (4.56%), although there was no significant (P>0.05) difference among them. Weight of shoulder was not significantly (P>0.05) different among dietary treatments, rabbits fed $T_2$ (5%) had the highest value (4.22%) and $T_4$ (15%) (4.20%) while those fed $T_1$ (0%) and $T_3$ (10%) had the least (3.69 and 3.07%) respectively. The highest relative weight for Rack in this study was recorded for rabbits fed $T_3$ (10%) (10.33%) followed by those fed $T_1$ (0%) (8.87%) and $T_2$ (5%) (7.78%) while the least was recorded for those fed $T_4$ (15%) (6.79%). Stomach was not significantly (P>0.05) influenced by dietary treatments but rabbits fed $T_4$ (15%) had the highest value (7.67%), followed by $T_3$ (10%) (7.50%) while T1 (0%) and $T_2$ (5%) had the least values (6.03 and 5.46%). Pancreas although not significantly (P>0.05) different, have higher value for rabbits fed $T_2$ (5%) (0.28%) and $T_1$ (0%) (0.16%) while $T_4$ (15%) and $T_3$ (10%) had the least (0.09 and 0.07%) each.

Relative weight of rabbit Neck ranges from 2.25-3.63, with the highest recorded for rabbits fed $T_4$ (15%) (3.63%) followed by those fed $T_3$ (10%) (3.28%) and $T_1$ (0%) (2 66%) and the least was $T_2$ (5%) (2.25%). Liver was not influenced (P>0.05) by dietary treatments but rabbits fed $T_1$ (0%) and T3 (10%) had the same values (2.90%) while $T_4$ (15%) and $T_2$ (5%) had the least (2.80 and 2.70%). Significant (P<0.05) difference was observed for Kidney among the treatments. Rabbits fed $T_3$ (10%) had significantly higher value (2.93%), the rest were statistically similar with $T_1$ (0%) having (0.76), $T_2$ (5%) (0.72%) and the least was $T_4$ (15%) (0.65%). Spleen was significantly (P<0.05) influenced by dietary treatments. Similar values were obtained for rabbits fed $T_1$ (0%), $T_3$ (10%), and $T_4$ (15%) (0.09%) while $T_2$ (5%) had the least (0.02%). Trachea was not significantly (P>0.05) different among dietary treatments. Numerically, higher values were obtained for rabbits fed $T_2$ (5%) (0.60%), while $T_1$ (0%) and $T_3$ (10%) had the same values (0.50%) and the least was recorded for $T_4$ (15%) (0.40). Visceral fat was significantly (P<0.05) influenced by dietary treatments. The highest value was recorded for rabbits fed $T_2$ (5%) (0.48%) followed by $T_3$ (10%) (0.06%) while $T_1$ (0%) and $T_4$ (15%) had none. Gall bladder was not significantly (P>0.05) different among dietary treatments, $T_3$ (10%) had the highest value (0.18%) followed by $T_4$ (15%) (0.13%), $T_1$ (0%) (0.12%) while the least was recorded for $T_2$ (5%) (0.01%). Duodenum recorded the highest value for rabbits fed $T_3$ (10%) (2.67%) followed by $T_1$ (0%) (2.00%) and $T_2$ (5%) (1.67%) and the least $T_4$ (15%) (1.33%), although was not significantly (P>0.05) influenced by dietary treatments. The heart was not significantly (P>0.05) different among dietary treatments. All treatments almost having similar values from $T_4$ (15%) (0.37%), $T_3$ (10%) (0.35%), $T_2$ (5%) (0.31%) and $T_1$ (0%) (0.30). Tail was not influenced (P>0.05) by dietary treatments and the highest value was recorded for rabbits fed $T_4$ (15%) (0.35%) followed by $T_3$ (10%) (0.27%) while $T_1$ (0%) and $T_2$ (5%) had the same value (0.21%).

## Discussion

### Growth performance characteristics of weaned rabbits fed tomato fruit waste meal (TFWM) based-diets

The significant differences indicated in final body weight and FCR between treatments agree with the report of Nweze and Ekwe (2012) who observed a significant (P>0.05) difference for finishing broilers fed African sweet basil (*Ocimum gratissimum*) leaf extract. Increased level of TFWM at (5%) improved the FCR (the lower the FCR the better it is for rabbits to convert feed consumed to flesh). The range of FCR (1.05-1.32) obtained in this study was lower compared with the range of 5.63-7.52 reported by Nadiatu (2013) who fed female rabbits *Tithonia diversifolia* leaf meal. Rabbits fed 5% TFWM recorded the least FCR (1.05) compared to other experimental groups. Rabbits on $T_2$ (5%) performed best with good feed intake and increased weight gain. The better feed conversion ratio (FCR) observed in treatment 2 ($T_2$ 5%) may be attributed to the higher weight gain.

Final body weight gain values were higher for rabbits fed diet $T_2$ (5% TFWM) followed by those fed 10% TFWM and then decreased with increasing inclusion of TFWM at $T_4$ (15% TFWM) and showed a significant difference (P<0.05) as reported by Odoemelam *et al*. (2013) for broiler chickens fed *Ocimum gratissimum* supplemented diets. Similarly, rabbits fed diet containing 5% inclusion of TFWM recorded a higher total weight gain (g/rabbit) of 452.39g, while the ones fed 15% TFWM had the least (360.00g/rabbit). The range (360.00-452.39g) total weight gain obtained in this study was lower compared to the range (671.18- 1149.79g) reported by Ajayi *et al*. (2007) when male rabbits were fed diets containing graded levels of blood-wild sunflower leaf meal mixture. Rabbits fed 5% TFW also recorded a weekly weight gain (g/rabbit) of 56.55g and average daily weight gain of 8.08 g as compared to other experimental groups. The same trend was followed in the total daily weight gain although rabbits fed $T_4$ (15% TFWM) had the least (6.43g). The average daily weight gain in this study ranges from 6.43-8.08g lower than 17.65-18.80g reported by Agunbiade *et al.* (1999), who fed cassava leaf and peel meal mixture to rabbits. Also, the values were lower than 11.20-12.08g reported by Ajayi *et al*. (2007) when male rabbit were fed diets containing graded levels of blood-wild sunflower leaf meal mixture. Total feed intake was not significantly (P>0.05) influenced by dietary treatments but rabbits fed $T_3$ (10%) diets consumed more feed (499.71g) compared to all the experimental groups, followed by rabbits fed 5% TFWM (477.34g). The range of 469.42-499.71 g obtained in this study for total feed intake was higher than the range of 241.70-248.29g reported by Khadr and Abdel-Fattah (2008), when rabbits were fed tomato waste (TW) supplementation at different levels on productive performance of female and suckling kits. Average daily feed intake was not significantly (P>0.05) influenced by dietary treatment. Rabbits fed 10% TFWM recorded the highest value (8.92g) followed by those fed 5% TFWM (8.52%). This finding agrees with the report of Khadr and Abdel-Fattah (2008) when rabbits were fed tomato waste (TW) supplementation at different levels on productive performance of female and suckling kits.

**Carcass and internal organs characteristics of weaned rabbits fed diets containing tomato fruit waste meal (TFWM)**

Result from (Table 3) showed no significant (P>0.05) difference for live weights of rabbits between treatment groups. $T_2$ (5%TFWM) had the highest live weight of 1250.00g while $T_4$ (15%TFWM) had the least (1083.33g). The range of 1083.33-1250.00 g obtained in this study is in line with the range of 1057-1460g reported by Henry *et al*. (2013) who fed rabbits orange (*Citrus sinensis*) waste meal as alternative fibre source. These values were also almost in agreement with the range of 1130.00-1375.00g reported by Akinmutimi *et al*. (2006) who fed ripe plantain and yam peels in the diets of weaner rabbits. However, this values are lower than the range of 1288.60-1330.60g reported by Olabanji *et al*. (2007) who fed rabbits different levels of Wild Sunflower (*Tithonia diversifolia*) Leaf-Blood meal mixture. They are also lower than the range of 1752-1785g in the report of Pinheiro *et al*. (2008) who examined the growth and carcass characteristics of rabbits housed in open air or standard system. The variation observed in this study may be attributed to the breeds of rabbits used and differences in dietary treatments. There was no significant (P>0.05) effect of the diets on the dressed weight. The dressed weight range (700.00-1033.33g) in this study was higher than the range (362.07-465.00 g) reported by Ajayi *et al*. (2007) who fed male rabbit diets containing graded levels of blood-wild sunflower leaf meal mixture. However, the values were almost in line with the range of 633.0-975.95g reported by Egbeyale *et al*. (2012) who examined the replacement of wheat offal with cassava root sievate in growing rabbit's diets. However, the values were lower than the range 1333-1490g reported by Pinheiro *et al*. (2008), who examined the growth and carcass characteristics of rabbits housed in open air or standard system. Rabbits fed diets containing 5% TFW had the highest dressed weight (1035.33g) while 750.00g and 716.67g were recorded for those fed 10% and 15% respectively. The ones fed the control diet 0% followed the trend with 700.00 g. The differences observed may be attributed to the age and weight at slaughter in the different studies.

Dressing percentage was not significantly (P>0.05) affected by dietary treatments whereas rabbits fed 5% TFWM diet recorded the highest dressing percentage (82.67%) compared to other experimental groups. Rabbits placed on 10% TFWM had (67.16% dry weight - DW) followed by those fed 15% with (66.15%) while the ones on control diet 0% had the least (63.64%). These findings agree with Omole*et al*. (2007) who reported a non-significant difference in the dressing percentage of rabbits fed *Stylosanthes guinensis* and *Lablab purpureus* forages. The values in this study were higher than the range 41.43-47.20% reported by Akinmutimi *et al*. (2006).

The non-significant difference (P>0.05) observed in carcass characteristics of rabbits fed varying levels of TFWM meal agree with the findings of Omole *et al*. (2007) and Amata (2010) who also reported non-significant (P>0.05) difference in carcass characteristics of rabbits fed *Gliricidia* leaf meal (GLM). The weight of the primal cuts (Head, shoulder, loin, hind limb, forelimb, rack, back cut) showed no significant (P>0.05) effect of dietary treatments. The same non-significant (P>0.05) trend was observed in the weight of some other body parts and organs such as neck, tail, heart, liver, adrenal gland, gall bladder, pancreas, entire intestine, lungs/trachea, appendix, esophagus, stomach, duodenum, jejunum, ileum, colon and caecum. This result agrees with the report of Fayemi *et al*.

(2011) and Ogunsipe *et al*. (2014), who observed non-significant differences in lungs, heart and pancreas weights in rabbit fed sorghum offal-based diets. Spleen was significantly (P<0.05) influenced by dietary treatments. The ranges of 0.093-0.02% obtained in this study were lower compared to the range of 0.89-1.39% and 0.08-0.10% reported by Orunmuyi *et al*. (2006), and Ozung et *al*. (2011), respectively. Significant (P<0.05) difference was observed also for the kidney with rabbits fed 10% TFWM having the highest value (2.93 %) followed by those fed control diet 0% TFWM (0.76%) and (0.72%) for those fed 5% while rabbits fed 15% TFWM had the least (0.65%). These values are slightly higher than the range of 0.87-1.34% reported by Ozung *et al*. (2011) who fed female rabbit cassava peel meal based diets. These values had no regular trend and therefore, could be attributed to dietary effect. Visceral fat was significantly (P<0.05) influenced by dietary treatments. The highest value was recorded for rabbits fed 5% TFWM (0.48%) followed by those on 10% TFWM (0.06%) while rabbits fed 5% had none. The range of 0.06-0.48% for $T_2$ (5%) and $T_3$ (10%) is lower than 0.34-0.77% reported by Njidda and Isidohomen (2009) who examined carcass characteristics of rabbits fed grasshopper meal as a substitute for fish meal. The no regular trend could be attributed to dietary effect.

**Conclusion**

Based on efficiency of feed utilization and dressing percentage, inclusion of tomato fruit waste meal at 5% level in rabbit's diets improved the FCR and dressed weight. Body weight gain and carcass yield were also higher for rabbits fed 5% TFWM meal followed by those fed 10% and then decreased with increasing inclusion of TFWM meal at 15% level. The study has shown that the inclusion of TFWM up to 10% in the diets of rabbits positively enhanced growth performance and carcass characteristics.

**Recommendations**

Based on the results of this study, it is therefore recommended that:
Inclusion of tomato fruit waste meal up to 10% in rabbit diets is nutritionally adequate for adoption by farmers for better growth performance and carcass yield. Further research may be necessary with tomato fruit waste meal to determine their effect on the economics of production of rabbits.

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Table 1: Composition of the experimental diets

| Ingredient | Dietary treatments | | | |
|---|---|---|---|---|
| | $T_1$ (0%) | $T_2$ (5%) | $T_3$ (10%) | $T_4$ (15%) |
| Maize | 42.30 | 42.30 | 42.30 | 42.30 |
| Cassava peel meal | 9.00 | 9.00 | 9.00 | 9.00 |
| Tomato waste | 0.00 | 5.00 | 10.00 | 15.00 |
| Palm kernel cake | 15.00 | 15.00 | 15.00 | 15.00 |
| Wheat offal | 11.00 | 11.00 | 11.00 | 11.00 |
| Soybean meal | 18.55 | 13.55 | 8.55 | 3.55 |
| Palm oil | 1.00 | 1.00 | 1.00 | 1.00 |
| DCP | 3.00 | 3.00 | 3.00 | 3.00 |
| *Mineral vitamin premix | 0.15 | 0.15 | 0.15 | 0.15 |
| **Calculated analysis:** | | | | |
| Crude protein (%) | 16.21 | 16.16 | 15.90 | 15.83 |
| DE (Kcal/kg diet) | 2644.23 | 2649.78 | 2655.51 | 2660.88 |
| Crude fibre (%) | 6.89 | 6.87 | 6.84 | 6.82 |

***Composition of mineral premix:** DAVO MIX, COMPANY: DAVOLAR VARIETIES CO.LTD
Vitamin A -10,000,000.00 I.U; Vitamin D3 -2,000,000.00 I.U; Vitamin E -20,000.00 mg; Vitamin K3 -2,000.00 mg; Vitamin B1 -3,000.00 mg; Vitamin B2 -5,000.00 mg; Niacin - 45,000.00 mg; Calcium -10,000.00 mg; Folic acid -1,000.00 mg; Iron -300,000.00 mg; Zinc - 80,000.00 mg; and Selenium -180,000.00 mg.

Table 2: Growth performance characteristics of weaned rabbits fed tomoto fruit waste meal based diets

| Parameters | Dietary Treatments | | | | SEM |
|---|---|---|---|---|---|
| | $T_1$ (0%) | $T_2$ (5%) | $T_3$ (10%) | $T_4$ (15%) | |
| Initial weight (g/rbt) | 750.00 | 933.00 | 617.00 | 887.00 | 148.10 |
| Final weight gain (g/rbt) | $1133.00^{a}$ | $1317.00^{a}$ | $1300.00^{a}$ | $983.00^{b}$ | 72.20 |
| Total weight gain (g/rbt) | 400.00 | 452.39 | 442.86 | 360.00 | 21.25 |
| Av, weekly weight gain (g/rbt) | 50.00 | 56.55 | 55.36 | 45.00 | 2.66 |
| Av. daily weight gain (g/rbt) | 7.14 | 8.08 | 7.91 | 6.43 | 0.88 |
| Total feed intake (g/rbt) | 469.42 | 477.34 | 4999.71 | 474.34 | 6.88 |
| Av. weekly feed intake (g/rbt) | 58.68 | 59.68 | 62.46 | 59.29 | 0.83 |
| Av. daily feed intake (g/rbt) | 8.38 | 8.52 | 8.92 | 8.47 | 0.32 |
| Feed conversion ratio | 1.17 | 1.05 | 1.13 | 1.32 | 0.16 |
| Mortality | 14.29 | 14.29 | 0.00 | 28.57 | 5.83 |

$^{a,b,c}$, Means on the same row with different superscripts are significantly different (P<0.05)
SEM: Standard error of mean
rbt: rabit

Table 3: Carcass characteristics of weaned rabbits fed tomato fruit waste meal based diets

| Parameters (%LW) | Dietary Treatments | | | | SEM |
|---|---|---|---|---|---|
| | $T_1$ (0%) | $T_2$ (5%) | $T_3$ (10%) | $T_4$ (15%) | |
| Live weight (g) | 1100.00 | 1250.00 | 1116.67 | 1083.33 | 38.11 |
| Dressed weight (g) | 700.00 | 1033.33 | 750.00 | 716.67 | 78.47 |
| Dressing % | 63.64 | 82.67 | 67.16 | 66.15 | 4.32 |
| Head | 11.15 | 10.54 | 11.34 | 11.55 | 2.18 |
| Forelimb | 6.41 | 6.81 | 6.81 | 7.71 | 0.73 |
| Back cut | 16.6 | 15.3 | 16.9 | 18.8 | 2.18 |
| Hind limb | 19.22 | 20.23 | 19.85 | 19.71 | 0.82 |
| Intestine (entire) | 26.72 | 22.41 | 27.11 | 22.43 | 1.26 |
| Duodenum | 2.00 | 1.67 | 2.67 | 1.33 | 0.29 |
| Jejunum | 0.28 | 0.13 | 0.21 | 0.25 | 0.06 |
| Ileum | 3.13 | 2.87 | 3.10 | 3.19 | 0.27 |
| Colon | 3.62 | 3.17 | 2.73 | 2.89 | 0.55 |
| Caecum | 12.05 | 8.82 | 10.73 | 8.21 | 1.06 |
| Appendix | 0.51 | 0.59 | 0.33 | 0.46 | 0.06 |
| Esophagus | 0.09 | 0.31 | 0.90 | 0.09 | 0.11 |
| Loin | 4.56 | 5.89 | 8.08 | 6.92 | 0.82 |
| Shoulder | 3.69 | 4.22 | 3.07 | 4.20 | 0.39 |
| Rack | 8.87 | 7.78 | 10.33 | 6.79 | 1.47 |
| Stomach | 6.03 | 5.46 | 7.50 | 7.67 | 0.88 |
| Pancreas | 0.16 | 0.28 | 0.07 | 0.09 | 0.12 |
| Neck | 2.66 | 2.25 | 3.28 | 3.63 | 0.51 |
| Liver | 2.9 | 2.7 | 2.9 | 2.8 | 0.10 |
| Kidney | $0.76^b$ | $0.72^b$ | $2.93^a$ | $0.65^b$ | 0.09 |
| Adrenal gland | 0.00 | 0.06 | 0.03 | 0.09 | 0.02 |
| Spleen | $0.09^a$ | $0.00^b$ | $0.09^a$ | $0.09^a$ | 0.00 |
| Trachea | 19.5 | 0.6 | 0.5 | 0.4 | 9.38 |
| Visceral fat | $0.00^c$ | $0.48^a$ | $0.06^b$ | $0.00^c$ | 0.04 |
| Gall bladder | 0.120 | 0.013 | 0.18 | 0.13 | 0.06 |
| Tail | 0.21 | 0.21 | 0.27 | 0.35 | 0.07 |
| Heart | 0.303 | 0.317 | 0.353 | 0.373 | 0.03 |

a,b,c, means on the same row with different superscripts are significantly different ($P<0.05$)
SEM: Standard error of mean
Relative weight values expressed as % live weight basis