Growth performance and cost benefit of broiler chickens raised on mash and pellet diets accessed at different feeding periods

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Abstract

A total of 160 7-day old Marshall broiler chickens were used in a 2 x 4 factorial experiment to evaluate the effects of different feed forms and feed access times on growth performance and cost benefits of broiler chickens. The birds were weighed and randomly distributed into 8 treatments with 4 replicates of 5 birds each, subjected to 2 feed forms (mash and pellet) and 4 different feed access time (2, 4, 6 h, *ad libitum)* for 3 wk. After this period, all birds were returned to *ad libitum* feeding until 8 wk of age. Data were collected on feed intake, weight gain, feed conversion ratio, mortality, cost of feed consumed and cost per g weight gained. Results indicated that pellet fed birds on *ad libitum*, 4 and 6 h feed access time recorded higher (P<0.05) weight gain of 1883.50 g, 1851.75 g and 1906.50 g, respectively. For cost benefit analysis, pellets fed birds on *ad libitum* recorded the highest (P<0.05) cost of feed consumed per bird (₦588.74). It was concluded that for a reduced cost of production without compromising growth performance, broiler chickens should be raised on pellet diet and should not be subjected to less than 4 h feed access time for a 3-wk duration out of 8 wk of production.

Keywords: feed access period, broiler, mash feed, pellet feed, growth performance, feed cost benefit

Introduction

Increased cost of feeding and early fat deposit are few of the problems of broiler farmers (Smith, 1990). This is because broiler birds are one of the most efficient converters of feed to animal protein and it is generally assumed that when birds eat more, they attain higher body weight at market age (Urdaneta and Leeson, 2002). In commercial poultry production system, profit can be maximized by minimizing feed cost which accounts for 60–70% of production cost (Wilson and Beyer, 2000). Any attempt to improve commercial poultry production and increase its efficiency should be employed (DZARC, 1997). Excessive fat deposition reduces carcass yield, decreases meat acceptance by consumers (Kessler *et al*., 2000) and causes difficulties during processing (Chambers, 1990). Consumers' choice for leaner meat has increased over time due to cases of cardiovascular disease as a result of human consumption of certain fats in excess. This has stirred interest in reducing abdominal fat deposition in broiler chickens and trend towards leaner carcasses (Cabel and Waldroup, 1990). It also sparked the interest in feed restriction studies and the concept of compensatory growth to correct

metabolic problems in order to meet consumers' demands for leaner carcasses (Zubair and Leeson, 1994). Feed restriction either as qualitative or quantitative implies denying birds a full access to nutrients needed for their normal growth and development (Khetani *et al.*, 2009). This is employed to tackle problems such as increased body fat deposition, high incidence of metabolic disorders, increased mortality and high incidence of skeletal diseases associated with fast growth rate in broiler chickens (Saleh *et al*., 2005; Rezaei *et al*., 2006). Early feed restriction in broiler is also practiced to induce catch-up growth and efficiency of feed utilization (Hocking *et al*., 2002; Teimouri *et al.*, 2005). Response to feed restriction, however, depends on the duration of feed restriction. Prolonged feed restriction diminishes the potential of compensatory growth (Gous and Cherry, 2004; Leeson and Summers, 2005). Olukomaiya *et al*. (2015) reported that milder forms of feed restriction and longer re-feeding period may be essential to attain full compensatory growth in broiler chickens. Although early feed restriction reduces growth performance, compensatory growth in the re-feeding period will be attained to accelerate growth to reach market weight (Hornick *et al*., 2000; Pinheiro *et al*., 2004). Recent reports on feed restriction during the growing period in broiler chickens indicate that restricting feed intake lowers body weight and carcass fat and improves feed efficiency with compensatory growth during re-feeding (Al-Taleb, 2003). Feed form is an important factor which directly influences the cost of mixed feed and production performance of broiler birds (Ghazi *et al*., 2012). The physical form of a feed (mash or pellet) plays a crucial role in the meat yield of broiler chickens (Agah and Norollahi, 2008; Mirghelenj and Golian, 2009). However, there are few published researches about the effects of feed forms and different feed access times on growth performance and cost benefit of broiler chickens. This study was therefore conducted to evaluate the growth performance and cost benefit of broiler chickens raised on mash and pellet diet accessed at different times.

Materials and Methods

The study was carried out at the Poultry Unit of the Directorate of University Farms (DUFARMS) of the Federal University of Agriculture, Abeokuta Nigeria. The site is located in the rainforest vegetation zone of South-Western Nigeria on latitude 7^{o} 13' 29.01" N and longitude 3^{o} 25' 26.40" E. Elevation 126 m above the sea level and eye altitude 380 m (Google Earth, 2014).

Experimental birds and design

One hundred and sixty day-old Marshall broiler chicks were sourced from a reputable hatchery in Abeokuta, Ogun State, Nigeria. The experimental birds were brooded together for 7 d and fed *ad libitum* on mash diet during this period. The birds were fed with a single formulated corn soybean meal diet as shown in Table 1. Normal prophylactic medication and vaccination were administered as and when due. On the 7th day, the birds were randomly allotted after balancing for live weights into 8 treatments consisting of 4 replicates of 5 birds each. The dietary experiment was laid out in a 2 × 4 factorial arrangement consisting of two groups given different feed forms (mash and pellet) which were accessed at different times namely: 2 h feeding from 0700 – 0900, 4 h feeding from 0700 – 1100, 6 h feeding from 0700 – 1300, and 24 h *ad libitum*. Feed access time was limited for a period of 3 wk from 7 - 28 d of age. After this period, all birds were returned to *ad*

libitum feeding until 8 wk of age. Birds in all treatments were provided with the same amount of feed at the commencement of feeding trial each day using the guide given by Aduku (2004) and leftover was withdrawn at the expiration of the access time for each treatment. Feed and water were provided during the period of feeding, while only water was provided during off-feed period. Pellet size of 2 mm was used for feeding the groups of birds fed pelleted diet from 1 wk until the end of the experiment. Pelleting was done by passing mixed and milled feed ingredients through a conditioning chamber where water (usually as steam) was added. Moisture provided the lubrication for compression and extrusion and in the presence of heat causing some gelatinization of raw starch present in the ingredients, resulting in adhesion. This was then forced through a 2-mm hole ring in the pellet mill. During the experiment, the initial weight, final live weight, body weight gain, feed intake, feed conversion ratio, mortality, cost of feed consumed and cost per gram gain were measured.

Table 1: Percentage composition of experimental diet

Ingredients	Diet composition (%)
Maize	45.00
Soyabean meal	15.00
Fish meal (72% CP)	1.00
Groundnut cake	12.50
Wheat offal	21.50
Oyster shell	1.50
Bone meal	2.50
Premix	0.25
Lysine	0.25
Methionine	0.25
Salt (NaCl)	0.25
TOTAL	100
Determined Analysis (%)	
Dry matter	88.35
Crude protein	21.05
Crude fibre	3.97
Ether extract	3.74
Ash	5.65

*Premix composition per kg diet: Vitamin A: 9000000 IU, Vitamin D_3: 2000000 IU, Vitamin $B_{1:}$ 1800 mg, Vitamin B_2-Riboflavin: 6600 mg, Vitamin B_3-Nicotinic acid: 10000 mg, Vitamin $B_{6:}$ 3000 mg, Vitamin $B_{12:}$ 15mg, Vitamin E: 18,000 mg, Vitamin K_3: 2000 mg, Vitamin B9: 1000 mg, Vitamin B5: 30000 mg, Folic acid: 21 mg, Nicotinic acid: 65 mg, Biotin: 14 mg, Choline Chloride: 500000 mg, Manganese: 100000 mg, Zinc: 85000 mg, Iron: 50000 mg, Copper: 10000 mg, Iodine: 1000 mg, Selenium: 200mg.

Statistical analysis

Data collected were subjected to Analysis of Variance (ANOVA) in a completely randomized design in factorial arrangement. Significant differences among treatment means were separated using New Duncan's Multiple Range Test as contained in SAS (2005) Statistical Package.

Results and Discussion

The main effects of feed forms and feed access time on growth performance of broiler chickens are presented in Table 2. Feed form significantly ($P<0.05$) influenced final weight, weight gain and average daily weight gain. Values for these parameters were higher ($P<0.05$) in pellet fed birds compared to mash fed birds. The higher values obtained for weight gain in birds on pellet diet agrees with the findings of Amerah *et al*. (2007) and Aderibigbe *et al*. (2013). The result is also in accordance with the report of Van Biljon (2005) who reported that chickens on crumble-pellet dietary regimen were significantly heavier at 42 d when compared with birds fed either all-mash regimen. Nir *et al*. (1995) reported that the improved growth rate observed in birds on pellet diet was as a result of increased feed intake and improved feed efficiency. The significantly ($P<0.05$) reduced feed conversion ratio observed in birds on pellet diet indicates that birds on pellet diet effectively converted feed into meat. This result is in agreement with the reports of Zang *et al*. (2009) and Mingbin *et al.* (2015) who concluded that crumble-pellet treatment significantly improved feed conversion. The advantage of the crumble-pellet diets may result from an increase in appetite, improving feed flow ability and diet density, a decrease in feed wastage and alterations in ingredients (Jensen *et al*., 2000; Fairfield., 2003). Birds fed *ad libitum* had the highest final weight (2018.75 g), followed by birds fed for 4 h (1878.75 g) and 6 h (1875.00 g), and the lowest final weight (1786.25 g) was recorded for birds fed for 2 h. The improved performance of broiler chickens fed *ad libitum* during feed restriction compared to the restricted fed groups is in agreement with the reports of Oyedeji and Atteh (2005) and Novel *et al*. (2009) who reported a significant reduction in the performance of feed restricted broiler chickens compared to those fed *ad libitum.* The significantly higher final weight of birds on 6 and 4 h feed access time when compared to birds on 2 h feed access time indicates that birds on 6 and 4 h feed access times were able to compensate for the weight they lost during the restriction period. Studies shown that the longer the period of under nutrition, the more difficult it is for broiler chickens to compensate for reduction in live weight (Yu and Robinson, 1992; Omosebi *et al*., 2014). Feed conversion ratio was significantly reduced in restricted birds when compared to *ad libitum* fed birds. This result is consistent with previous reports (Palo *et al*., 1995; Camacho *et al.*, 2004 and Omosebi *et al*., 2014).

Table 2: Main effects of feed forms and feed access time on growth performance of broiler chickens

	Feed form			Feed access time				
Parameters	Mash	Pellet	SEM	2 h	4 h	6 h	*ad libitum*	SEM
Initial weight (g)	145.25	146.75	1.76	143.00	149.50	146.50	145.00	2.35
Final weight (g)	1799.38[b]	1980.00[a]	28.78	1786.25[c]	1878.75[b]	1875.00[b]	2018.75[a]	42.86
Total weight gain/bird (g)	1658.19[b]	1839.00[a]	29.90	1641.38[c]	1736.75[b]	1741.25[b]	1875.00[a]	44.15
Total feed intake/bird (g)	3857.44[b]	3962.44[a]	91.67	3637.25[c]	3738.13[b]	3758.38[b]	4506.00[a]	32.37
FCR	2.33[a]	2.16[b]	0.03	2.23[b]	2.16[b]	2.17[b]	2.41[a]	0.05

[a-d]Means in the same row with different superscripts are significantly different (P<0.05)

The effects of interaction of feed form and feed access time on growth performance of broiler chickens is shown in Table 3. Final weight of broilers was significantly (P<0.05) influenced by the interaction of feed forms and feed access time. Despite the sign of compensatory growth shown during realimentation in this study, feed-restricted birds that were fed mash diet still failed to fully recover their initial body weight loss as their final live weights were significantly lower when compared to the *ad libitum* fed birds. Birds fed for 4 and 6 h feed access time on pelleted diet had similar weight gain for the entire period of experiment when compared with the *ad libitum* fed birds. It suggests that pellet feeding of broiler birds on a mild restriction strategy will allow for a better compensatory growth. This also indicated that broilers tend to utilize pelletized feed better than mash when the same diet is fed in these two different forms. The result of this study is consistent with findings of earlier researchers (Jahan *et al.,* 2006; Adeyemi *et al.,* 2008) who reported improvement in growth performance indices of birds fed pelleted diet over mash, when the same diet was fed in these 2 different forms. Also from this result, pellet fed birds on 4 and 6 h recorded lower (P<0.05) feed conversion ratio and feed intake when compared to the *ad libitum* fed birds which suggests that they had a better conversion of feed given into meat.

Table 3: Effects of interaction of feed forms and feed access time on growth performance of broiler chickens

Feed form	Mash				Pellet				
Feed access time	2 h	4 h	6 h	*ad libitum*	2 h	4 h	6 h	*ad libitum*	SEM
Initial weight (g)	143.00	148.00	146.00	144.00	143.00	151.00	147.00	146.00	3.52
Final weight (g)	1707.50^{c}	1760.00^{cb}	1745.00^{c}	1985.00^{a}	1865.00^{b}	1997.50^{a}	2005.00^{a}	2052.50^{a}	33.99
Total weight gain/bird (g)	1568.50^{c}	1621.75^{cb}	1599.00^{cb}	1843.50^{a}	1714.25^{b}	1851.75^{a}	1883.50^{a}	1906.50^{a}	36.57
Total feed intake/bird (g)	3593.75^{d}	3677.50^{cd}	3675.25^{cd}	4483.25^{a}	3680.75^{cd}	3798.75^{bc}	3841.50^{b}	4528.75^{a}	37.51
FCR	2.30^{abc}	2.27^{bc}	2.30^{abc}	2.44^{a}	2.15^{cd}	2.06^{d}	2.05^{d}	2.38^{ab}	0.05

$^{a-e}$ Means in the same row with different superscripts are significantly different (P<0.05)

The main effects of feed forms and feed access time on cost of feeding broiler chickens is presented in Table 3. Total cost of feed consumed and feed cost per weight gain for the entire period of experiment was significantly (P<0.05) influenced by forms of feed. Birds on mash diet recorded a significantly (P<0.05) lower total cost of feed consumed. The increase in cost of feeding pellet diet may have arisen from the extra cost of making the feeds into pellets. Also, the total cost of feed consumed significantly (P<0.05) increased from ₦418.04 in birds fed for 2 hours during restriction to ₦518.53 in birds fed *ad libitum* throughout the experiment. This might be due to the fact that as the levels of feed access time increased, feed intake also increased and subsequently resulted in an increase in the cost of production. Other earlier studies had confirmed that feeding pelleted diet increased feed cost compared to mash and linked the high cost to high feed intake and high cost of producing pellet feeds (Asha Rajini *et al.*, 1998; Jahan *et al.*, 2006). Total feed cost per weight gain was significantly lower in birds on 4 hours and 6 hours feed access times compared to birds fed *ad libitum*. This reduction in feed cost per weight gain was observed in birds in these restriction groups relative to their *ad libitum* fed counterparts showing that feed-restricted birds were able to gain more weight at low cost. The reason for this may be due to improved feed conversion ratio in mildly restricted birds. This result is in agreement with the finding of Omosebi *et al*. (2014) who reported a significantly lower feed cost per weight gain on birds in restricted groups when compared to *ad*

libitum fed birds. This is also in consistence with Hassanien (2011) who reported that feed-restricted birds gave better economic efficiency than control (*ad libitum*).

Table 4: Main effects of feed forms and feed access time on cost of feeding broiler chickens

	Feed form			Feed access time				
Parameters	Mash	Pellet	SEM	2 h	4 h	6 h	*ad libitum*	SEM
Total feed intake/bird (g)	3857.44[b]	3962.44[a]	91.67	3637.25[c]	3738.13[b]	3758.38[b]	4506.00[a]	32.37
Total cost of feed consumed/bird (₦)	385.74[b]	515.12[a]	10.48	418.94[c]	430.79[b]	433.46[b]	518.53[a]	24.65
Total weight gain/bird (g)	1658.19[b]	1839.00[a]	29.90	1641.38[c]	1736.75[b]	1741.25[b]	1875.00[a]	44.15
Feed cost/weight gain for entire period of experiment (₦/g)	0.23[b]	0.28[a]	0.00	0.26[b]	0.25[b]	0.25[b]	0.28[a]	0.01

The effects of interaction of feed forms and feed access time on cost of feeding broiler chickens is presented in Table 5. The effect of interaction of feed forms and feed access time had significant ($P<0.05$) effect on feeding costs. Cost of feeding during restriction was lower in restricted fed birds placed on both mash and pelleted diets compared to their control groups and ranged significantly ($P<0.05$) from ₦37.22/bird in birds fed mash for 2 h to ₦156.94/bird in birds fed *ad libitum* on pelleted diet. Feeding pelleted diet was more costly compared to mash diet at each corresponding level of feed access time. This relatively higher cost of feeding pellet diet can be directly related to higher feed intake recorded in birds fed pelleted diet which increased feed cost as a result of more feed being consumed. This high cost of feeding can also be directly related to higher purchase cost per kg of pelletized feed which is owed to further processes involved in pellet production. According to Behnke and Beyer (2002), cost of processing is said to represent a significant portion of feed cost. However, regardless of the high cost of raising birds on pellet diet, those reared on 4 and 6 h feed access time still showed a better economic efficiency when compared with the *ad libitum* fed birds because they consumed lesser feed to gain a gram of meat.

Table 5: Effects of interaction of feed forms and feed access time on cost of feeding broiler chickens

Feed forms	Mash				Pellet				
Feed access time	2 h	4 h	6 h	*Ad libitum*	2 h	4 h	6 h	*Ad libitum*	SEM
Total Feed intake/bird (g)	3593.75^{d}	3677.50^{cd}	3675.25^{cd}	4483.25^{a}	3680.75^{cd}	3798.75^{bc}	3841.50^{b}	4528.75^{a}	37.51
Total cost of feed consumed/ bird (₦)	359.38^{e}	367.75^{e}	367.53^{e}	448.33^{d}	478.50^{c}	493.84^{b}	499.40^{b}	588.74^{a}	4.29
Total weight gain/bird (g)	1568.50^{c}	1621.75^{cb}	1599.00^{cb}	1843.50^{a}	1714.25^{b}	1851.75^{a}	1883.50^{a}	1906.50^{a}	36.57
Feed cost/weight gain (₦/g) for entire period of experiment	0.23^{cd}	0.22^{d}	0.23^{cd}	0.24^{c}	0.28^{b}	0.27^{b}	0.26^{b}	0.31^{a}	0.01

$^{a-f}$Means in the same row with different superscripts are significantly different (P<0.05)
SEM Standard error of mean
Mash feed ₦100/kg
Pellet feed ₦130/kg
Naira exchanged at N250 to a Dollar at the time this study was conducted

Conclusion

It was concluded that for a reduced cost of production without compromising growth performance, broiler birds should be raised on pellet diet and should not be subjected to less than 4 h feed access time for a 3-wk duration out of 8 wk of production.

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