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Reproductive Performance of Rabbits (*Oryctolagus cunniculus*) fed Diets Containing Varying Levels of Dried Bovine Rumen Digesta

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Abstract
Sixteen female and four male growing rabbits of mixed breed, aged 18 weeks, with average initial body weight of 1750.00 g were used in a completely randomized design experiment to evaluate the nutritive values of Dried Bovine Rumen Digesta (DBRD) in rabbit diets for reproductive performance. The levels of inclusion of DBRD were 0 , 25 , 50 and 75 % for diets T_1 (control), T_2, T_3 and T_4, respectively. The reproductive performance showed significant ($P<0.05$) differences for most of the parameters measured except for gestation length, litter weight at weaning and litter weight gain. The values obtained for litter size at birth (LSB) were 5.25, 3.75, 6.75 and 4.24, respectively, while values obtained for litter size at weaning (LSW) were 3.75, 3.00, 5.50 and 4.00, respectively. The highest value 5.50 was obtained from animals on diet T3 (50 % DBRD), while the lowest value 3.00 was obtained from animals on diet T_2 (25 % DBRD . The values obtained for survival rate to weaning (SRW) were 64.58 %, 70.00 %, 64.30 %, and 54.00 % for rabbits on diets T_1, T_2, T_3 and T_4 respectively. Rabbits on diet T_2 had the best survival rate and showed significant ($P<0.05$) difference among others. The does on diet T_3 (50 % DBRD) recorded the highest ($P<0.05$) 6.75 litter size at birth (LSB), while the lowest 3.75 LSB was obtained from does on diet T_2 (25 % DBRD). The values obtained for neo-natal mortality (NNM) were 16.67 %, 18.75 %, 20.73 % and 21.25 % for animals on diets T_1, T_2, T_3 and T_4, respectively. The results of the co-efficient of milking capacity (CMC) were 0.17, 0.15, 0.17 and 0.14 for diets T_1, T_2, T_3 and T_4, respectively. The overall performance of Rabbits on diet T_3 (50 % DBRD) was better than those in the other treatment groups. Therefore, it was concluded that up to 50 % level of DBRD can be included in the diets of breeding rabbits for better reproductive performance without any deleterious effect.
Key words : Reproduction, Response, Rabbits, Diet, Dried Bovine Rumen Digesta.

Introduction

In Nigeria and in most developing countries average consumption of animal protein is very low, estimated at 4.5 g/head/day as against a minimum requirement of 35 g/head/day (FAO, 2001). Yusuf *et al.*(2009) reported that high cost of conventional feeds might be responsible for the low protein consumption. This reduced animal protein intake has far-reaching implication on the health status and well-being of the populace (Alu *et al.*, 2009).
Rabbit meat production has been on the increase in Nigeria in recent years, this is because rabbit (*Oryctolagus cunniculus*) is the most productive meat-producer among all domesticated animals **(**Odeyinka *et al.*, 2008). Nutritionally, the meat is high in protein (about 22 %), low in fat (4 %) and cholesterol (5 %), and thus possesses health promoting qualities (Obinne and Mmereole, 2010). In addition to these unique characteristics, they have small body size and short generation interval with a relatively short gestation period (Average of 30 – 31 days). These factors result in rabbit reaching the weight of a sexually mature animal 30 % faster than other animals (Ajayi *et al.*, 2005) and also makes rabbits suitable as meat-producing small livestock in developing countries (Arijeniwa *et al.*, 2000).

The rabbit (*Oryctolagus cunniculus*) is a non-ruminant herbivore which utilizes much undigested, unabsorbed feed materials, primarily cellulose, as a source of nutrients for maintenance and production. They are known to have the ability to thrive on non-conventional feedstuffs and forages which cannot be consumed directly by man. Such forages are cheap, abundant and available all the year round in many parts of Nigeria (Odeyinka and Ijiyemi, 1997; Shiawoya and Musa, 2006). Although rabbits can survive on all forage diets, optimum performance can only be ensured in a mixed feeding regime involving forage and formulated feeds (Arijeniwa *et al.*, 2000). The profitability of rabbit production as an enterprise depends on the number of rabbits kindled per doe per year and the postnatal survival of the kittens.

Feed constitute the dominant input in animal production ranging from 65 - 75 % of the total cost of production. Similarly, feed ingredient account for over 90 % of compound feed industry (Esonu *et al.,* 2006). Therefore, the relationship between feed ingredient and animal production output is both direct and obvious. It has been reported that conventional protein and energy feed ingredients for non-ruminants including rabbits, are very scarce and expensive because of the competition between humans and this group of livestock (Esonu *et al.,* 2004).

Recycling of slaughter house waste, as feed for various categories of livestock has been a continuous subject of investigation (Igwebuike *et al.,* 2006). Rumen digesta is one of the by-product of abattoir, it is the partially digested forage mainly found in the rumen of ruminant animals. It is fairly rich in crude protein (18.52 %) and other micro-flora such as fungi, protozoa and bacteria (Ayoade *et al*., 2000; Dairo *et al*., 2005; Esonu *et al*., 2006). Dried rumen digesta not only serve as a feed nutrient, recycling it will also reduce disposal and environmental pollution problem (Esonu *et al.,* 2006). The disposal of this material may be achieved by its incorporation into livestock feeds (Esonu *et al*. 2006). Bovine blood-rumen content mixture (BBRCM) has been used to feed poultry (Adeniji and Balogun, 2001, 2002; Odunsi, 2003; Adeniji and Jimoh, 2007), rabbit (Dairo *et al*., 2005; Togun *et al*., 2009) and ruminant (Salinas-Chavina *et al*., 2007; Rios-Rincon *et al*., 2010) as a cheap untraditional feed stuff to reduce feeding cost and alleviate pollution problems without any reported deleterious clinical effect on animal health and performance. However, higher levels of dried bovine rumen digesta (DBRD) up to 75 % level have not been reached according to the literature available on the use of DBRD in the diets of livestock generally, and rabbits in particular. This study was conceived to determine the effect of feeding varying inclusion levels of dried bovine rumen digesta on the reproductive performance of rabbits.

Materials And method

The experiment was conducted at the rabbitry unit of the Teaching and Research Farm of the Department of Animal Production, School of Agriculture and Agricultural Technology of the Federal University of Technology, Gidan Kwano (Permanent site) campus, Minna, Niger State. Minna is located within latitudes 09^{o}30' and 09^{o}45 N and longitudes 06 ^{o} 30 and 06 ^{o}45 E with an altitude of 1475 m above sea level (Lanko, 2005).

Maize was purchased from one of the local markets in Minna, while all other ingredients such as groundnut cake (GNC), rice offal, fish meal, bone meal, oyster shell, salt, lysine, methionine and vitamin mineral premix were purchased from one of the milling centres in Minna. Fresh bovine rumen content emptied by the butchers at Minna abattoir was collected in the months of February – March (as early as 7:00 am). The rumen digesta collected was thoroughly air-dried with periodic turning to facilitate drying. It was pounded into coarse particles of dried bovine rumen digesta (DBRD) before inclusion in the diets. Four treatmental diets were formulated. Diet T_1 was the control diet (0 % rumen digesta), while diets T_2, T_3, and T_4 contained 25 %, 50 %, and 75 % rumen digesta, respectively (Table 1).

Sixteen female (does) and four male (bucks) rabbits aged 18 weeks with average initial body weight of 1750.00 g were used in this experiment. They were mixed breeds purchased from rabbit keepers in Minna. They were balanced for sex and weight and allocated into four treatment groups with each treatment having four (4) animals. Each animal was housed in a wooden hutch with wire mesh and net at the bottom, top and sides of the hutches. The hutches measured 60 cm x 60 cm x 60 cm. 100 mg of Mectizan $^{(R)}$ tablet was dissolved in one litre of water and administered orally at a dosage of 10 ml per rabbit to take care of endo and ecto-parasites. The animals were allowed a pre-treatment period of two weeks to enable them acclimatize following which they were fed the compounded diets.Water was provided *ad-libitum* throughout the experiment.

The does were weighed prior to mating and weekly thereafter until the end of experiment. Mating was achieved by taking the doe to the buck. The reproductive parameters measured were birth traits like Gestation length (GL), Litter size at birth (LSB), Litter weight at birth (LWB),Gestation gain (GG), Kindling loss (KL), Neo-natal mortality (NNM) and Coefficient of milking capacity (CMC). Weaning traits like Litter size at weaning (LSW),Litter weight at weaning (LWW), Litter weight gain (LWG), Survival rate to weaning (SRW) and Weaning sex ratio (WSR).

Proximate analysis were carried out to determine the dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), ash and nitrogen free extract (NFE) components of the test material DBRD (Table 2) and the experimental diets (Table 3) using A.O.A.C (2005) method. The data collected from this study were subjected to

analysis of variance (ANOVA) using statistical package (SPSS 16.0, 2006 and MINITAB, 2003). The means were separated using the Duncan multiple range test.

Results And Discussion

The proximate composition of the dried bovine rumen digesta (DBRD) is presented in Table 2. The values showed that DBRD contained high level of crude fibre and adequate protein that in line with those recommended for both growing and breeding rabbits (Obinne, 2008). The value obtained for CP was higher than 13.56 % reported by Okpanachi *et al.* (2010) who fed sun-dried bovine rumen digesta to growing rabbits but fell within the range of 9 – 20 % and 18.56 % reported by Dairo *et al.* 2005 and Esonu *et al.* 2006 who also fed dried bovine rumen digesta to growing rabbits and broiler finisher, respectively.

Table 3 shows the proximate composition of the experimental diets. The CP content ranged from 19.50 % for diet (T_4) to 20.25 % for diet (T_1). The values were in agreement with the report of other workers (Dairo *et al*., 2005 and Mohammed *et al*., 2005; 2010) who fed similar diets to growing rabbits. The CF level ranged from 12.55 % to 15.23 %. The crude fibre increased as the level of dried bovine rumen digesta increased in the diets and the values were adequate for growing and breeding rabbits as recommended by Johnson-Delaney (2006) and Mohammed *et al*. (2010; 2011) who fed similar diets to rabbits. The values of EE, ranged from 5.26 % (T_4) to 6.52 % **(**T_1). The value of fat was higher than the 2.00 % to 4.50 % reported by Mohammed *et al*. (2010). The difference observed could be attributed to level of dietary fibre inclusion which increased with the different diets (T_1 – T_4). Ash increased (10.00 % in T_1) to 12.00 % in T_4) as the level of DBRD increase in the diets while NFE values reduced progressively with increasing levels of DBRD (47.66 %, 47.21 %, 45.58 % and 44.38 %).

Reproductive performance.

The result of reproductive performance of rabbits fed varying inclusion level of dried bovine rumen digesta is presented in Table 4. There was no significant (P>0.05) difference in the values obtained for gestation length (GL) in all the dietary treatments, the values fell within the average gestation length of 28-31days recommended for rabbits. This is in agreement with the findings of Nguyen *et al.* (2006) and Odeyinka *et al.* (2008). The findings showed that DBRB has no negative effects on gestation length of rabbits.

The values obtained for litter size at birth (LSB) were 5.25, 3.75, 6.75 and 4.24 for diets T_1, T_2, T_3 and T_4 respectively. The does on diet T_3 (50 % DBRD) recorded the highest (6.75 , P<0.05) litter size at birth (LSB), while the lowest (3.75) LSB was obtained from does on diet T_2 with 25% DBRD. This result falls within the range of 5.09 reported by Mai (2005); and 4.06 – 5.81 reported by Odeyinka *et al.* (2008) who fed *Moringa oleifera* as a replacement for *Centrosema pubescens* during reproductive study conducted on New Zealand White and Chinchilla breed of rabbits. The values obtained for litter size at weaning (LSW) were 3.75, 3.00, 5.50 and 4.00 for diets T_1 (0%), T_2 (25 %), T_3 (50 %) and T_4 (75 %), respectively. The highest value (5.50) was obtained from animals on diet T3 (50 %), while the lowest value 3.00 was obtained from animals on diet T_2 (25 %). The values obtained showed that diet T3 (50 %) performed better in LWB, LWW and LWG than the control diet (T_1). The better performance could be attributed to factors of good mothering ability, maternal environment and effect of dietary fibre inclusion(Rahim *et al.*,1997; Das and Yadav,2007; Iyeghe-Erakpotobor *et al.*, 2008). The values 1.44 – 2.18 kg obtained for LWG was lower than the 3.09 and 6.5 g/day reported by Roy *et al.* (2002) and Ren *et al.* (2003).

The values obtained for gestation gain (GL) were 168 g, 140 g, 230 g and 113 g for animals on diets T_1 (0 %), T_2 (25 %), T_3 (50 %) and T_4 (75 %), respectively. Rabbits on diet T_3 significantly (P<0.05) performed better than the control diet T_1. The better performance could be attributed to positive effect of dietary fibre on the gut health, welfare and reproductive performance of the rabbits especially during pregnancy period (Jonhson *et al.*,2003). The values obtained for survival rate to weaning (SRW) were 64.58 %, 70.00 %, 64.30 %, and 54.00 % for diets T_1 (0 %), T_2 (25 %), T_3 (50 %) and T_4 (75 %) respectively. Rabbits on diet T_2 (25 %) had the best survival rate and showed significant (P<0.05) difference among others. The best performance of T_2 could be attributed to good mothering ability Roy *et al.*, (2002); Das and Yadav (2007) and effectiveness of dietary fibre utilization which shows great potential for health, welfare and reproductive performance of livestock (Iyeghe-Erakpotobor *et al*., 2008). The values obtained for neo-natal mortality (NNM) and co-efficient of milking capacity (CMC) were 16.67 %, 18.75 %, 20.73 % ,21.25 % and 0.17, 0.15, 0.17, 0.14 for diets T_1 (0 %), T_2 (25 %), T_3 (50 %) and T_4 (75 %), respectively. The values of milk productivity showed similarities between dietary

treatments T_1 and T_3. The lowest milking capacity was obtained from animals on diet T_4 and the reason might be attributed to reduced feed intake of the rabbits doe leading to reduced ability for milk productivity.

The values obtained for kindling loss were 180 g, 108 g, 240 g and 138 g for diets T_1 (0 %), T_2 (25 %), T_3 (50 %) and T_4 (75 %), respectively and showed significant difference ($P<0.05$) between the dietary treatments. The result revealed that there was more loss of kittens among does on diet T_3 than other treatments. The reason could be attributed to environmental factors.

Conclusion And Recommendation.

Rumen content, a by – product of abattoirs that could be environmentally unfriendly if not properly handled, can be used as a potential non – conventional feed ingredient in rabbit production. The usage of this material will help to reduce cost, scarcity of rabbit feeds and also reduce dependency on conventional feed ingredients such as grains that bring competition between man and animals. The data obtained from this study indicate that DBRD can be incorporated in the diets of breeding rabbits up to 50 % level for better reproductive performance without any deleterious effect. Therefore incorporation of DBRD as feed ingredient up to 50 % in breeding rabbit diets should be encouraged among rabbit keepers for optimum performance.

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Table 1. Composition of the experimental diets

Ingredient (kg)	Dietary Treatments			
	T_1	T_2	T_3	T_4
Maize	54.86	49.29	40.38	29.76
Groundnut cake	24.14	22.28	19.31	13.56
Dried bovine rumen digesta	0.00	7.43	19.31	35.68
Rice offal	15.00	15.00	15.00	15.00
Fish meal	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00
Oyster shell	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Vit/min premix	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Crude protein (%)	18.00	18.00	18.00	18.00
Metabolizable Energy (Kcal/Kg)	2751.01	2702.43	2624.73	2594.25

Vitamins: A = 10,000IU; D_3 = 2,000IU; E = 5IU; K = 2mg; Riboflavin = 4.2mg; B_{12} = 0.01mg; Pantothenic acid = 5mg; Nicotinic acid = 20mg ; Folic acid=0.5mg.
Minerals: Se = 100mg; Cu = 1.0mg; Fe = 20mg; Iodine = 0.8mg; Choline = 3mg; Mg = 56mg; Co = 1.25mg; Lycine, Methionine and Tetramycine (Broad-spectrum anti-biotics and growth promoters).

Table 2. **Proximate composition of dried bovine rumen digesta (DBRD)**

Nutrient	(%) composition
Moisture	5.40
Dry matter	94.60
Crude protein	18.25
Crude fibre	26.25
Ether extract	2.50
Ash	7.60
Nitrogen free extract	40.00
Total	100.00

Table 3. **Proximate composition of the experimental diets (%)**

Nutrients	Dietary treatments			
	T_1	T_2	T_3	T_4
Moisture	3.02	3.09	3.50	3.63
Dry matter	96.98	96.91	96.50	96.37
Crude protein	20.25	20.00	20.00	19.50
Crude fibre	12.55	13.00	13.83	15.23
Ether extract	6.52	6.20	5.84	5.26
Ash	10.00	10.50	11.25	12.00
Nitrogen free extract	47.66	47.21	45.58	44.38
Total	100.00	100.00	100.00	100.00

Table 4. The reproductive performance of rabbits fed diets containing varying inclusion levels of dried bovine rumen digesta (DBRD)

	Dietary treatments.					
Parameters	T_1	T_2	T_3	T_4	SEM	LS
Gestation length (days)	30.75	29.75	30.25	29.75	0.16	NS
Litter size at birth (No)	5.25^{ab}	3.75^{b}	6.75^{a}	4.25^{b}	0.40	*
Litter weight at birth (kg)	0.26^{ab}	0.19^{b}	0.34^{a}	0.21^{b}	0.20	*
Gestation gain (g)	1.68^{ab}	1.40^{b}	2.30^{a}	1.13^{b}	0.14	*
Kindling loss (g)	1.80^{ab}	1.48^{b}	2.40^{a}	1.38^{a}	0.17	*
Neo-natal mortality (%)	16.67^{c}	18.75^{b}	20.73^{ab}	21.25^{a}	3.84	*
Co-efficient of milking Capacity (kg)	0.17^{a}	0.15^{b}	0.17^{a}	0.14^{c}	0.01	*
Litter size at weaning (No)	3.75^{ab}	3.00^{b}	5.50^{a}	4.00^{ab}	0.35	*
Litter weight at weaning (kg)	2.17	1.88	2.53	1.65	0.26	NS
Litter weight gain (kg)	1.95	1.69	2.18	1.44	0.24	NS
Survival rate at weaning (%)	64.58^{ab}	70.00^{a}	64.30^{ab}	54.00^{b}	2.97	*
Sex ratio (M : F).	1: 2	1: 1	3: 2	1: 2		

Key: ^{abc}Means with different superscripts on the same row are significantly different (P<0.05).
SEM= Standard error of means.
DBRD= Dried bovine rumen digesta
***** = Significant (P<0.05)
NS = Non-significant (P>0.05)

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