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DIETARY LEVELS OF PINEAPPLE PEELS ON GROWTH PERFORMANCE, REPRODUCTIVE PERFORMANCE, NUTRIENT DIGESTIBILITY AND CARCASS CHARACTERISTICS OF WEANER RABBITS

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ABSTRACT
A feeding trial was conducted on weaner rabbit (*Oryctolagus cunniculus*) to assess the growth, reproductive performance, nutrient digestibility and carcass characteristics rabbits fed graded levels of inclusion of dried pineapple peal meal. Thirty-six (36) composite weaned rabbits of mixed sexed and aged between 6 and 8 weeks were randomly allotted to four dietary treatments group with nine rabbits per treatments. Each treatment had three replicates with 3 rabbits in the ratio of 2 females and 1 male per replicate. The pineapple peal was included in the diet at varying inclusion levels of 0,5,10 and 15 % (forming diets T_1, T_2, T_3 and T_4, respectively) T_1 was the control diet. The experiment lasted for fourteen (14) weeks. Data were collected on growth parameter (body weight feed intake and conversion ratio.), at the end of the 7 weeks digestibility trial using a total collection method. Reproductive performance trial was also determined and carcass characteristics 8 weeks, 2 rabbits per replicate were slaughtered eviscerated and dressed to obtain carcass information on the carcass, weighted and expressed as percentage live weight. Result revealed non- significant ($P<0.05$) differences in the values obtained for final weight gain, feed conversion ratio and mortality. Result of nutrient digestibility revealed a significant different ($P<0.05$) most of the parameters (CP. CF and Ash). Significant ($P<0.05$) different were also recorded in the semen characteristics (sperm per ejaculate and % live sperm. Also, carcass characteristics were observed to be significantly ($P<0.05$) different on head, fore limb and hind limb). Result obtained for the experiments revealed significant differences in most of growth parameters, higher values of total weight gains and feed intake were observed in T_2(5%) 508.33level of inclusion level with T_4(15 %) 485.33 lower values. Results of carcass characteristics revealed significant difference ($P<0.05$) in back, hind limbs and fore limbs, respectively, with T_2 having higher values of 181.60, 23.76, for organ weight of weaner rabbits the kidney revealed significant effects ($P<0.05$) with T_2 (5%) having a higher value 6.00 and lower value of 5.20 at T_4(15%) inclusion level. Also, the result of semen characteristics revealed significant difference ($P<0.05$) on sperm ejaculate and live sperm % with T_3(10%) having the highest value 355.00 and lowest value of 0.275.00 at T_1(5%). It can therefore be recommended that 5% (T_2) of dry peal pineapple meal can be included in the diet of weaner rabbit for optimum growth performance, nutrient rabbit digestibility and carcass characteristics while T_4(15%) inclusion level for reproductive

Keywords: Dietary, Carcass, Growth performance, Nutrient digestibility, Rabbits.

INTRODUCTION
The need for adequate supply of quality protein in developing countries like Nigeria is on the increase and it has become necessary to exploit species of animals that are prolific and have short cycle of production. Rabbit production exemplifies the vast possibilities for increasing meat production in the most poverty-stricken parts of the world. This is due to its high fecundity, fast growth rate, short generation interval and low feed cost (Etchu *et al.*, 2012).

Apart from their high rate of reproduction, these species are character1zed by the best efficiency of nutrient transformation into high quality animal protein (Aboh *et al.,* 2013).

Reproductive performance of farm animals depends mainly on adequate level of vitamins and essential minerals due to their vital roles in cellular metabolism, maintenance and growth. It was reported that administration of vitamins especially A, D, E and/or supplementation with selenium improved reproductive performance in sheep (Gamal *et al.,* 2014). The efficiency of sperm production, libido and quality of sperm tend to remain uniform throughout the reproductive life of an animal but may be significantly altered by age, nutrition, environment, health status, drugs, and chemicals (Mahima *et al.,* 2012).

High cost of protein feedstuff for livestock feeding, such as groundnut cake and soybean meal and the high competition that exists between man and animals for these conventional feedstuffs has necessitated the need for maximizing the effective utilization of non-conventional feedstuffs (Aboh *et al.,* 2013). One of the non-conventional feedstuffs that have potential for rabbit feeding is the pineapple peel waste. It is a by-product obtained from pineapple processing.

The aim of this study was to investigate the effect of the dietary levels of pineapple peels on growth performance, reproductive performance, nutrient digestibility and carcass characteristics of weaner rabbits. The specific objectives of this study were to:

i. evaluate the effect of graded levels of pineapple peel meal supplementation on the growth performance of weaner rabbits
ii. determine the effect of graded levels of dry pineapple peels meal supplementation on the nutrient digestibility of weaner rabbits
iii. assess the effect of graded levels of dry pineapple peels on the carcass characteristics of weaner rabbits
iv. evaluate the effect of graded levels of dry pineapple peels on the reproductive performance of rabbit bucks.

MATERIALS AND METHODS

Experimental Animals and Managements

A total of 36 weaned rabbits of mixed breed between the ages of 6-8 weeks weighing between 225-300 kg were used for the study. They were purchased from Rabbit Multiplication Centre Minna, Niger State. On arrival, the rabbits were dewormed with Ivermectin to treat both internal and external parasites at a recommended dosage of 0.2 ml per animal and given Tridox long-acting antibiotics. The animals were allowed to acclimatize for seven days before the commencement of the research work and Trisulmycine Forte (sulfadiazine) was used to control the coccidiosis.

Each of the rabbits were housed in an individual hutch made of wire/nets with a dimension of 100 cm x 80 cm 100 cm raised at 80 cm above the floor. Two earthen pots for feed and water were placed in each hutch. All conventional management practices were followed. The growth phase lasted for 12 weeks. The entire study lasted for 14 weeks. Each hutch was provided with wire screen floor, which permit faeces and urine to drop. All animals had free access to drinking water, and the experimental diets were offered ad-libitum. An adaptation to experimental diet lasted for seven days before experimental feeding. The daily feed intake was recorded per animal to calculate feed consumption. Also, the live weights (LW) were recorded before feeding and watering.

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Experimental design

Thirty-six (36) rabbits were assigned to the test diets using a completely randomized design (CRD). Nine (9) rabbits were randomly allotted to each dietary treatment T_1, T_2, T_3 and T_4 (diet formulated to contain 0, 5, 10 and 15 0) pineapple peel, respectively.

Table 1: Composition of the experimental diets

Ingredients	**Level of dry pineapple peel inclusion (%)**			
	0	**5**	**10**	**15**
Maize	15.90	14.90	10.90	10.90
Maize offal	49.70	47.70	46.70	43.70
Brewers dried gain	6.50	5.50	5.50	5.50
Groundnut cake	7.00	7.00	7.00	6.00
Soybeans meal	9.00	8.00	8.00	7.00
Rice offal	9.00	9.00	9.00	9.00
Pineapple peel	0.00	5.00	10.00	15.00
Bone meal	2.20	2.20	2.20	2.20
Salt	0.25	0.25	0.25	0.20
Vitamin premix	0.25	0.25	0.10	0.20
Lysine	0.10	0.10	0.10	0.10
DL-Methionine	0.10	0.10	0.10	0.10
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis				
Energy (Cal/kg)	2575.40	2413.66	2282.52	2154.43
Crude protein	16.24	15.75	15.58	15.11
Crude fibre	9.64	9.42	9.53	9.05
Calcium	0.10	0.35	0.66	0.96
Phosphorus	0.12	0.42	0.72	1.02

Method of Data collection

Parameters measured for growth performance include; weekly body weight, feed intake, feed conversion ratio, total weight gain, mortality and for carcass characteristics are, live weight, dressed weight, dressed percent, head weight, liver weight, kidney weight, lung weight, intestine weight, skin weight, tail weight, feet weight. Mortalities records were also monitored. This weight was determined using matter electronic digital scales which were subjected to analysis of variance (ANOVA) using SPSS 14.0 (2004).

$$\text{Mortality (\%)} = \frac{\text{Number of dead rabbit}}{\text{Total stock}} \text{ x } 100$$

Body weight of individual rabbit was determined in kilogram (kg) by placing each rabbit on the loading pan of the mettle Toledo ® top loading of 20kg capacity scale. Feed conversion ratio (FCR) was calculated according to this formula:

$$\text{FCR} = \frac{\text{Average daily dry matter intake (g)}}{\text{Average daily live weight gain (g)}}$$

Nutrient Digestibility

Three rabbits from each of the experimental group were assigned to four experimental diets. They were housed individual in hutches, which permits faeces collection and urine to drop. The leftover diet and faeces were recorded daily per animal during the seven days. The daily feed intake was recorded per animal to calculate feed consumption. These data were used

to analyze proximate composition. Nutrient digestibility was used to determine with the used of this formula:

$$\text{Digestibility} = \frac{\text{Dry matter excreted in faeces}}{\text{Dry matter intake}}$$

Carcass and Organ Characteristics

At the end of the experiment, one doe rabbit and one buck rabbit from each treatment were randomly selected and slaughtered in order to evaluate carcass and organ characteristics. Live weight as well as slaughtered weight, weight of the small intestine, head, lungs, heart, liver, and kidney was considered for evaluation during carcass characteristics. The selected rabbits were weighed, starved over night to clear the gut and were slaughter by cutting the jugular vein with a sharp knife. During evisceration, the internal organs and other guts contents were removed and weigh. Then the dressed carcass, body parts and organs were also weighed and expressed as percentage of the live weighed.

Reproductive Performance

The semen collection and evacuation were done with the aid of an artificial vagina (AV) as was designed and described by Herbert *et al.* (2005). Does were used as teasers on the day of semen collection. The ejaculate obtained was evaluated as described by Zemjanis (1970). This included the visual or gross evaluation of the ejaculate soon alter collection for volume, pH and color as well as microscopic examination for motility, Concentration, percentage live spermatozoa and morphological abnormalities.

Volume of Semen

The volume of semen was measured directly from the calibrated tube used for the collection.

Color of Semen

Three color categories of milky, creamy and watery designated 1, 2 and3 was used for scoring the semen as described by Zemjanis (1970).

Semen pH

Semen pH was determined by dipping a litmus paper into the ejaculate and corresponding color changes was observed and recorded.

Gross Motility of Sperm

This was examined quickly after collection by placing a drop of the semen sample on a pre- warmed glass slide, cover slipped and examined at x10 magnifications.

Spermatozoa Concentration

This was determined using Neubauer haemocytometer as described by Azawi and Ismaeel (2012). Micropipette was used to aspirate 25 ul of semen and diluted with 5 ml of 3 % NaCl in a test tube, dilution factor of 5000. The exterior of the pipette was wiped to remove any adhering semen. A cover slip was placed on the haemocytometer and two drops of the diluted semen were placed under the cover slip on each side of the haemocytometer. The haemocytometer was carefully placed in a pre-wetted chamber and the lid closed and left for five minutes. It was then examined using a microscope at x40 magnification and the Sperm cells was counted in five Thoma squares of the chamber (that is, four cormer and the centre squares).

The semen concentration was calculated as follows:

Concentration (sperm cells/mL) = Number of sperm cells x dilution factor x 10^6 (Azawi and Ismacel, 2012).

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Percentage Live sperm Cells

This was determined as described by Esteso *et al.* (2006). A thin smear of the semen was made on a clean grease free slide and stained with eosin-nigrosin stain. This technique was based on the principle that eosin-nigrosin penetrates and stains dead sperm cells while live sperm cells repel the stain. Dead spermatozoa stained pinkish or reddish while live spermatozoa remained colorless. Stained and unstained sperm cells were counted when the slides were dried, using light microscopy at x40 magnification and percentage of each estimated (Esteso *et al.*, 2006).

Sperm Abnormalities

This was determined by making a thin smear of the semen sample, on clean grease-tree glass slide and stained with eosin-negrosin. One hundred sperm cells were counted per slide using hand counter under light microscopy at x 40 magnifications. Five cell types were recorded: normal cell, detached head, free tail, coiled tail and bent tail (Rekwot *et al.*,1987).

Digestibility Trial

Three (3) rabbits from each of the experimental group were assigned to the four experimental diets. They were housed individual hutches, but provided with material, which permits faeces collection and urine to drop. The left-over diet and faeces were recorded daily per animal during the seven days. The daily feed intake was recorded per animal to calculate feed consumption. All these data were used to calculate apparent digestibility coefficient of dry matter for each diet according as:

$$\text{Digestibility} = \frac{\text{Dry matter intake - Dry matter excreted in faece}}{\text{Dry matter intake}} \times 100$$

Statistical Analysis

Data obtained were subjected to one way analysis of variance (ANOVA) using the general linear model (GLM) procedure of SAS (2004). Means with significant differences were compared using Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Proximate Analysis of Experimental Diet Meal

The results of proximate analysis of experimental diet meal in Table 2 the moisture content, crude fibre and crude protein of the diets ranges from 5.20 6.20, 5.00 - 7.00 % and 26.00-27.30 %, respectively. While that of the dried pineapple peel reveal a dry matter content of dry matter, 80.18%, moisture, 15.20%, crude protein, 5.78%, crude fibre, 42.10%, ash, 3.78% respectively. The results obtained for ash, ether extract and nitrogen free extract ranges from 8.50 - 10.00, 11.50 - 14.00 and 38.90 -42.55 %, respectively. Presented in Table 2 is the results of proximate analysis of dried pineapple peels meal, the dry matter was 13.19 %, moisture 86.81 %, crude protein 5.04%, crude fibre 42.02%, Ash 6.20%, respectively. The proximate composition of pineapple peels meal contains 80.18% dry matter, 15.20% moisture, 5.20% crude protein, 42.10% crude fibre, 3.78 ask, respectively. The proximate composition of pineapple peels contain 13.19%, dry matter, 5.04, crude protein,42.02 crude fibre, 6.20 ash86.81 moisture, respectively, which is higher than the values obtained for all the proximate parameters similar" but lower than the values obtained by Izhaki (1993) and Nurhayati (2013) who reported that pineapple waste (peels) contains 14.22 % dry matter, 81.90 % organic matter, 8.10 % ash, 0.56 % nitrogen, 3.50 Yo Crude protein, 3.49 % crude lipid and 4,481.2 kcal/kg of gross energy. The authors also revealed that pineapple skin waste contains 16.7 % crude fibre content and that it 1s rich in vitamin C and bromelain, which hydrolyzes protein. The differences in the values could be due to the source of the pineapple peels, agronomic practices

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and the methods or harvest/handling process which is capable of affecting the compositions of the pineapple peels.

Table 2: Proximate analysis of experimental diets and dried pineapple peel fed to the weaner Rabbits

Parameters (%)	**Level of dry pineapple peel inclusion (%)**				**Pineapple peel**
	0	**5**	**10**	**15**	
Dry matter	94.80	94.20	93.80	94.80	80.18
Moisture	5.20	5.80	6.20	5.20	15.20
Crude protein	26.94	27.30	26.50	26.00	5.78
Crude fibre	5.38	5.50	5.00	7.00	42.10
Ash	8.50	9.50	9.00	10.00	3.78
Ether extract	11.50	13.00	14.00	11.50	-
NFE	42.48	38.90	42.55	40.30	-

Note: NFE = Nitrogen free extract; T_1: 0% inclusion level of dried pineapple; T_2: 5% inclusion level of dried pineapple; T_3: 10% inclusion level of dried pineapple; T_4: 15% inclusion level of dried pineapple.

The Growth Performance of Weaner Rabbits Fed Graded Levels of Dry Pineapple Peels

The results of the growth performance of weaner rabbits fed graded levels of pineapple peel are presented in Table 3. The results obtained revealed no significant ($P>0.05$) difference in all the parameters except for total feed intake, daily feed intake and on the feed intake/day/rabbit. The final weight ranged from 1092.33 g - 1251.67 g while the total weight gain ranged from 458.33 g-598.33 g. The results for total feed intake, daily feed intake and feed intake/day/rabbit were found to be higher in 0% inclusion, although similar with 5 % inclusion and 10 % inclusion and significantly ($P<0.05$) different from those in 15 % inclusion for total feed intake, daily feed intake and feed intake/day/rabbit. In general, the growth performance of rabbits reduced with the increase of the pineapple peel (PP) level in the diet (Table 3) but not statistically different. The rabbits fed 15 % inclusion diet recorded the lowest ($P<0.05$) in all the growth parameters taken.

The results of the growth performance of weaner rabbit were presented in Table 3. Feed intake and growth performance during the period of the trial were enhanced by the inclusion of pineapple peel. It may indicate that this long-term post-ingestion of experimental diets feedback is positive. In addition, this result may express those diets based on pineapple peel as formulated, met feedstuff characteristics in relation to the gut capacity, rabbit's requirements and nutrient concentrations. However, the crude protein contents (15.11-16.25 %) of the experimental diets were relatively lower than that of conventional diets (18.8%) used by Kpodekon *et al.* (2009) and that based on unfermented pineapple peel (19.5-19.8%) formulated by Adeyemi *et al.* (2010). The decrease in growth performance could be due to low digestibility as a result of increase inclusion of pineapple peels. The average live weight gains recorded in this experiment were lower than the value reported (11g/ day) by Adeyemi *et al.* (2010) with 12.5 to 25% PP inclusion in rabbit diet which could be due to differences in the source of the experimental materials and animals, handling and processing methods implored by the authors. The present live gains are lower than 19.7 to 23.1 g/day and 19 to 22 implored by the authors. The present live gains are lower than 19.7 to 23.1 g/day and 19 to g/day recorded, respectively, by Houndonougbo *et al.* (2012) and Kpodekon *et al.* (2009). The final average live weight gains and feed conversion rate of weaner rabbits significantly reduced as inclusion level of pineapple peels increased. Adeyemi *et al.* (2010) and Fapohunda *et al.* (2008) observed the same trend when using pineapple peel in the rabbits feed.

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However, the feed conversion ratio recorded in this experiment is better than that recorded by Adeyemi *et al.* (2010) when pineapple peel was fed. The difference may due to the nutrient imbalance, particularly the CP contents of diets. To balance dietary CP contents, an increase in feed ingredient rich in CP such as soya bean cake and cotton cake in diets 10% inclusion and 15% inclusion can be done.

Feed intake and growth performance during the period of the trial were enhanced by the inclusion of pineapple peel. It many indicate that this long-term post-ingestion of experimental diets feedback is positive. In addition, this result may express those diets based on pineapple peel as formulated, met feedstuff characteristics in relation to the gut capacity, rabbit's requirements and nutrient concentrations. However, the crude protein contents (13.92 - 16.67 6) of the experimental diets were relatively lower than that of conventional diets (18.8 6) used by Kpodekon *et al.* (2009) and that based on unfermented pineapple peel (19.5-19.8 %) formulated by Adeyemi *et al.* (2010). The decrease in growth performance could be due to low digestibility as a result of increase inclusion of pineapple peels. The average live weight gains recorded in this experiment were lower than the value reported (1 1g/ day) by Adeyemi *et al.* (2010) with 12.5 to 25 % PP inclusion in rabbit diet which could be due to differences in the source of the experimental materials and animals handling and processing methods implored by the authors. The present live gains are lower conventional diets (18.8 %) used by Kpodekon *et al.* (2009).

Table 3: Growth performance and mortality of weaner rabbits fed graded levels of dry pineapple peels meal

Parameters	**Inclusion levels of dry pineapple peel (%)**					
	0	**5**	**10**	**15**	**SEM**	**LSD**
Initial weight (g)	653.33	623.67	632.00	634.00	48.17	0.94
Total weight gain (g)	1251.67	1132.00	1107.33	1092.33	110.87	0.50
Final weight (g)	598.33[a]	508.33	475.33	458.33[b]	111.79	0.62
Weight gain/day/rabbit (g)	7.12	6.05	5.66	5.46	1.33	0.09
	4011.33[a]	3735.67[a]	3424.33[a]	3215.00[b]	254.21	0.06
	47.75[a]	44.47[a]	40.77[a]	38.27[b]	3.03	0.01
	6.70	7.35	7.20	7.02	2.03	0.97
	11.11	0.00	0.00	11.11		

SEM= Standard error of mean, LSD= Level of significance, a,b= Means in the same row with difference superscript were significant (P<0.05) different; FCR= Feed conversion ratio; (%) = Percentage; Key: T_1= 0% inclusion level of dried pineapple; T_2: 5% inclusion level of dried pineapple; T_3: 10% inclusion level of dried pineapple; T_4: 15% inclusion level of dried pineapple.

Nutrient Digestibility of Weaner Rabbits Fed Graded Levels of Pineapple Peels

From the results obtained in Table 4, there were significant (P<0.05) differences across the treatment groups for crude protein, crude fibre and ash while moisture content, ether extract and nitrogen free extract had no significant (P>0.05) difference. For the crude protein, the highest value (18.02) was found in 15 % inclusion followed by 5 % inclusion (17.21) which is similar with 0 % inclusion and 10 % inclusion while the highest values for crude fibre and ash were found in 0 9% inclusion (20.46) and 15 % inclusion (11.19), respectively.

The result of nutrient digestibility is presented in Table 4. The sun drying of pineapple peel (PP) allows the conversion of that perishable feed into a stabilized product through the

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dehydration at suitable level. Aboh *et al.* (2011) got a stabilized product using the same method to keep cashew apple. The sun drying of PP would avoid the microbial attacks and the deterioration of the product quantity related to the undesirable biochemical reactions. Also, the conservation by Sun dying contributes to reduce the losses of the by-product and mention of environment pollution. The values of the ash recorded from sun dried PP in the present study indicated that it is a useful feed source for rabbits. However, its crude protein content is low. The PP crude protein value obtained is slightly higher than the value recorded 5.11 %) by Adeyemi *et al.* (2010). In contrast, ash content is lower than that recorded (11.80 %) by the same authors. Apart from the varietal differences between pineapples, another Teason for this may be the supply of fertilizer. According to Adeyemi *et al.* (2010), PP crude fibre (27.95 %) and gross energy (8.45 MJkg-1) contents are higher and these finding 1ndicates that PP is a good source of dietary fibre. The trend indicates that as inclusion level of is increasing digestibility for all the parameters increases except for crude fibre. However, the values obtained for all the parameters followed the same trend and similar with the report of Ginting *et al.* (2005). Which in his report gives digestibility valued as dry matter 90.44, moisture 82.85, crude protein 76.33, crude fibre 76.62, ash 52.00 ether extract 55.65, NFE 76.00.

Table 4: Nutrient digestibility of weaner rabbits fed graded levels of pineapple peels meal

Parameters	**Inclusion levels of dry pineapple peel (%)**				
	0	**5**	**10**	**15**	**SEM**
Dry matter	90.44	91.06	90.31	90.30	0.30
Moisture	9.66	8.94	9.69	9.70	0.30
Crude protein	17.09^{b}	17.21^{b}	16.89^{b}	18.02^{a}	0.16
Crud fibre	20.46^{a}	19.70^{ab}	18.62^{bc}	17.82^{c}	0.27
Ash	8.83^{c}	9.86^{b}	9.86^{b}	11.19^{a}	0.25
Esther extract	3.86	3.96	4.78	5.21	1.56
NFE	39.92	40.32	40.07	38.09	0.67

a,b,c = means in the same row with different superscript were significantly ($p<0.05$) different; SEM = Standard error of mean; LSD = Level of significance; FCR = Feed Conversation Ratio; NFE = Nitrogen Free Extract. Key: T_1= 0% inclusion level of dried pineapple; T_2: 5% inclusion level of dried pineapple; T_3: 10% inclusion level of dried pineapple; T_4: 15% inclusion level of dried pineapple.

Carcass Characteristics and Organs Weights of Weaner Rabbit Fed Graded Levels of Dried Pineapple Peels Meal

The results in Table 5 shows that there were no significant ($P>0.05$) differences in the live weight, slaughtered weight, head and tail of the rabbits across various treatment groups in this study. The table indicated that rabbits on 10 % inclusion were consistently better in the carcass parameters measured herein and while differences ($P<0.05$) occur in their respective mean performances.

The results presented in Table 5 showed that the values obtained on the carcass parameters measured across the treatment groups were a true reflection of the body weight performance indices and that of body development. However, the nutrient supplied by the pineapple peel at 5 % and 10 % diet was adequate and produced carcass parameters that were better than those on other dietary treatments for visceral weight, back, front leg, kidney, lungs, intestine and liver weights. Meanwhile, the live weight, slaughter weight was not affected by pineapple peel inclusion across the treatment groups. The values of these organs indicate that there were no metabolic defects among rabbits fed the experimental diets. The lower weight of some organs has been attributed to the pathological effect of residual anti- nutritional factors

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present in the pineapple peel (Hetland and Svihus, 2001). The results obtained in this investigation are in close conformity with the results reported by Sen and Bhagwan (1999). (1999) and Farghaly and El-Mahdy (1999) who fed weaner rabbits with agro-industrial by-products like pineapple and cassava waste, respectively. However, higher values were obtained by the authors and this could be due to differences in the experimental animals and sources of the experimental animals and other genetic and environmental factors.

Table 5: Carcass characteristics of weaner rabbits fed graded levels of pineapple peels meal

Parameters	**Inclusion levels of dry pineapple peel (%)**				
	0	**5**	**10**	**15**	**SEM**
Live weight	1815.50	2023.60	2081.70	1837.30	59.60
Head	100.85	113.77	114.53	90.20	0.02
Back	136.75^{b}	181.60^{a}	206.10 ^{a}	105.50^{b}	13.29
Fore limb	6.50^{ab}	7.86^{a}	8.00 ^{a}	6.07^{b}	1.01
Hind limb	20.50^{a}	23.76 ^{a}	22.67 ^{a}	15.50^{b}	1.01
Tail	8.50	8.83	12.60	26.00	5.15
Skin	64.75	88.23	87.63	54.90	7.30

a,b,c = means in the same row with different superscript were significantly ($p<0.05$) different; SEM = Standard error of mean; LSD = Level of significance; FCR = Feed Conversation Ratio; NFE = Nitrogen Free Extract. Key: T_1= 0% inclusion level of dried pineapple; T_2: 5% inclusion level of dried pineapple; T_3: 10% inclusion level of dried pineapple; T_4: 15% inclusion level of dried pineapple.

Organs Weight of Weaner Rabbits Fed Graded Levels of Dry Pineapple Peels

The result in Table 6 shows that there were no significant ($P>0.05$) differences in the weight of the large intestine, lung and heart. There were however significant ($P<0.05$) differences in those of small intestine, kidney and liver.

The result in Table 6 shows that there were no significant ($P>0.05$) differences in the weight of the large intestine, lung and heart. There were however significant ($P<0.05$) differences in those of small intestine, kidney and liver.

The results in this study were also similar with reports given on carcass characteristics of rabbits fed other relatively high fibre sources such as cassava peels and cassava peal meal (Agunbiade *et al.*, 1999). The non-significant ($P>0.05$) difference in the relative weights of the heart, drumstick and ski among the treatment groups in the present study can be explained by the observations of Hight and Baston (1965) that the organs mentioned above attain most of their mature weight during development of the faeces. Therefore, experimental diets do not significantly ($P>0.05$) change heart weights for instance in the later stages of growth. This is in agreement with the report of Aboh *et al.* (2013) who report no significant difference in rabbit's heart, gut and skin fed graded levels of pineapple peels. This finding shows pineapple has no significant effect on the aforementioned parameters.

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Table 6: Organ weight of weaner rabbits fed graded levels of pineapple peels meal

Parameters	Inclusion levels of dry pineapple peel (%)				
	0	**5**	**10**	**15**	**SEM**
Small intestine	33.20^{a}	42.00^{bc}	53.63^{b}	35.90^{c}	3.15
Large intestine	87.55	117.67	116.60	83.83	7.02
Kidney	5.55^{ab}	6.00^{a}	5.92^{a}	5.20^{b}	0.79
Lungs	3.46	4.70	4.62	3.82	0.52
Heart	1.83	1.86	1.86	1.19	0. 06
Liver	45.86^{ab}	53.40^{a}	51.63^{a}	38.0^{b}	2.45

a,b,c = means in the same row with different superscript were significantly ($p<0.05$) different; SEM = Standard error of mean; LSD = Level of significance; FCR = Feed Conversation Ratio; NFE = Nitrogen Free Extract. Key: T_1= 0% inclusion level of dried pineapple; T_2: 5% inclusion level of dried pineapple; T_3: 10% inclusion level of dried pineapple; T_4: 15% inclusion level of dried pineapple.

Semen Characteristics of Weaner Rabbits Fed Graded Levels of Dry Pineapple Peels Meal

The semen characteristics of weaner rabbits fed graded levels of pineapple peel are presented in Table 7 The results for all the parameters were no significant ($p>0.05$) difference across the treatment groups except for sperm per ejaculate and live sperm. The result for sperm cell in semen per ejaculate of the rabbit in 10% inclusion (355.00) was significantly ($p<0.05$) higher than the sperm in treatments 1(0 %) and 2(5 %) inclusion level. The result also showed that the live sperm in the rabbits on 15% inclusion (93.00) was significantly ($p<0.05$) comparable to the sperm in treatments 1(0 %) and 2(5 %), respectively. Similarly, the result of live sperm showed that rabbit in 10 % inclusion had significantly ($p<0.05$) higher value than those in 15 % inclusion. It also showed that live sperm count in 5 % inclusion and 15 % inclusion were not significantly ($p<0.05$) different but they were both significantly similar to the live sperm count in 0 % inclusion and 10% inclusion, respectively. There were no significant ($p>0.05$) differences in semen volume, semen pH, semen motility, head abnormality, midpiece abnormality and tail abnormality.

Table 7 shows that the higher values obtained in 10 % inclusion of pineapple peels for sperm per ejaculate and live sperm is in agreement with the report of Daramola *et al.* (2016) that supplementing rabbits' diet with fruit Juice (orange and pineapple) at 10 % consistently improved motility, acrosome integrity and membrane integrity, and reduced sperm abnormality. The improvement in semen quality in 10 % inclusion could be attributed to the presence of substances in pineapple such as vitamins and phenolic compounds which are known to function as antioxidants (Kiwon *et al.*, 2003; Cutler *et al.*, 2008). Gardner *et al.* (2000) had earlier reported that concentrations of vitamins and total phenolic contents in fruit have a strong relationship with antioxidant capacity (Daramola *et al.*, 2016). Similarly, Amedu and Idoko (2016) reported that *Cilrullus lanatus* promotes normal sperm morphology, sperm concentration, Sperm volume and sperm mortality in rat semen, probably due to the antioxidant activity of ycopene present, Similar reports also corroborates this claim in chilled or frozen rabbit, Turkey and Fowl semen (Rosato *et al.*, 2012). Motility is an important parameter used for semen evaluation and Concannon and Battista (1989) suggested that at least 40 %- 50 % sperm motility is necessary for success in artificial insemination. The results obtained show that inclusion of pineapple peel will help improve the semen quality of rabbits thereby improving the general reproductive performance of rabbit bucks.

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Table 7: Semen characteristics of weaner rabbits fed graded levels of pineapple peels meal

Parameters	**Inclusion levels of dry pineapple peel (%)**				
	0	**5**	**10**	**15**	**SEM**
Semen color	Creamy	Creamy	Creamy	Creamy	Creamy
Semen volume (ml)	0.35	0.45	0.50	0.30	0.04
Semen pH	6.50	7.00	7.50	6.50	0.40
Semen mortality (%)	6.00	5.50	7.00	6.50	0.37
Sperm per ejaculate ($\times 10^6$)	275.00^{b}	295.50^{b}	355.00^{a}	305.00^{ab}	2.20
Live sperm (%)	90.50^{b}	92.00^{ab}	95.50^{a}	93.00^{ab}	0.79
Head abnormality (%)	4.50	4.00	2.50	5.00	0.46
Midpiece abnormality (%)	4.50	4.00	4.00	4.50	0.37
Tail abnormality (%)	3.50	4.50	5.00	4.50	0.42

a,b,c = means in the same row with different superscript were significantly ($p<0.05$) different; SEM = Standard error of mean; LSD = Level of significance; FCR = Feed Conversation Ratio; NFE = Nitrogen Free Extract. Key: T_1= 0% inclusion level of dried pineapple; T_2: 5% inclusion level of dried pineapple; T_3: 10% inclusion level of dried pineapple; T_4: 15% inclusion level of dried pineapple.

CONCLUSION AND RECOMMENDATION

The study concluded that the inclusion of the test ingredient (dry pineapple peel) at 5% and 10% inclusion level in the diets of rabbits improved the traits such as semen and cacarass characteristics monitored without any detrimental effect. The values of various parts indicate that there were no metabolic defects among rabbits fed the experimental diets. Supplementing rabbits' diets with dry pineapple at 10% consistently improved nutrient digestibility, mortality, acrosome integrity and membrane integrity, and reduced sperm abnormality. Base on the finding of this research, 10 % of dry pineapple meal is recommend. Consequently, more research should be carried out on dry pineapple peel as growth and reproductive promoter in order to have a standard inclusion level percentage for commercial production which will aid in meeting up with the protein requirement of the populace and profitable prolific production.

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