EFFECT OF FEED FORMS AND CONICAL FEEDER OPENINGS ON GROWTH PERFORMANCE AND ORGAN CHARACTERISTICS OF BROILER CHICKENS AT FINISHER PHASE

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ABSTRACT

This study investigated the effect of feed form and conical feeder openings on broiler chickens' performance and organ characteristics. 180 starter broiler chickens four weeks old were allotted to two treatments in a 2 x 3 factorial experimental design (two feed forms – mash and pellet; three conical feeder openings – 1.5, 2.0 and 2.5 cm) were used for the investigation that lasted four weeks. Broiler chickens were fed ad libitum. Daily feed intake was recorded, and the birds' weight changes and feed conversion ratio (FCR) were determined during the feeding trial. At eight weeks of feeding, 32 birds were randomly selected and slaughtered for organ characteristics. The result showed that the final weight (3795.56 ± 39.25 g) and weight gain (2342.22 ± 34.66 g) of birds fed pelleted feed were significantly different (p<0.01) from those on mash. The FCR was significantly lower (p<0.01) for broilers fed pellet (2.57 ± 0.04) compared with those offered mash (2.85 ± 0.02). The growth performance of broiler chickens fed pelleted feed in a 1.5 cm conical feeder opening was best (p<0.05) compared with other treatments. The relative organs had no significant (p>0.01) effect except for the large intestine which was significantly lower in birds fed mash feed form compared to the pelleted group. It is concluded that feeding broiler chicken finishers with pelleted feed and a feeder opening of 1.5 cm greatly influenced the feed intake and performance of the broiler chickens.

Keywords: Feed form, Feeder openings, Growth performance, Organ characteristics, Broiler chicken

INTRODUCTION

Poultry production plays a pivotal role in meeting the global demand for high-quality protein, with broiler chickens being a primary source. Achieving optimal growth performance and organ characteristics in broiler chickens is a multifaceted challenge influenced by various factors, among which the feed form and feeder design hold significant importance. Mash, pellet and crumbles are the three major physical forms of feeds produced for birds by livestock feed manufacturers which affect the productivity of the birds (Abadi *et al.,* 2019). Mash, pellets and crumbles have individual merits and demerits. Furthermore, the digestibility, conversion efficiency and effectiveness of each differ from each other. The mash diet is economical and each mouthful provides a well-balanced diet. However, it is not so palatable and does not retain its nutritive value like unground

feed. Previous research indicates that pelleted feeds affect the performance of birds in several ways. The positive effects include reduced segregation of feed ingredients, decreased selective feeding, reduced waste of feed, less energy and time expended on the prehension of feed, thermal modification of protein and starch, destruction of pathogenic organisms in feed, and enhanced feed palatability (Dozier *et al*., 2010). Since broilers are kept in total confinement to improve their body weight gain, efforts are therefore required to increase access of broilers to feed such as improved feeder design and feeder arrangement in an accessible manner. The shape and type of feeder or feeding trough have an impact on the performance of birds as the well-being of birds plays a significant role in their level of performance (Mench, 2008). The level of performance refers to the ability of birds to effectively convert feed to meat or eggs (Rollin, 2004).

Amerah *et al*. (2007) showed that the relative gizzard weight and contents were lower in birds fed pelleted feeds than those fed mash feeds. However, Chickens fed pelleted diets had heavier livers than birds fed mash, also, birds fed mash diets had heavier heart, crop, spleen, lung, gizzard, pancreas, proventriculus, and caecum than those fed pelleted, but dietary forms did not influence the kidney (Adeyemi *et al*., 2008). Thus, the objective of this study was to determine the effect of feed forms and conical feeder opening on growth performance and organ characteristics in broiler-chicken finishers.

MATERIAL AND METHODS

Experimental Site: The research work was carried out at the Poultry Unit of the Teaching and Research Farm (Livestock Section) of the Federal University of Technology, Akure, Ondo State, Nigeria. The geographical coordinates of the farm are between 7° 17′ North and 5° 9′ East. The farm is located in Nigeria's rainforest vegetation belt, characterized by two rainfall peaks and high humidity during the rainy season.

Procurement and Processing of Experimental Feed: The feeds were procured from a reputable feed merchant in Ondo State. The experimental feed used was Hope Finisher Pelleted Feed (9% crude protein (CP), 2875 Kcal/kg metabolizable energy). The grinding of the pelleted feed to mash form was done using a hammer mill at the feed mill of the Teaching and Research Farm of the University. The feed miller declarations on the label are shown in Table 1.

Table 1: Feed miller declaration of the experimental diets

Nutrients	Broiler finisher
Crude protein (%)	19.00
Metabolizable Energy (kcal)	2875
Fat (%)	3.85
Fibre (%)	6.00
Calcium (%)	1.00
Phosphorus (%)	0.45
Lysine (%)	0.70
Methionine (%)	0.50

Source: Hope Feed Limited, Ogun State, Nigeria

Procurement and Pre-Experimental Management of Broiler: 180-day-old broiler chicks (Arbor Acre) were purchased from CHI Hatchery, Ibadan, Nigeria. They were brooded for four weeks while daily and routine management practices such as feeding, provision of water via clean drinkers, changing of litters, and vaccinations were done under a deep litter management system.

Experimental Birds: 180 starter broilers of four weeks were used in the experiment. Routine management practices such as feeding, provision of water via clean drinkers, changing of litters and vaccinations were done under a deep litter management system.

Experimental Feeders: The feeders used in the experiment were bought from a conical feeder fabricator in Akure, Ondo State. A total of 18 aluminium feeders were bought. The feeders were modified into three feeder openings of 1.5, 2.0, and 2.5 cm at six feeders for each opening.

Feeding of the Experimental Animals: The birds were fed throughout the period. At weeks 0 to 4 they were fed with starter crumbles, at weeks 4 to 8 they were fed with broiler finisher pellets or mash.

Parameters Monitored: Parameters measured were the initial body weight, final weight (FW), feed intake (FI), daily weight gain (DWG), weekly weight changes (WWC), feed conversion ratio (FCR), and mortality were calculated.

Experimental Design, Experimental Treatments, and Replication: The experimental design was completely randomized in a 2 x 3 factorial arrangement i.e. two feed forms and three conical feeder openings. The nutrient declaration of the experimental diet is shown in Table 1. Each treatment was replicated three times with 10 birds per replicate in a 2 x 3 factorial experiment. The proximate analysis of all the diets was determined according to AOAC (2023) procedures.

Slaughtering and Organ measurement: At the end of the experiment (28 days), two chickens were randomly selected per replicate, weighed, and slaughtered by severing the jugular vein, they were then bled properly and scalded by dipping in hot water at a temperature between 70 - 75°C before de-feathering. The internal organs were removed. The weight of selected organs; liver, heart, small intestine, large intestine, and gizzard were recorded.

Statistical Analysis: All data collected were subjected to analysis of variance (ANOVA) using SPSS version 23.0 (SPSS, 2015). The differences between treatment means were subjected to Duncan's multiple range test of the same statistical package.

RESULTS

Proximate Composition of the Experimental Diets: The proximate composition of the feed used in the feeding is shown in (Table 2). The laboratory-analysed proximate composition value of the experimental feed was similar to that of the manufacturer's specification but the CP of the feed was slightly higher than that of the manufacturer (20.21 vs. 19.00%).

Table 2: Proximate composition of the experimental diet for experimental birds

Nutrient Composition (%)	Starter (pre-experimental diet)	Finisher
Moisture	13.30	10.42
Crude protein	23.50	20.21
Crude fibre	5.40	5.90
Ash	8.47	7.50
Ether extract	7.84	9.70
Nitrogen Free Extract	41.49	38.5

Performance Characteristics of Broiler Chickens: The performance characteristics of the broiler chicken fed with different feed forms using different feeder openings indicated that the final weight, weight gains and feed conversion ratio were highly significantly influenced ($p<0.01$) by the feed forms (Table 3). Broiler chicken finishers fed pellet had a final weight of 3795.56 ± 39.25 g which was higher than the broiler-fed mash diet (3546.67 ± 19.63 g). The same trend was observed for weight gains as the higher value was obtained for the total weight gain (2342.22 ± 34.66 g), while birds fed mash had 2090.00 ± 17.33 g. There was no significant difference ($p>0.05$) between the total feed intake per bird and daily feed intake per bird between the broiler chickens fed pellet and mash. Broiler chickens fed pellet had a better feed conversion ratio (2.57 ± 0.04) than broiler chickens fed with the mash diet (2.85 ± 0.02) (Figure 1). The feeder openings significantly ($p<0.05$) influenced the weight gains. There were no significant differences ($p>0.05$) due to the interaction of the feed form and feeder openings on the growth performance of the broiler chicken finishers.

The weekly cumulative weight gain of the broiler chicken fed different feed forms with different feeder openings is shown graphically in Figure 2. There was a progressive increase in the weight of the broiler chickens. The weight gain was influenced by the form of feed and the opening of the feeder.

Table 3: Performance of broiler chickens fed different forms of feed and different conical feeder openings

Parameters		IW(g)	FW(g)	TWG(g/b)	DWG(g/b/d)
Feed forms	**Pellet**	1453.30 ± 0.47	3795.56 ± 39.25*	2342.22 ± 34.66*	83.65 ± 1.24*
	Mash	1456.70 ± 0.94*	3546.67 ± 19.63	2090.00 ± 17.33	74.64 ± 0.62
Feeder opening	**1.5 cm**	1455.00 ± 0.08^{b}	3765.00 ± 48.07^{c}	2310.00 ± 42.45^{c}	82.50 ± 1.52^{c}
	2.0 cm	1460.00 ± 0.12^{c}	3665.00 ± 32.05^{b}	2205.00 ± 28.30^{b}	78.75 ± 1.01^{b}
	2.5 cm	1450.00 ± 0.04^{a}	3583.33 ± 16.02^{a}	2133.33 ± 14.15^{a}	76.19 ± 0.51^{a}
Feed form-feeder opening (Pellet)	**1.5cm**	1453.30 ± 0.13^{d}	3886.67 ± 67.99^{f}	2433.33 ± 50.03 ^{f}	86.91 ± 2.14^{f}
	2.0cm	1460.00 ± 0.16^{f}	3826.67 ± 56.65^{e}	2366.67 ± 50.03^{e}	84.52 ± 1.78^{e}
	2.5cm	14.47 ± 0.02^{a}	3673.33 ± 45.33^{d}	2226.67 ± 40.02^{d}	79.52 ± 1.42^{d}
Feed form-feeder opening (Mash)	**1.5cm**	14.57 ± 0.05^{b}	3643.33 ± 33.99^{c}	2186.67 ± 30.01^{c}	78.10 ± 1.07^{c}
	2.0cm	1460.00 ± 0.11^{e}	3503.33 ± 22.66^{b}	2043.33 ± 20.01^{b}	72.98 ± 0.71^{b}
	2.5cm	1453.30 ± 0.08^{c}	3493.33 ± 11.33^{a}	2040.00 ± 10.00^{a}	72.86 ± 0.36^{a}

Parameters		TFI/b(g/b)	DFI/b(g/b)	FCR
Feed forms	**Pellet**	5993.06 ± 53.11*	214.04 ± 1.90*	2.57 ± 0.04
	Mash	5956.96 ± 26.56	212.75 ± 0.95	2.85 ± 0.02*
Feeder opening	**1.5 cm**	6041.63 ± 65.04^{c}	215.77 ± 2.32^{c}	2.63 ± 0.02^{a}
	2.0 cm	5895.55 ± 21.68^{a}	210.56 ± 0.77^{a}	2.69 ± 0.03^{b}
	2.5 cm	5987.83 ± 43.36^{b}	213.85 ± 1.54^{b}	2.81 ± 0.05^{c}
Feed form-feeder opening (Pellet)	**1.5cm**	5969.63 ± 30.66^{c}	213.20 ± 3.29^{b}	2.46 ± 0.01^{a}
	2.0cm	6000.17 ± 61.98^{d}	214.29 ± 1.65^{d}	2.54 ± 0.02^{b}
	2.5cm	6009.37 ± 76.65^{e}	214.62 ± 2.19^{e}	2.70 ± 0.04^{c}
Feed form-feeder opening (Mash)	**1.5cm**	6113.63 ± 91.98^{f}	218.34 ± 2.74^{f}	2.80 ± 0.06^{d}
	2.0cm	5790.93 ± 15.33^{a}	206.82 ± 0.54^{a}	2.84 ± 0.06^{e}
	2.5cm	5966.30 ± 45.99^{b}	213.08 ± 1.09^{c}	2.93 ± 0.07^{f}

*Means with a different superscript in the same column are significantly different (p<0.05), * = significant mean at p<0.05 for pairwise comparison using t-test, IW: Initial weight (gram), FW: Final weight (gram), TWG: Total weight gain (gram/bird), DWG: Daily weight gain/bird (gram/bird/day), TFI/bird: Total feed intake (gram/bird), DFI/bird: Daily feed intake (gram/bird), FCR: Feed conversion ratio*

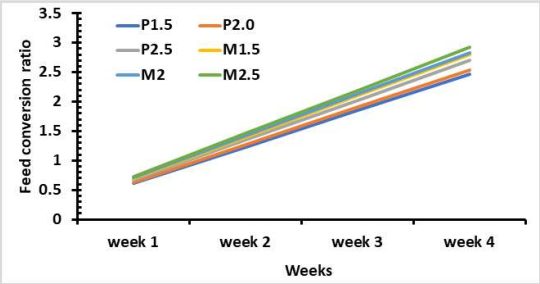

Figure 1: Feed conversion ratio of broiler chickens fed different feed forms with different conical feeder openings

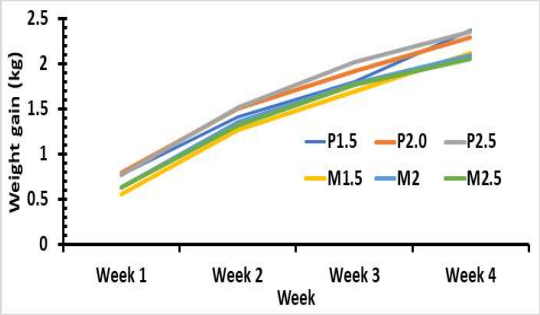

Figure 2: Cumulative weekly weight gain of broiler chickens fed different feed forms with different conical feeder openings

Broiler chickens fed pelleted feed and fed using a conical feeder with a 1.5 cm opening had the highest cumulative weight gain than the broiler chickens fed with pellet or mash with other feeder openings. The broiler chickens fed with mash feed using a conical feeder with 2.5 cm had the lowest weekly weight gain. The cumulative feed intake of the broiler chicken fed with different forms of feeds with different feeder openings is depicted graphically in Figure 3.

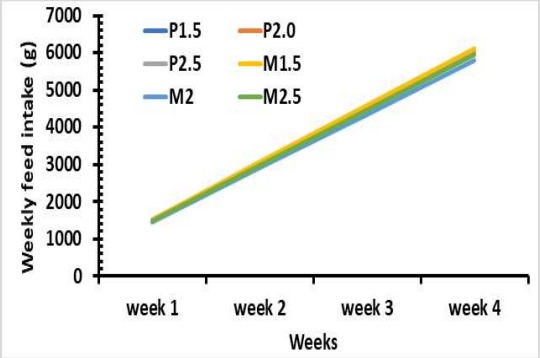

Figure 3: Cumulative total feed intake of broilers chickens fed different feed forms with different conical feeder openings

There was a progressive increase in the cumulative feed intake by the broiler chickens used for the experiment. Broiler chicken fed with pellet using a conical feeder with 1.5 cm had a slight reduction in the quantity of feed consumed, while broilers fed with mash feed did not show a regular pattern of the influence of the size of the feeder opening.

Relative Lengths of Vital Organs from Broiler Chickens Fed Different Feed Forms with Different Feeder Openings: The relative length of the vital organs of the broiler chickens fed different feed forms with varied feeder openings are shown in Table 4. There were no significant ($p>0.05$) differences in the length of the organs small caeca, large caeca, small intestine and large intestine resulting from the forms of feed. However, the relative lengths of small caeca, small intestine, and large intestine of birds fed pellet were minimally higher than those fed mash. The effect of the feeder openings on the length of the parameters was not also significantly affected ($p>0.05$). The interaction between the feed form and the size of the feeder openings was not significantly influenced ($p>0.05$) by any of the factors examined.

DISCUSSION

The results of this study showed that feeding broiler chicken finishers in different feed forms with different feeder openings resulted in improved growth performance throughout the experimental period. Broiler chickens fed with pelleted feed gained higher body weight which could be attributed to the increase in feed intake. The physical form of feed significantly impacts feed intake and feeding pellets have been identified as a strategy to increase feed intake (Dozier *et al.,* 2010). The improvement in feed intake, final weight, and the feed conversion ratio obtained in the present study can be attributed to pelleting which agreed with the report of Abdollah *et al.* (2013) that the performance of birds was improved due to pelleting of feed. The final live weights were numerically improved with the feeding of pelleted diets using a 1.5 cm feeder opening compared with those fed mash diets using a 2.5 cm feeder opening.

Table 4: Relative lengths of vital organs from broiler chickens fed different feed forms with different feeder openings

Parameters		LIVER (g/kg BW)	HEART (g/kg BW)	SI (g/kg BW)	LI (g/kg BW)
Feed Form	**Pellet**	12.96 ± 0.41	4.26 ± 0.31*	22.52 ± 0.81*	1.97 ± 0.15*
	Mash	13.4 ± 0.82*	3.62 ± 0.16	20.86 ± 0.41	1.30 ± 0.08
Feeder Opening (cm)	**1.5**	12.34 ± 0.27^{a}	3.78 ± 0.20^{b}	20.19 ± 0.27^{a}	1.92 ± 0.15^{c}
	2	13.06 ± 0.54^{b}	4.45 ± 0.31^{c}	21.69 ± 0.54^{b}	1.47 ± 0.05^{a}
	2.5	14.14 ± 0.82^{c}	3.59 ± 0.10^{a}	23.2 ± 0.81^{c}	1.52 ± 0.10^{b}
Feeder Opening + Pellet	**1.5**	13.03 ± 1.14*	3.57 ± 0.65	22.12 ± 0.96*	2.49 ± 0.32*
Feeder Opening + Mash	**1.5**	11.66 ± 0.38	3.99 ± 0.39*	18.26 ± 0.32	1.36 ± 0.16
Feeder Opening + Pellet	**2**	12.81 ± 0.75	5.02 ± 0.78*	23.01 ± 1.63*	1.64 ± 0.21*
Feeder Opening + Mash	**2**	13.31 ± 1.89*	3.88 ± 0.26	20.36 ± 0.65	1.3 ± 0.10
Feeder Opening + Pellet	**2.5**	13.05 ± 1.51	4.2 ± 0.52*	22.44 ± 1.30	1.78 ± 0.26*
Feeder Opening + Mash	**2.5**	15.23 ± 2.27*	2.99 ± 0.13	23.96 ± 1.96*	1.25 ± 0.05

Parameters		GIZZARD (g/kg BW)	SI (cm/kg BW)	LI (cm/kg BW)
Feed Form	**Pellet**	9.69 ± 0.45*	60.38 ± 2.18*	3.78 ± 0.23*
	Mash	9.34 ± 0.23	57.48 ± 1.09	3.46 ± 0.12
Feeder Opening (cm)	**1.5**	8.67 ± 0.15^{a}	60.64 ± 2.18^{c}	4.32 ± 0.23^{c}
	2	9.71 ± 0.30^{b}	59 ± 1.45^{b}	3.35 ± 0.15^{b}
	2.5	10.15 ± 0.45^{c}	57.15 ± 0.72^{a}	3.2 ± 0.07^{a}
Feeder Opening + Pellet	**1.5**	8.34 ± 0.20	62.67 ± 6.11*	4.85 ± 0.50*
Feeder Opening + Mash	**1.5**	9.00 ± 0.20*	58.6 ± 4.07	3.78 ± 0.41
Feeder Opening + Pellet	**2**	9.93 ± 01*	61.81 ± 5.09*	3.63 ± 0.33*
Feeder Opening + Mash	**2**	9.49 ± 0.60	56.19 ± 1.01	3.07 ± 0.16
Feeder Opening + Pellet	**2.5**	10.79 ± 1.20*	56.66 ± 2.03	2.87 ± 0.08
Feeder Opening + Mash	**2.5**	9.52 ± 0.80	57.65 ± 3.05*	3.54 ± 0.25*

*Means with a different superscript in the same column are significantly different ($p<0.05$), * = significant mean at $p<0.05$ for pairwise comparison using t-test, SI - Small Intestine, LI - Large Intestine*

This corroborated the findings of Massuquetto *et al.* (2019) who fed broiler chickens with mashed and pelleted diets and observed a significant increase in the final weight, total weight gain and performance of broiler chickens fed with pelleted diets compared to those fed with mashed diets. Also, Dozier *et al*. (2010) observed similar results for broilers fed crumbles or pellets compared to those fed a mash diet during a 42-day study which resulted in a higher body weight. Broilers fed pellets with 1.5 cm feeder openings had increased feed intake, improved final weight and improved feed conversion ratio compared to those fed mash and other feeder openings. Jensen (2001) suggested that feeding pelleted feed to broiler chicken finishers improves feed efficiency by reducing feed wastage because fewer feed particles fall from feeders.

The sizes of the internal organs of the experimental birds were not significantly affected by the opening sizes and the forms of the served feed. Studies have shown that the type of feed affects the length of the digestive system (Kuleile and Molapo, 2019). The small intestine is the main organ in the gastrointestinal tract (Neugut *et al.,* 1997) that supports the digestion and absorption of nutrients. Feed form is said to influence the functional status of the small intestine (Murakami *et al.,* 2007). It was further stressed that longer GIT might be combined with increased surface area and hence greater absorption (Soltan, 2009). Carré (2004) opined that larger particles usually result in longer transit time due to the longer retention time of the feed in the gizzard (Carré, 2004), although the relative weight of the birds' fed pellets was higher but not significantly different from those fed mash.

However, several studies have shown that pelleting has little effect on nutrient availability, while more intensive processes such as expansion and extrusion lead to more structural modifications in the ingredients (Svihus *et al.,* 2005; Zimonja *et al.,* 2008). When the amount of pelleted diet provided was the same as the mash diet, that is, the consumption factor was isolated; there were no differences in digestibility parameters, demonstrating that the pelleting process may not be sufficient to modify

the fractions of ingredients (Massuquetto *et al*., 2019).

Conclusion: Feeding broiler chickens with the pelleted feed increased feed intake and weight gain, hence, improving growth performance, feed conversion ratio, and relative weights and lengths of organs of broilers compared to feeding mash. Feeding broiler chicken finishers with pelleted feed and a smaller feeder opening of 1.5 cm greatly influenced the feed intake of the broiler chickens and in return improved the growth performance of the birds.

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