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Evaluation of Sex and Feed form on Growth Performance, Carcass Yield, Economic Benefit and Serum Biochemistry of Rabbit

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ABSTRACT

Background and Objective: Feed form (mash, pellet) plays an important role in the livestock industry. There's a need to evaluate the specific form of feed that can help to improve the growth performance, carcass yield, health benefits and cost of production in rabbit production. **Materials and Methods:** A total of forty-eight 7-8 weeks old male and female crossbreed rabbits were used to determine the effect of sex and feed form on growth performance carcass, cost benefits and serum biochemistry of male and female rabbits fed diets in mash and pellet form. The animals were weighed and allotted to 4 treatments (T1-12 male rabbits fed mash diets, T2- 12 female rabbits fed mash diet, T3-12 male rabbits fed pelletized diets, T4-12 female rabbits fed pelletized diets) and were in a 2×2 factorial arrangement. Data collected on growth performance, carcass yield, cost-benefit and serum biochemistry were analyzed using ANOVA. **Results:** Significant ($p<0.05$) differences were obtained in the effect of feed form on cost per kg diet (₦/kg) and cost per daily feed intake (₦). A higher ($p<0.05$) cost per kg diet (₦159.86) was obtained on the rabbit-fed pelletized while rabbit-fed mash diet had the least (139.76). Higher ($p<0.05$) cost per daily feed intake (₦12.95) was obtained on the rabbit-fed pelletized while rabbit-fed mash diet had least (₦10.71). Sex and feed form had no significant ($p>0.05$) difference in growth performance, carcass yield, or effect of sex on cost-benefit. **Conclusion:** The study concluded that sex and feed form had no detrimental effect on growth performance, carcass yield, cost-benefit and serum biochemistry of male and female rabbits. However, feeding diet in mash form could be assumed to be more economical in terms of growth, efficient feed utilization, least cost diet formulation and optimum profit in the rabbit production enterprise.

KEYWORDS

Rabbit, sex, feed form, serum biochemistry, economic benefit, livestock industry

INTRODUCTION

Rabbit production is a veritable way of alleviating animal protein deficiency in Nigeria. The minimum nutrient requirement to be consumed per day is 2,191 kcal and 53.8 g of crude protein, but the protein intake in Nigeria falls short of the recommendation. According to reports, animal products provide up to

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around 2% of Nigeria's 44 g protein supply per capita, which causes malnutrition and undernutrition in all age groups reported by Cheeke *et al.*[1].

In order to address the issue of insufficient animal protein, it is essential to enhance the management of livestock feeding and productivity in Nigeria. The rabbit is an animal device for multiplication due to its prolific nature, short gestation period and generation intervals. The challenge of providing enough nutrients has consistently impeded the growth of these animals, among other things. Economic goals like sellable meat production and customer appeal must be met by the quality of the carcass according to Zotte[2].

Lazzaroni *et al.*[3] reported an indication that diets have been a significant factor in the diversity of rabbits' growth performance and carcass features. The physical makeup of feed, particularly the size of its particles, is another crucial factor that affects how rabbits digest their food. In addition to offering feed, feed presentation methods including mash, crumbs and pellets are critical for efficient use and a major component of meat production. Available data suggest that grain particle size is higher in mash feeds than in pelletized feed[4]. The feeding pellet method is just a modified version of the mash system according to Jafarnejad *et al.*[5].

Reduced selective feeding, fewer pathogenic organisms destroyed, decreased feed waste and increased palatability are all factors contributing to improved pellet feeding performance[6]. Reducing the size of constituent particles is one way to enhance the quality of the pellet. Because the animal has more surface area accessible for enzyme access, particle size reduction has been shown to promote higher interaction with digestive enzymes[7]. The serum is the component that is neither a blood cell (serum does not contain white or red blood cells). Serum includes all proteins not used in blood clotting (coagulation) and all the electrolytes, antibodies, antigens, hormones and any exogenous substance (such as drugs and microorganisms) as reported by Saladin[8]. Serum is used in numerous diagnostic tests as well as in blood typing and also helps in liver function. The study was designed to evaluate the influence of sex and feed form on growth performance, carcass yield, cost-benefit and serum biochemistry of rabbits.

MATERIALS AND METHODS

The study was conducted around February 6 to 16th April, 2023 at the Rabbitary Unit of Institute of Food Security, Environmental Resources and Agricultural Research Federal University of Agriculture Abeokuta and the experiment was carried out during dry season. The location lies within the rainforest vegetation zone of Southwest Nigeria with a mean annual rainfall of 1420.06 mm, a temperature of 31.2°C and a relative humidity of 72%. It is located about 836 feet above sea level, on Latitude 7025'19,7''N and Longitude 30 51'30.5''E.

Experimental animals: After 2 weeks of acclimatization, the animals were bought from a respectable farm. They comprise 24 each of male (buck) and female (doe) rabbits. The rabbits were weighed and allotted to 4 treatments on an equal weight basis in a 2×2 factorial arrangement comprising of sex (male and female) of rabbits and feed form (mash and pellet). Each treatment has 6 replicates of 2 rabbits each. The experimental diet fed to the animals consisted of 17.25% crude protein (CP) and 10.53 MJ/kg metabolizable energy supplied in pelletized and mashed form. Water and food were provided on a daily basis. The pen was carefully cleaned and disinfected before being stocked. All other routine management practices were observed (sweeping the floor, washing the drinker and cleaning the feeder). The feeding trial lasted for 10 weeks. Each rabbit was weighed separately before the experiment started and then once a week after that. The difference between the final body weight and the initial body weight was used to calculate weight gain. Feed intake was calculated by deducting the remaining feed from the available supply.

Carcass yield: At the end of 10th week of dietary treatment, 4 animals per treatment whose weights were close to the average of the rabbits were selected, fasted for 12 hrs and slaughtered for carcass analysis. Before slaughtering inspection of animals was carried out to ensure animals were in good condition at slaughter. The process will involve (slaughtering, bleeding, singeing, washing and evisceration). After evisceration, the internal organs such as the liver, heart, kidney and lungs will be carefully excised and weighed using an electronic weighing scale. The measurement was expressed as a percentage relative to the live weight.

Serum biochemistry analysis: About 24 samples of blood were collected in 10th week for serum biochemistry analysis. Blood was collected through the vein in the ear. About 2.5 mL of blood were collected in tubes containing EDTA anticoagulant to determine the values. The blood was slowly expressed into EDTA tubes to reduce the risk of hemolysis after removing the needles from syringes. Serum parameters include a total protein obtained by biuret method in the assay as described by Kohn and Allen[9]. The globulin concentration was obtained by subtracting albumin from the total protein. Albumin was determined using Bromocresol Green (BCG) method. Aspartate transferase (AST) activities were determined using spectrophotometric method. Alanine transferase (ALT) activities were determined using spectrophotometric method. Serum urea was determined using a kit (Quinica clinical spam) having a linear measurement of about 566.6 mL per liter of urea concentration. The serum urea was determined calorimetrically. The serum cholesterol was determined using the enzymatic endpoint method by Kohn and Allen[9]. Cost per kilogram feed (N) and total feed intake per animal (kg/rabbit) were calculated using prevailing market price. After 10 weeks of feeding the trail, three animals were slaughtered for carcass evaluation.

Statistical analysis: Data collected were analyzed using ANOVA at significant level ($p<0.05$) as contained in SAS (2002). Significant means were separated using the Duncan's Multiple Range Test.

RESULTS

Table 1 shows effect of sex and feed form on growth performance of male and female rabbit-fed diets in mash and pellet. No significant ($p>0.05$) differences in the final weight gain, total weight gain, average daily weight gain, average daily feed intake and feed conversion ratio.

Table 2 shows interaction between sex and feed form on growth performance of male and female rabbit-fed diets in mash and pellet form. No significant ($p>0.05$) differences were obtained on the final weight gain, total weight gain, average daily weight gain, average daily feed intake and feed conversion ratio.

Table 3 shows main effect of sex and feed form on carcass of male and female rabbits fed diets containing mash and pellet form. Sex and feed form had no significant difference ($p>0.05$) was recorded on live weight, bled weight singeing weight, eviscerated weight, dressed weight, head neck, fore limb, hindlimb, lion, liver, kidney, heart and lungs.

Table 4 shows interactive effect of sex and feed form on carcass of male and female rabbits fed in mash and pellet form. There was a significant ($p<0.05$) difference in singing weight. Highest singeing weight (93.46%) was recorded with a female rabbit-fed diet in pelletized form and lowest (89.34%) with a female rabbit-fed diet in mash form. However, there was no significant difference ($p>0.05$) difference recorded on live weight, bled weight, eviscerated weight, dressed weight, head, neck, fore limb, hindlimb, loin, liver, kidney, heart and lungs. Table 5 shows the main effect of sex and feed on serum biochemistry of male and female rabbit-fed diets in mash and pellet form. No significant ($p>0.05$) differences were recorded on total protein, albumin, globulin, creatinine, aspartate transaminase, alanine transaminase, cholesterol and urea. Table 6 shows the interactive effect of sex and feed form on serum biochemistry of male and female rabbit-fed diets in mash and pellet form. No significant ($p>0.05$) differences were recorded on total

Table 1: Main effect of sex and feed form on growth performance and economic benefit of rabbits

	Sex				Feed form			
Parameter	Male	Female	SEM	p-value	Mash	Pellet	SEM	p-value
Initial weight (g)	1394.6	1529.9	76.6	0.41	1424.3	1508.3	76.6	0.64
Final weight gain (g)	1956.1	2151.6	62.26	0.14	2028.6	2089.6	62.26	0.67
Total weight gain (g)	561.48	621.63	29.85	0.34	604.32	581.37	29.85	0.74
ADWG (g/r/d)	10.68	12.06	0.67	0.33	11.6	11.2	0.67	0.79
ADFI (g/r/d)	79.71	77.91	1.8	0.58	76.56	81.34	1.8	0.25
FCR	8.23	8.91	0.63	0.63	7.96	9.23	0.63	0.39

ab: Means in the same row with different superscripts differ significantly ($p<0.05$), ADWG: Average daily weight gain, ADFI: Average daily feed intake, FCR: Feed conversion ratio and g/r/d: Gram/rabbit/day

Table 2: Interactive effect of sex and feed form on growth performance of male and female rabbit fed diets in mash and pellet form

Parameter	Male/mash	Female/mash	Male/pellet	Female/pellet	SEM	p-value
Initial weight (g)	1398.73	1448.31	1390.21	1611.56	76.60	0.59
Final weight gain (g)	1942.13	2109.75	1971.07	2193.38	62.26	0.82
Total weight gain (g)	543.40	661.44	580.86	581.81	29.85	0.35
ADWG (g/r/d)	10.32	12.80	11.07	11.31	0.67	0.42
ADFI (g/r/d)	78.46	74.78	81.04	81.04	1.80	0.58
FCR	8.11	7.82	8.35	9.99	0.65	0.47

ADWG: Average daily weight gain, ADFI: Average daily feed intake, FCR: Feed conversion ratio and g/r/d: Gram/rabbit/day

Table 3: Main effect of sex and feed form on carcass yield of rabbits

	Sex				Feed form			
Parameter	Male	Female	SEM	p-value	Mash	Pellet	SEM	p-value
Live weight (g)	1681.30	1650.00	70.67	0.85	1643.80	1687.50	70.67	0.79
Bled weight	94.95	95.30	0.55	0.65	94.41	95.84	0.55	0.08
Singeing weight	90.75	91.40	0.75	0.53	90.50	91.65	0.75	0.28
Eviscerated weight	71.09	70.54	2.15	0.89	66.13	75.51	2.15	0.05
Dressed weight	56.06	54.72	1.67	0.73	52.68	58.10	1.67	0.18
Cut part (%)								
Head	19.08	16.15	1.16	0.10	19.22	16.02	1.16	0.08
Neck	3.51	3.64	2.19	0.77	3.50	3.65	2.19	0.75
Forelimb	39.83	34.32	2.73	0.18	39.33	34.82	2.73	0.26
Hind limb	45.57	38.78	0.23	0.19	44.09	40.35	0.23	0.44
Loin	30.47	26.34	1.93	0.30	30.33	26.48	1.93	0.33
Organ (%)								
Liver	5.85	5.49	0.26	0.43	5.93	5.41	0.26	0.26
Kidney	1.42	1.26	0.07	0.33	1.41	1.26	0.07	0.36
Heart	0.64	0.59	0.05	0.48	0.64	0.58	0.05	0.46
Lungs	1.11	1.17	0.08	0.64	1.26	1.02	0.08	0.10

Table 4: Interactive effect of sex and feed forms on carcass of male and female rabbits-fed diets in mash and pellet form

Parameter	Male/mash	Female/mash	Male/pellet	Female/pellet	SEM	p-value
Live weight (g)	1750.00	1537.50	1612.50	1762.50	70.67	0.29
Bled weight (%)	94.61	94.19	95.28	96.40	0.55	0.32
Singeing weight(%)	91.66	89.34	89.84	93.46	0.75	0.02
Eviscerated weight (%)	68.44	63.81	73.73	77.28	2.15	0.35
Dressed weight (%)	54.04	51.32	58.07	58.12	1.67	0.72
Cut part (%)						
Head	19.32	19.12	18.84	13.19	1.16	0.13
Neck	3.23	3.77	3.78	3.52	2.19	0.40
Forelimb	40.31	38.35	39.34	30.30	2.73	0.37
Hindlimb	45.23	42.95	45.91	34.60	0.23	0.37
Loin	31.96	28.71	28.98	23.97	1.93	0.82
Organ (%)						
Liver	6.07	5.80	5.63	5.18	0.26	0.84
Kidney	1.43	1.40	1.41	1.12	0.07	0.42
Heart	0.68	0.61	0.61	0.56	0.05	0.85
Lungs	1.22	1.30	0.99	1.04	0.08	0.86

Table 5: Main effect of sex and feed form on serum biochemistry of rabbits

	Sex				Feed form			
Parameter	Male	Female	SEM	p-value	Mash	Pellet	SEM	p-value
Total protein (g/dL)	6.59	7.01	0.14	0.20	6.98	6.63	0.14	0.29
Albumin (g/dL)	4.05	3.81	0.07	0.07	4.04	3.83	0.07	0.10
Globulin (g/dL)	2.56	3.18	0.15	0.08	2.95	2.79	0.15	0.61
Creatinine (mg/dL)	2.46	2.88	0.43	0.67	2.46	2.89	0.43	0.67
Aspartate transaminase (U/L)	69.38	65.00	2.80	0.46	66.25	68.13	2.80	0.75
Alanine transaminase (U/L)	68.00	65.13	2.28	0.45	64.25	68.88	2.28	0.24
Cholesterol (mg/dL)	46.18	64.25	7.23	0.21	49.70	60.73	7.23	0.43
Glucose (mg/dL)	115.53	130.74	4.95	0.07	120.60	125.66	4.95	0.51
Urea (mg/dL)	19.55	15.68	1.70	0.30	15.33	19.90	1.70	0.23

Table 6: Interactive effect of sex and feed form on serum biochemistry of male and female rabbit fed diets in mash and pelletized form

Parameter	Male/mash	Female/mash	Male/pellet	Female/pellet	SEM	p-value
Total protein (g/dL)	6.70	7.25	6.48	6.78	0.14	0.69
Albumin (g/dL)	4.20	3.88	3.90	3.75	0.07	0.46
Globulin (g/dL)	2.53	3.38	2.60	2.98	0.15	0.46
Creatinine (mg/dL)	1.90	3.03	3.03	2.75	0.43	0.49
Aspartate transaminase (U/L)	71.25	61.25	67.50	68.75	2.80	0.35
Alanine transaminase (U/L)	68.00	60.50	68.00	69.75	2.28	0.24
Cholesterol (mg/dL)	51.13	48.28	41.23	80.23	7.23	0.15
Glucose (mg/dL)	121.55	119.65	109.50	141.83	4.95	0.05
Urea (mg/dL)	15.73	14.93	23.38	16.43	1.70	0.40

Table 7: Main effect of sex and feed on cost benefit of rabbits

	Sex				Feed form			
Parameter	Male	Female	SEM	p-value	Mash	Pellet	SEM	p-value
Cost per kg diet (₦/kg)	149.41	149.86	1.36	0.73	139.76^{b}	159.86^{a}	1.36	0.0001
Cost per daily feed intake (₦)	11.94	11.7	0.31	0.58	10.71^{b}	12.95^{a}	0.31	0.0002
Cost of feed per kg body weight gain (₦/kg)	1230.2	1346.6	101.56	0.6	1115	1473.4	101.56	0.1

ab: Means in the same row with different superscripts differ significantly (p<0.05)

Table 8: Interactive effect of sex and feed form on cost benefit of rabbits.

Parameter	Male/mash	Female/mash	Male/pellet	Female/pellet	SEM	p-value
Cost per kg diet (₦/kg)	139.65	139.65	159.86	159.86	1.36	0.73
Cost per dialy feed intake (₦)	10.97	10.46	12.96	12.94	0.31	0.61
Cost of feed per kg body weight gain (₦/kg)	1135.52	1095.81	1331.68	1597.34	101.56	0.45

protein, albumin, globulin, creatinine, aspartate transaminase, alanine transaminase, cholesterol and urea. Table 7 shows the main effect of sex and feed form on cost benefits of male and female rabbits. Sex had no significant (p<0.05) effect on cost per kg diet, cost per daily feed intake and cost of feed per kg body weight. Table 8 shows the interactive effect of sex and feed form on cost-benefit of male and female rabbit fed diets in mash and pellet form. No significant (p>0.05) differences were obtained in cost per kg diet, cost per daily feed intake and cost of feed per kg body weight.

DISCUSSION

The results of this study show that sex had no effect on growth performance and this result for the effect of sex on growth performance was in line with that of Okanlawon *et al.*[10] who reported that sex had no

effect on growth performance and cost benefits of rabbits fed diets supplemented with turmeric (*Curcuma longa*) powder. Ekpo *et al.*[11] found that the growth of rabbits fed cassava peel meal and both peeled and unpeeled cassava tuber meal was not significantly affected by either sex or feed type. There is no discernible correlation between the buck and doe rabbits' body weight gain, feed consumption and feed conversion ratio.

Furthermore, there were no discernible variations ($p>0.05$) in the feed conversion ratio between the buck and doe rabbits. This was in agreement with the findings of Okanlawon *et al.*[10] and Bello *et al.*[12] who reported that sex had no effect on growth performance parameter measured (body weight gain, feed intake and feed conversion ratio) of rabbits. Feed form did not affect some parameters of rabbit and the findings of the effect of feed form in this study agreed with that of Sogunle *et al.*[13] who studied that feed form and particle size had no significant effects on the parameters measured except in the cost per kilogram feed. The observed similarity supported earlier research showing that grain particle size had a greater influence in mash feeds than in pelletized feeds[4] the incapacity of rabbits to distinguish between favored feed ingredients in pellets and crumbs may be the main cause of this. The size of the pelletized meal and its composition may be the cause of this variance. This was supported by the finding that there is little to no fluctuation in the feed's nutrient composition, weight gain is directly proportionate to feed intake.

There was no interactive effect of sex and feed form on growth and cost-benefit of rabbits. The study agreed with the findings of Laxmi *et al.*[14] who reported no significant effect of sex on body weight of rabbits reared under different systems. The result of this study was also in line with the report of Sogunle *et al.*[13] who stated that feed form and particle size had no significant effects on the parameters measured.

Sex and feed form had no significant ($p>0.05$) on carcass yield and agreed with the report of Bello *et al.*[12] who stated that sex had no significant ($p>0.05$) effect on all carcass parameters of rabbits. This result was also in agreement with the findings of Hernández *et al.*[15] and Yalçin *et al.*[16] who reported no influence of sex on dressing percentage weight of some organs of the rabbit such as heart, liver and kidney not significant ($p>0.05$) different with sex. This finding was similar to that of El-Deighadi *et al.*[17] who reported that there was no significant ($p>0.05$) effect of sex on different organ weights. The non- significant effect of feed form on carcass yield might be due to the nutrient composition of the diet in this study however this was agreed with the notion of Rahman *et al.*[18] that particle size of rabbit diets does not always lead to modifications in slaughter yield.

The result of interactive effect of feed form and sex on carcass yield was in line with the report of Hernndez and Lozano[15] who reported no significance on the effect of sex on body weight of rabbits reared under different systems. This however agreed with the notion of Nicodemus *et al.*[19] who states that particle size of rabbit diets does not always lead to modifications in slaughter yield. The significant effect obtained for singeing weight was in agreement with the results of Tufarelli *et al.*[20] that a smaller particle size of concentrates in pelletized diets improved carcass traits in rabbits.

Sex and feed form showed no effect on the serum of the male and female rabbits and this result was in line with the report of Elamin[21] who reported that sex may have effect on some serum biochemistry parameters. Also drop in value of urea below the normal value for healthy rabbits in this experiment attests to the report of Adebisi[22] who reported a drop in urea value as the age of the animal increases.

The result on cost was in agreement with that of Okanlawon *et al.*[10] who reported that sex had no significant effect on cost of rabbits. Feed form had significant ($p<0.05$) differences obtained on cost per kg diet and cost per daily feed intake. Highest ($p<0.05$) cost per kg diet value (₦159.86) was recorded

with was a significant difference ($p<0.05$) in cost per daily feed intake. Highest cost per daily feed intake value (₦12.95) was recorded with rabbit fed pelletized diet while rabbit fed mash diet had the least cost per kg diet value (₦10.71). However, cost of feed per kg body weight was not significantly ($p>0.05$) influenced by feed form. The result of feed form on cost benefits in this study was in agreement with the report of Sogunle *et al.*[13] which states that feed form and particle size had no significant ($p>0.05$) effects on the parameters measured. The cost of pelletizating will be higher than the mash feed because of the cost of pelletizing.

The interactive effect of sex and feed form shows that the price of mash diet is lower than that of pelletized feed because the cost of pelletizing has been included in cost of production and was in line with the report of Okanlawon *et al.*[10] who studied cost benefit of rabbit fed graded level of turmeric.

It is therefore recommended that mash feed should be used in feeding rabbits in other to reduce cost of production. The limitation of the study includes the wastage of feed by rabbits but provided a well-designed feeding trough to prevent them from wasting the feed.

CONCLUSION

The study concluded that sex and feed form had no effect on growth performance, carcass yield, cost-benefit and serum biochemistry of male and female rabbits. However, feeding diet in mash form could be assumed to be more economical in terms of growth, efficient feed utilization, least cost diet formulation and optimum profit in rabbit production enterprise.

SIGNIFICANCE STATEMENT

The purpose of this study is to evaluate the effect of sex (male/female) and feed form (mash/pellet) on overall performance of rabbits. In order to meet up with animal protein intake in a country like Nigeria, there is a need to look into rabbit production and types of feed form that can help to improve their growth performance and health status Thus, there is growing worry about information regarding how feed form and size of the particles interact to affect the growth and health of rabbits. Furthermore, the paucity of data regarding the interplay between the mash and pelletized forms of feed and their effects on rabbit growth performance, carcass yield and benefit necessitated this study.

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