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The effect of physical forms of feed and time regimes of feeding on the growth performance and nutrient digestibility of broiler chickens

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Target Audience: *Poultry farmers; Animal Scientists; Livestock Extension officers; Livestock Consultants.*

Abstract

Two hundred and seventy (270) day-old Arbor-acre broiler chicks randomly distributed over 2 dietary treatments (mash and pellet) and 2-time regimes (06.00 -14.00 h and 10.00 – 18.00 h) in a 2 x 2 factorial experiment were used for the feeding trial which evaluated the performance responses of broiler chickens. The starter mash diets were control T1 (MCDS), and time regimes of 06.00-14.00 h T2 (MRS06.00-14.00 h) and T3 (MRS10.00 – 18.00 h), starter pellet diets which were control T4 (PCDS) and time regimes of 06.00 – 14.00 h for T5 (PRS06.00-14.00 h) and 10.00 -18.00 h for T6 (PRS10.00-18.00 h). This gave six (6) treatments in all replicated thrice and contained 15 birds each. During the finisher phase, the time regimes were readjusted to allow half of the treatment group to ad libitum feedingto give T9 (MRS06.00-14.00 Fad) and T10 (MRS10.00-18.00Fad) while the other half of the group was maintained on the restriction period from the starter phase to give 2 x 2 x 2 factorial arrangements of 8 treatment groups replicated 3 times and each contained 7 birds. Growth performance indices monitored were, average daily feed intake (ADFI), average daily body weight gained (ADWG), final live weight gain (FLW), feed conversion ratio (FCR) and protein efficiency ratio (PER). Apparent nutrient digestibility for dry matter (DM), crude protein (CP), ether extract (EE) and carbohydrate were determined between 21 – 27 days and 49- 56 days of the starter and finisher phases, respectively. Each phase lasted 28 days. Results at the starter phase indicated that the main effect of feed form was only significantly ($p<0.05$) higher on FCR, PER and water intake for birds fed pellet feed than those fed mash. However, main effect of feed form was significantly higher ($p<0.05$) for ADFI for mash feed form than the pellet but the FCR and PER values were better in birds fed the pellet feed during the finisher phase. The main effect did not affect ($p>0.05$) apparent digestibility of nutrients at the starter phase but birds fed pellet feed consistently recorded higher ($p<0.05$) values at the finisher phase. At the starter and finisher phases, interactive effect of the feed form x time regimes for feed restriction had consistent significant highest values ($p<0.05$) for FLW, FCR, PER and water intake for birds fed pellet control diet (PCDS). However, at the finisher phase, the ADFI was highest ($p<0.05$) for birds on mash control diet and similar to the intake of treatments T9 and T10. Birds fed pellet feed gave better performance than those on mash.

Keywords: *Pellet, Mash, Restriction, Growth, Phases*

Description of problem

The enhanced growth performance as a result of genetic, nutritional and environmental improvement is a good development in poultry meat production particularly in broiler chickens. However, this has come with other challenges such as excessive fat deposition and the attendant high cost of production (1, 2). Other prevailing problem is the observed on-farm irregular and untimely supply of broiler chicken feed that is common in the least developing countries (LCDs) because of the rural settings peculiar challenges such as delay in transportation of inputs due to inadequate infrastructural support like good roads and vehicles. This often leads to a sub-conscious application of feed restriction or daytime broiler chicken access to feed by farmers because of their location in rural areas. These challenges are more felt in the least developing countries (LDCs) in addition to others such as availability of credit, high interest rate, supply of good quality chicks as well as quality feed as at when required that constitute more than 75% of the total cost of production (3,4).

Efforts to overcome the overfeeding that leads to excessive fat deposition with a resultant high cost of production and reduction in the meat quality index required by consumers have led to a robust means of scientific feed restriction techniques both quantitively and qualitatively as reported by previous workers (5,6,7). Studies have shown that physical forms of diet such as mash or pellet do affect the process of feed utilization and hence growth performance of the animal (8,9,10,11), particularly when applied as a factor in feed restriction methods (12, 13). In Nigeria and many of the LDCs, high cost of feed often times depicts its availability and consequently accessibility of broiler chicken to quality feed. In addition, most farmers in the rural areas where 24 hours lighting is not possible for broilers compelled feeding their stock during a particularly period of the day. Therefore, this study was designed to evaluate the feed restriction by daytime and feed forms on broiler chickens during the two different phases of their life span.

Materials and Methods

Location and site of study

The experiment was conducted in the Teaching and Research Farms of the Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti. The town is located on latitude 7^0 38' North of the equator and longitude 5^0 13' East of the Greenwich Meridian. It has two distinct seasons which are; the rainy seasons (April to October) and the dry season (November to March), every year and average annual temperature range of $21^oC – 28^oC$ (14).

Starter Phase

Experimental design, preparation of diets, birds and management

The experimental diets were formulated as recommended by (15) for the starter and finisher broiler chicken using the same feed ingredients for both mash and pellet forms of feed to ensure uniformity quantitively and qualitatively (Table 1). The pellet was produced by extruding the mash feed after mixing through a ring die pellet mill machine sieve of 2mm and 4mm for the starter and finisher phases, respectively.

Two hundred and seventy (270) day-old Arbor-acre commercial hybrid broiler chicks of average initial weight 70.00g were randomly assigned to six dietary treatment groups of 2 x 2 factorial arrangement in a completely randomized design experiment with two control groups. Each treatment group was replicated thrice and contained 45 birds per group. The factorial experiment model is;

$Y_{ijk} = N + A_i + B_j + (AB)_{ij} + e_{ijk}$ where

Y_{ijk} = individual observation

N= general mean

A_i = effect of factor A

B_j =effect of factor B

$(AB)_{ij}$ = effect of interactions of factors A and B, while

e_{ijk} = experimental error.

Table1: Composition of experimental diets (%)

Ingredients	Starter Diets		Finisher Diets	
	Mash	Pellet	Mash	Pellet
Maize	50.00	50.00	56.00	56.00
Soybean meal	12.00	12.00	12.00	12.00
Groundnut cake	18.00	18.00	14.00	14.00
Fish meal	3.00	3.00	2.00	2.00
Wheat offal	4.60	4.60	3.00	3.00
Palm kernel cake	3.00	3.00	6.00	6.00
Brewer's dried grain	4.00	4.00	2.00	2.00
Bone meal	1.50	1.50	1.50	1.50
Oyster shell	2.00	2.00	1.50	1.50
DL-Methionine	0.30	0.30	0.40	0.40
L-Lysine	0.10	0.10	0.10	0.10
*Starter Premix	0.25	0.25	-	-
**Finisher Premix	-	-	0.25	0.25
Iodized Salt	0.25	0.25	0.25	0.25
Cassava root starch	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.0
Crude protein	22.2	22.4	19.94	19.94
Crude fibre	3.95	4.00	3.99	4.00
Ether extract	5.12	5.12	4.85	4.85
Calcium	1.30	1.30	1.08	1.08
Phosphorous	0.78	0.78	0.71	0.71
Ash	3.72	3.72	3.10	3.10
Metabolizable Energy (ME) MJ	11.92	11.92	12.24	12.24

* Composition of Starter Premix- contained the following per 2.5kg; vitamins A (10,000,000iu); D(2,000,000 iu); E (35000 iu); K (1900mg); B12 (19mg); Riboflavin (7,000mg); Pyridoxine (3800mg); Thiamine (2,200mg); D Pantothenic acid (11,000mg); Nicotinic acid (45,000mg); Folic acid (1400mg); Biotin (113mg); and Trace elements as Cu (8000mg); Mn (64,000mg); Zn (40,000mg); Fe (32,000mg) Se (160mg); I2 (800mg) and other items as Co (400mg); Choline (475,000mg); Methionine (50,000mg); BHT (5,000mg) and Spiramycin (5,000mg)

Finisher- contained the following per 2.5kg; mineral premix provided the following vitamin and minerals per kg of diet:A, 10,000 I.U.; D3, 300 I.U.; E. 8.0 I.U.; K, 2.0mg; B1, 2.0mg; B6, 1.2mg; B12, 0.12mg; Niacin 1.0mg; Panthothenic acid, 7.0mg; Folic acid, 0.6mg; Cholic, 500mg; C, 10.0mg; Fe, 60mg; Mn, 80mg; Mg, 100mg; Cu, 8.0mg; Zn, 50mg; Co, 0.45mg; I, 2.0mg and Se, 0.1mg.

The 6 treatment groups have T1 as the Mash Control Diet Starter phase (MCDS); T2 as the Mash Feed Restriction Starter phase from 06:00–14:00 hours of the day (MRS6-14hr); Mash Feed Restriction Starter phase from 10:00–18:00 hour of the day (MRS 10 – 18hr); T4 Pellet Control Diet Starter phase (PCDS); Pellet Feed Restriction Starter phase 06:00–14:00 hour of the day (PRS6-14 hr); Pellet Feed Restriction Stater phase 10:00 – 18:00 hours of the day (PRS10 – 18 hr). The birds were fed on commercial broiler starter feed for a period of four days before the commencement of the study. Routine management principles in terms of the medication schedule such as administration of anti-stress in drinking water in the first week of the arrival of the birds. Lasota vaccine as prophylactic against Newcastle disease was given orally in water on commencement of the 2nd week while Gumboro was administered on the third week. Litters were changed every two weeks of the trial as schedule in the management practice of the Teaching and Research Farms. The birds were fed for a period of 28 days that constitute the starter phase and another 28 days for the finisher phase.

Table 2. Main effect of feed forms and restriction periods on the growth performance and apparent nutrient digestibility of broiler starter chickens

Parameters	Mash	Pellet	±SEM	p-Value
Growth Performance				
Initial body weight (g/b)	72.1	76.1	1.84	0.09
Final live weight (g/b)	1324	1337	0.15	0.09
Average daily feed intake (g/b)	87.07	90.01	1.04	0.31
Average daily weight gain (g/b)	44.61	45.09	0.10	0.92
Feed conversion ratio	1.91^{b}	2.00^{a}	2.75	0.01
Protein efficiency ratio	7.95^{b}	8.83^{a}	2.74	0.02
Water intake (ml/b/d)	22.30^{b}	24.40^{a}	16.30	0.12
Apparent nutrient digestibility				
Dry matter	82.00	81.20	0.37	0.72
Crude Protein (%)	83.40	82.20	0.86	0.40
Crude Fibre (%)	90.10	89.00	0.99	0.34
Ether Extract (%)	91.60	90.80	0.88	0.39
Ash (%)	63.20	70.70	1.91	0.07
Carbohydrate (%)	82.30	82.90	0.30	0.77

a, b, : Means with different superscript letters on the same row differs significantly ($p<0.05$)

Table 3. Interaction effect of feed forms (Mash and Pellet) and restriction periods on growth performance and apparent digestibility coefficients by broiler starter chickens

Parameters	M A S H			P E L L E T			±SEM
	Feed Restriction Period			Feed Restriction Period			
	T1 (MCDS)	T2 (MRS6-14)	T3 (MRS10-18)	T4 (PCDS)	T5 (PRS6-14)	T6 (PRS10-18)	
Growth Performance							
Initial body weight (g/b)	72.70	72.00	75.70	73.00	76.70	77.70	-
Final liveweight (g/b)	1560.0^{a}	1146.7^{c}	1266.7^{b}	1570.3^{a}	1230.00^{b}	1256.7^{b}	237
Average daily feed intake (g/b)	83.90^{b}	72.58^{c}	76.93^{b}	108.46^{a}	81.16^{b}	80.41^{b}	2.74
Average daily body weight gain (g/b)	53.10^{b}	38.40^{c}	42.50^{b}	54.50^{a}	41.20^{b}	42.10^{b}	0.92
Feed conversion ratio (FCR)	1.58^{b}	1.89^{a}	1.81^{a}	1.99^{a}	1.97^{a}	1.91^{a}	0.20
Protein efficiency ratio (PER)	7.14^{b}	8.51^{a}	8.20^{a}	8.99^{a}	8.84^{a}	8.67^{a}	1.86
Water intake (ml/b/d)	26.40^{b}	19.50^{d}	21.00^{d}	28.80^{a}	23.30^{c}	23.10^{c}	0.06
Apparent Nutrient Digestibility							
Dry matter (%)	81.20	82.90	81.80	82.60	83.70	82.30	2.04
Crude Protein (%)	82.70	84.20	84.20	82.50	80.50	83.50	2.71
Crude Fibre (%)	84.60	80.20	90.10	89.70	89.40	87.70	12.4
Ether Extract (%)	91.30	92.00	91.40	91.40	90.90	90.10	0.98
Ash (%)	61.70	65.00	63.00	67.10	71.00	71.70	1.62
Carbohydrate (%)	81.70	83.30	82.00	82.70	83.70	82.30	2.04

a, b, c: Means with different superscript letters on the same row differs significantly ($p<0.05$)

Apparent Nutrient Digestibility Study

On the 21st day of the starter and 49th day of the finisher phases, two birds each per replicate were randomly selected from their respective groups and transferred to the metabolic cage constructed with galvanized iron, where the apparent digestibility of the nutrients were carried out. The birds were fed the treatment diets as per their replicates and the droppings collected on the polythene used as a lining for the aluminum drawer underneath each of the metabolic cage cells. The feed intake was measured, recorded and samples taken for proximate analysis. The droppings were harvested using total collection procedure and feathers, feed particles and other impurities removed. It was sprayed with 0.5 ml of concentrated sulphuric acid to repel flies and for adequate preservation against larva growth from eggs of flies. The droppings were weighed wet and later sundried to reduce the moisture before oven drying in a Gallenkamp oven at 55^{o}Celsius for a period of 36 hours.

Finisher Phase

Design of experiment, preparation of experimental diets and animal management

The broiler birds of the started phase were arranged in a 2 x 2 x 2 factorial manner in a completely randomized design. The factors were; the physical feed forms (Mash and Pellet), the time of feed restriction 06:00 – 14:00 hours and 10:00 -18:00 hours. The broiler birds at this stage were again further split into two groups namely, one group maintained the feed restriction periods or daytime access to feed as it were from the starter phase while the other group was fed *ad libitum.* The birds on the control groups were maintained on continuous *ad libitum* feeding. The following treatment arrangements were obtained:

T1 = Mash control diet fed *ad libitum* at the starter and finisher phases (MCDF),

T2 = Mash feed fed at the starter phase from 06:00 – 14:00 hours and restriction maintained during the finisher phase (MRF6-14hr),

T3 = Mash feed fed at the starter phase from 10:00 – 18:00 hours and restriction maintained during the finisher phase (MRF10-18hr),

T4 = Mash feed fed at the starter phase for 06:00 – 14:00 hours but fed *ad libitum* at the finisher phase (MRS6-14Fad),

T5 = Mash feed at the starter phase from 10:00 – 18:00 hours but fed *ad libitum* at the finisher phase (MRSF10-18Fad),

T6 = Pellet Control diet fed *ad libitum* at the starter and finisher phase (PCDF),

T7 = Pellet feed fed at the starter phase from 06:00 – 14:00 hours and restriction maintained during the finisher phase (PRF6-14hr),

T8 = Pellet feed fed at the starter phase from 10:00 – 18:00 hours and maintained as it were during the finisher phase (PRF10-18),

T9 = Pellet feed fed at the starter phase from 06:00 – 14:00 hours but fed *ad libitum* at the finisher phase (PRSF6-14Fad) and

T10 =Pellet feed fed at the starter phase from 10:00 – 18:00 hours but fed *ad libitum* during the finisher phase (PRSF10-18Fad).

The experimental diets for the finishers are shown in Table 1 along with the starter as earlier indicated and were formulated to contain same nutrient contents but differed in the physical forms i.e. Mash and Pellet.

Data collection

Data were collected on live weight, average daily body weight gain (ADWG) and average daily feed intake (ADFI). Feed conversion ratio (FCR) and protein efficiency ratio (PER) were calculated from the primary data obtained during the starter and finisher phases.

Chemical analysis

Samples of the experimental diets and faeces were analyzed for proximate composition as described by (15) and the metabolizable energy (ME) calculated using the prediction equation M.E. = 37 x % CP + 81.8 x% EE + 35.5 x% NFE as described by (16).

Statistical analysis

All the data obtained were subjected to analysis of variance using (17) analytical package and the means separated by the use of Duncan Multiple Range Test.

Results and Discussion

Starter Phase

Table 2 shows the result of the main effect of the feed forms on the growth performance and apparent nutrient digestibility at the broiler starter phase. All the growth performance indices were not influenced by the feed forms ($p>0.05$) except the feed conversion ratio (FCR), protein efficiency ratio and the water intake ($p<0.05$). The FCR (2.00) and PER (8.83) were significantly ($p<0.05$) better for broiler starter birds fed pellet feed than those fed mash which were 1.91 and 7.95, respectively. Broiler starter fed pellets significantly ($p<0.05$) drank more water (24.40ml/b/d) than those on mash feeds (22.30ml/b/d). All the nutrient digestibility indices were not affected by the main effect of the feed forms.

Table 4. Main effect of feed forms on the growth performance and apparent nutrient digestibility of broiler finisher chickens

Parameters	Mash	Pellet	±SEM	p-Value
Growth Performance				
Initial body weight (g/b)	1270.70	1299.30	0.54	0.59
Final live weight (g/b)	2318.80	2367.50	0.52	0.61
Average daily feed intake (g/b)	119.00 ^{a}	108.00 ^{b}	3.43	0.002
Average daily weight gain (g/b)	37.30	38.10	0.35	0.73
Feed conversion ratio	3.23 ^{b}	2.88 ^{a}	2.28	0.03
Protein efficiency ratio	1.75 ^{b}	1.98 ^{a}	2.26	0.03
Water intake (ml/b/d)	23.80	25.80	1.38	0.18
Apparent nutrient digestibility				
Dry matter (%)	83.50 ^{b}	86.70 ^{a}	3.70	0.001
Crude Protein (%)	83.90 ^{b}	87.80 ^{a}	3.82	0.005
Crude Fibre (%)	86.70 ^{b}	91.80 ^{a}	6.24	0.001
Ether Extract (%)	91.30 ^{b}	93.90 ^{a}	5.62	0.001
Ash (%)	73.30 ^{b}	76.50 ^{a}	2.24	0.033
Carbohydrate (%)	83.90	87.30	0.99	0.329

a, b,: Means with different superscript letters on the same row differs significantly ($p<0.05$)

Table 3 shows the interaction effect of the feed forms and restriction or access of birds to feed in the daytime period on growth performance and the apparent nutrient digestibility. Birds fed the PCDS diet (Pellet control group) significantly ($p<0.05$) recorded higher ADFI (108.46g) and was closely followed by those fed with mash control diet (MCDS) 83.90g. Broiler chickens restricted to daytime feeding of 06:00 – 14:00 hrs (MRS6 -14 hrs) recorded the least ($p<0.05$) ADFI (72.58 g). The final live weight (FLW) of 1570.30 g was attained by birds fed the control pellet diet but similar to 1560.00g obtained by starter birds fed mash diets and were significantly higher ($p<0.05$) than values for other treatment groups. The lowest FLW was observed in birds fed mash restricted daily to 06:00-14:00 hours (MRS6-14hr) 1146.70g. The average daily weight gain (ADWG) was highest for birds fed pellet feed and almost followed the same trend as observed in the FLW. The FCR and PER values were higher ($p<0.05$) and similar in values for all the treatment groups except birds on the mash control group (MCDS). Birds on the pellet control group recorded highest ($p<0.05$) water intake (28.8 ml/b/d) while, those on MRS6-14hr diet had the lowest water intake (19.50 ml/b/d). The apparent nutrient digestibility indices were not significantly ($p<0.05$) affected by the interaction of the feed form and restriction periods.

Finisher Phase

The main effect of the feed forms on the growth performance and apparent nutrient digestibility values on the finisher broiler is shown on Table 4. ADFI was significantly higher ($p<0.05$) for birds fed mash feeds (119.0 g) than those on pellet feed (108.0 g) while, the FCR and PER were significantly better in groups fed pellet feed with 2.88 and 1.98, respectively than values for the mash feed form which were 3.23 and 1.75 respectively. The water intake was not affected by the main effect ($p>0.05$). The ADWG was not significantly affected by the feed forms as the daily body gains were similar for birds on mash and pellet feed forms with 37.30g and 38.10g, respectively. Groups of birds fed the pelleted feed consistently recorded significantly higher ($p<0.05$) apparent nutrient digestibility for dry matter (86.70%), crude protein (87.80%), crude fibre (91.83%), ether extract (93.90%) and ash (75.50%) than the mash feed form while, there was no significant influence on carbohydrates ($p>0.05$).

Table 5. Interaction effect of fed forms (Mash and Pellet) and restriction periods on growth performance and apparent digestibility coefficients in broiler finisher chickens

Parameters	MASH					PELLET					
	(T1) MCDSF	(T2) MRSF6-14	(T3) MRSF10-18	T4 MRSF6-14ad	T5 MRSF10-18Fad	T6 PCDF	T7 PRSF6-14	T8 PRSF10-18	T9 PRSF6-14Fad	T10 PRSF10-18Fad	±SEM
Growth Performance											
Initial body weight (g/b)	1560.0	1146.7	1266.7	1146.7	1233.3	1570.3	1230.0	1256.7	1230.0	1256.7	29.10
Final live weight (g/b)	2827.0^{a}	2082.7^{d}	2118.3^{cd}	2276.7^{bc}	2289.3^{bc}	2869.7^{a}	2130.0^{cd}	2232.0^{bcd}	2354.7^{b}	2398.0^{b}	53.80
Average daily feed intake (g/b)	125.00^{a}	107.00^{b}	110.70^{b}	123.30^{a}	129.00^{a}	108.60^{b}	106.30^{b}	109.70^{b}	110.30^{b}	106.00^{b}	4.01
Average daily weight gain (g/b)	45.30^{a}	33.40^{c}	30.40^{d}	40.40^{b}	37.70^{bc}	46.40^{a}	32.00^{c}	34.70^{c}	40.00^{b}	41.00^{b}	2.20
Feed conversion ratio (FCR)	2.78^{b}	3.20^{c}	3.66^{d}	3.06^{c}	3.45^{d}	2.35^{a}	3.30^{c}	3.15^{c}	2.76^{b}	2.60^{b}	0.20
Protein efficiency ratio (PER)	1.82^{b}	1.67^{c}	1.38^{d}	1.64^{c}	1.47^{cd}	2.14^{a}	1.52^{cd}	1.59^{c}	1.83^{b}	1.94^{b}	0.09
Water intake (ml/b/d)	31.90^{b}	20.30^{c}	21.30^{de}	22.10^{de}	23.40^{d}	36.90^{a}	22.60^{de}	23.00^{d}	26.40^{c}	26.30^{c}	0.78
Apparent Nutrient Digestibility (%)											
Dry matter	83.70^{c}	87.30^{ab}	87.10^{ab}	85.20^{b}	90.40^{a}	83.60^{c}	83.60^{c}	81.70^{d}	85.10^{b}	83.50^{c}	1.09
Crude Protein	84.50^{bcd}	88.20^{b}	87.70^{bc}	85.80^{bcd}	92.80^{a}	84.20^{cd}	83.80^{d}	82.10^{d}	85.50^{bcd}	84.00^{cd}	1.14
Ether Extract	92.50^{bcd}	94.10^{ab}	94.00^{ab}	93.20^{bc}	95.60^{a}	92.00^{cde}	91.30^{cde}	90.20^{e}	92.00^{cde}	91.10^{de}	0.62
Crude fibre	89.50^{bcd}	91.80^{ab}	93.70^{a}	90.40^{abc}	93.80^{a}	88.30^{bcde}	86.40^{de}	84.90^{c}	87.70^{cde}	86.40de	1.11
Ash	70.50^{d}	77.20^{b}	76.80^{bc}	75.20^{bcd}	82.80^{a}	71.60^{d}	73.6^{abcd}	71.00^{d}	76.40^{bc}	73.90^{bcd}	1.62
Carbohydrate	84.30	87.80	87.60	84.70	90.80	84.20	84.00	82.40	85.70	84.20	1.25

a ,b, c, d; Means within *the same row with different superscripts significantly differ ($p<0.05$)*

Table 5 shows interaction effect of feed form x restriction (or access of birds to feed in the daytime periods) on the growth performance at the finisher phase. At the end of the finisher phase, the average daily feed intake (ADFI) of 125 g was significantly highest ($p<0.05$) for birds on MCDF (mash control group at the starter and finisher phases) and similar to

123.30 g recorded by those fed MRS6-14Fad and MRS10- 18Fad. The FLW was significantly highest ($p<0.05$) and similar in values for the birds on the two control groups: 2869.70 g for the pellet control diet group (PCDF) and 2827.00 g for mash control diet birds (MCDF). Birds that were maintained on the mash feed restriction from 06:00- 14:00 hr of the daytime (MRF6-14 hr) gave the lowest FLW (2082.70 g). The average daily weight gained (ADWG) had the same trend observed in the FLW. The FCR and PER values were best for broiler finisher on PCDF with values of 2.35 and 2.14 respectively. Birds fed PCDSF diet also had the highest ($p<0.05$) water intake (36.90 ml/b/d) while those on MRSF6-14 hrs recorded the lowest (20.30 ml/b/d).

The apparent nutrient digestibility values were highest ($p<0.05$) for dry matter, crude protein, crude fibre, ether extract, and ash in broiler finisher fed MRS10–18Fad. Carbohydrate digestibility was not significantly ($p<0.05$) affected by the feed form x restriction periods interaction.

The result showed that the physical feed form did not have a positive effect on feed intake of the starter birds but, significantly affected the utilization of the feed as indicated for by the feed conversion ratio and the protein efficiency ratio. Birds on the pellet feed consumed more water than those on mash and this may be because more water would be required to dissolve the pellet bound by binders used which was not in the binder. More water is necessary for enhanced metabolic process in the birds especially for the exposure of the feed particles to enzymatic activities and subsequent utilization, hence the observed better growth performance in this study. This corroborates the report of (12) that physical feed forms did not influence feed intake in a study where Japanese quail was used to determine the effect of physical feed forms and restriction feeding on growth performance, carcass characteristics and day at first egg. However, it is contrary to the findings of (10) and (11) that physical feed forms (pellet) had a significant influence on the feed consumption of broiler chicken. The pellet feed form is more concentrated in nutrient per bite of feed eaten which may have quickly yielded to dissolution thereby exposing the surface area of the feed as substrate to the biological enzymes for better digestion, absorption, improved conversion and utilization than the mash as observed in this study. In addition, the cumulative energy expended during feeding might have contributed to the reduced daily gain in birds fed mash as compared to those fed pellets, where a bite of the feed requires less energy, because one bite of the pellet could be equivalent to two or more bites by the birds fed mash which agreed with (19).

The observed increase in the ADFI of birds fed MRSF6 – 14Fad and MRSF10 – 18Fad could be attributed to the unrestricted access to feed at the finisher phase during daylight period contrary to the restriction experienced during the starter phase. The birds had more access to feed because of the longer daytime hours available to them. This obviously must have improved nutrient availability and utilization, with the resulting compensatory growth performance. Birds fed pellet feed form at the finisher phase with restriction or *ad libitum* feeding did not show any remarkable difference in their ADFI. The birds may have had their gut filled due to swelling of the digesta resulting into bulk in the gastro intestinal tract (GIT) and possibly increased viscosity in the GIT that may have slowed down intake. The fore-gut or upper GIT has been shown to influence the efficiency and intake of feed in broiler chickens particularly when feed is not continuously available that goes a long way to affect intake, digestion and nutrient absorption (20).

The longer hours of activeness of the birds and particle nature of the feed that may have allowed for longer enzyme action can be responsible for the observed high apparent digestibility results for the birds fed *ad libitum* mash diet at the finisher phase (11, 21, 22). The observed apparent digestibility values in mash fed broiler chickens resulted to similar weight gained among them. This may be due to loss of energy due to feeding process as against what obtained in pellet fed broilers (22, 23). It is obvious from this study that pellet feed form when fed to broiler chicken both at starter and finisher phases improved utilization as recorded by previous workers (11, 23, 24,) but contrary to the report of (25) that feed forms had no significant effect on the growth performance particularly weight gain.

Conclusion and Applications

1. The study revealed that feed forms did not affect both the body weight gain and the final live weight of broiler starter and finisher while the interaction between the physical form of diet and different time regimes the birds were allowed to have access to feed resulted in inferior growth performance.
2. Farmers could take advantage of better utilization of the pellet form of feed to enhance gain in weight of the birds and in the event of feed scarcity practice feed restriction whereby irrespective of whether mash or pellet, starter and finisher broilers are allowed access to feed for 10:00 - 18:00 hr.

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