EFFECT OF FEED RESTRICTION ON GROWTH, CARCASS, INTERNAL ORGANS AND ECONOMIC BENEFIT OF MEAT CHICKENS

***[1]Ndelekwute, E.K., [2]Okey, S.N., [3]Nwokoro, C., [4]Madu, H.C. and [1]Okonkwo, A.C.**

[1]Department of Animal Science, University of Uyo, Uyo, Nigeria.
[2]Depatrment of Animal Health and Production, Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria.
[3]Department of Animal Nutrition and Forage Science, Michael Okpara University of Agriculture, Umudike, Nigeria.
[4]Department of Fisheries and Marine Technology, Imo State Polytechnic, Umuagwo, Imo State, Nigeria.

**Corresponding author's e-mail:* ndelekwute.ek@gmail.com

ABSTRACT

A study was conducted to determine the effect of feed restriction on growth, carcass yield, internal organ characteristics and economic benefit of meat chickens. Quantitative feed restriction during the day was employed. One hundred and thirty-two (132) finisher broilers were used. The birds were reared from day old to 4 weeks. At the end of 4 weeks, they were divided into four treatments (T), in a completely randomized design (CRD). Birds in T_1 (control) were fed ad libitum while birds in T_2, T_3 and T_4 had their feed restricted for 2, 4 and 6 hours daily respectively. Each treatment was replicated thrice, with 11 birds each. The experiment lasted for 4 weeks. At the end of the experiment, feed restriction for six hours resulted to smaller live weight and reduced feed intake but better feed: gain ratio compared to ad libitum feeding. Dressing percentage, abdominal fat, gizzard and intestine were significantly reduced ($p < 0.05$) by six hour feed restriction. The liver and kidneys were however significantly ($p < 0.05$) enlarged by six hour feed restriction. Six hour feed restriction reduced gross profit margin. Therefore, feed restriction during the finisher phase did not improve growth but two hours feed restriction marginally improved gross profit margin and is therefore recommended.

Keywords: Carcass, Feed restriction, Growth, Internal organs, Meat chickens, Economic benefit

J. Agric. Prod. & Tech.2014; 3:1-7

INTRODUCTION

The development of breeds of chicken capable of producing enough meat and exhibiting fast growth rate has increased markedly in recent years, and this has greatly improved the poultry industry (Rahjhan, 2001). But the progress made so far in the industry is threatened by the escalating cost of feeds. Feed accounts for 60 – 75% of the total production cost of raising poultry (Olomu, 2000). This has led to suggestions and practices aimed at reducing cost of production without reducing performance. One of such suggestions is the practice of feed restriction.

Feed restriction implies denying birds, particularly the fast growing broilers,

full access to feed that are required for their normal growth and development (Okonkwo *et al.,* 2011). Commercial broiler producers, who before now adopted *ad libitum* feeding from day old chick to market age, now adopt feed restriction. Scott (2002) observed that *ad libitum* feeding leads to a high fat deposition, reduced carcass yield, poor feed efficiency and adverse effect on human health when consumed. It was in the light of these that Urdaneta and Leeson (2002) defined feed restriction as a management tool used to modify bird's growth pattern by decreasing their maintenance requirements, thereby reducing the incidence of metabolic and skeletal disorders, sudden death syndrome and other problems associated with *ad libitum* feeding. Feed restriction has also been reported to improve feed efficiency, reduced carcass fat, reduced incidence of leg disorder and mortality. Zubair and Leeson (1996) observed that feed restricted broilers showed improved feed efficiency, reduced feed cost and mortality along with the production of quality meat at cheaper rate. According to Okonkwo *et al.* (2011), feed restriction may be categorized as qualitative or quantitative. In qualitative feed restriction, birds are denied full access to certain nutrients through the provision of feed diluted mainly with inert fibre. In quantitative feed restriction, birds are physically denied access to feeding during certain times of the day. Various methods of restricted feeding programmes such as intermittent feeding and skip-a-day feeding have been employed in broiler production. This research was therefore carried out to examine the effect of varying duration of feed restriction on the live weight performance, carcass characteristics and economic efficiency of broilers.

MATERIALS AND METHODS

The research was conducted at the Teaching and Research Farm of the University of Uyo, Uyo in southern Nigeria. One hundred and eighty (180) 4-week old Hubbard broilers were randomly allotted to four treatments in a Completely Randomized Design (CRD). Each treatment was replicated three times with 15 birds per replicate. The treatments (T) were: T1 (control) which was *ad libitum* feeding; T2 was two hours of feed restriction; T3, four hours of feed restriction and T4, six hours daily feed restriction. Quantitative feed restriction during the day starting from 9.00hrs was employed. The birds were however fed *ad libitum* during the starter phase which lasted for four weeks. Routine management practices and vaccinations were strictly adhered to while the research lasted. Feed used both at the starter and finisher phases were formulated to meet the requirements for broiler birds (NRC, 1994) as shown in Table 1. The experiment lasted for four (4) weeks from fifth to eighth week. The birds were weighed weekly while feed intake was obtained on daily basis after subtraction of the leftover feed.

Carcass and Internal Organ Analyses: At the end of the experiment, two birds from each replicate were used for carcass and internal organ analyses according to Scott *et al*. (1969) and Ndelekwute *et al*. (2014a). Weight of the carcass cut-parts, abdominal fat and internal organs were determined. Dressed weight, internal organs and abdominal fat were expressed as percentage live weight while weight of different cut-parts were expressed as percentage of dressed carcass weight according to Abaza *et al*. (2008) as cited by Ndelekwute *et al.* (2014a). Data generated were subjected to Analysis of Variance (ANOVA) and treatment means were compared using Duncan Multiple Range Test (Steel and Torrie, 1980).

Economic Benefit Analysis: Economic benefit analysis was carried out to determine the economic implications of feed restriction

on dressed broilers according to Ndelekwute *et al*. (2014b).

Table 1: Ingredients and nutrients composition of experimental diets

Ingredients (%)	**Starter**	**Finisher**
Maize	53.00	54.00
Soyabean meal	29.00	27.00
Fish meal	4.00	-
Palm kernel cake	10.20	15.30
Bone meal	3.00	3.00
Table salt	0.25	0.10
L-Lysine	0.20	0.20
DL-Methionine	0.10	0.10
Premix*	0.25	0.25
Total	**100**	**100**
Nutrient Composition (%)		
Crude Protein	22.60	20.40
Crude Fibre	4.00	5.03
Ether Extract	4.10	4.86
Calcium	1.18	1.00
Phosphorus	1.00	0.85
Lysine	1.14	1.0
Methionine	0.50	0.45
Energy (KcalME/kg diet)**	2890	2925

***Starter premix** supplied *per kg diet: vitamin A 15,000 I.U, vitamin D_3 13000 iu, thiamin 2mg, Riboflavin 6mg, pyridoxine 4mg, Niancin 40mg, cobalamine 0.05g, Biotin 0.08mg, chooline chloride 0.05g, Manganese 0.096g, Zinc 0.06g, Iron 0.024g, Copper 0.006g, Iodine 0.014g, Selenium 0.24mg, Cobalt 0.024mg and Antioxidant 0.125g.*
***Finisher premix** supplied per kg diet; vitamin A 10, 0001.u., vitamin D_3 12,0001.u. Vitamin E 201.U., Vitamin K 2.5mg, thiamine 2.0mg, Riboflavin 3.0mg, pyridoxine 4.0mg, Niacin 20mg, cobalamin 0.05mg, pantothenic acid 5.0mg, Folic acid 0.5mg, Biotin 0.08mg, choline chloride 0.2mg, Manganese 0.006g, Zinc 0.03g, Copper 0.006g, Iodine 0.0014g, Selenium 0.24g, cobalt 0.25g and antioxidant 0.125g. **Calculated values.*

Cost/kg feed = Summation of price per kg of feed ingredients x their proportions in the feed formula ÷ 100

$$\text{Average Cost/kg feed} = \frac{\text{Cost/kg feed (Starter phase)} + \text{Cost/kg feed (Finisher phase)}}{2}$$

Feed cost/bird (dressed) = Feed cost/bird at (starter phase + finisher phase)
Revenue/dressed bird = Price/kg dressed weight x dressed carcass weight/bird.
Goss margin = Revenue/bird – feed cost/bird.

RESULTS AND DISCUSSION

Growth Performance: The result of the effects of feed restriction on growth performance of finisher broilers is as presented in Table 2. Feed restriction clearly affected growth indices ($p < 0.05$). Six hours daily restriction (T4) significantly reduced final live weight compared to *ad libitum* feeding, two and four hours feed restrictions. There was no difference ($p > 0.05$) in final live weight of birds on *ad libitum* feeding and feed restriction for two and four hours. Similar trend was observed in daily feed intake, and feed: gain ratio. Contrary trend was however recorded in total feed intake. Control group consumed

more ($p < 0.05$) feed compared to all the groups of birds exposed to feed restriction. Six hours daily feed restriction (T4) reduced daily weight gain compared to *ad libitum* feeding and two hours feed restriction (T2). Daily gain did not differ ($p > 0.05$) in groups fed *ad libitum* and those restricted for two and four hours. This result indicated that prolong and consistent withdrawal of feed from broilers could be detrimental to their growth. There was no room for compensatory growth which would have occurred if *ad libitum* feeding was introduced later in the life of the birds. This was attested to by the final live weight and daily gain of the broilers restricted feed for six hours on daily basis for the four weeks the experiment lasted. The poor body weight could be as a result of the birds using part of their body protein for metabolic purposes during the six hours of the feed starvation. It has been reported that animals utilize their body protein (amino acids) to generate energy when energy supply is in short supply such as during starvation due to fall in glucose level (Bender and Mayes, 2006). Persistence and continual fall in glucose level of the body is detrimental to growth and could be good reason for the poor performance of broilers on treatment four (T4). This result is in agreement with Okonkwo *et al.* (2011) and Lee and Leeson (2001) who independently reported decreasing body weight of broilers that were restricted of feed. The better feed: gain ratio exhibited by treatment four signified certain level of compensatory growth. However, this growth compensation did not manifest in the final live weight probably because feed restriction was continuously observed to the end of the experiment. The result of feed: gain ratio was in agreement with the findings of Deaton (1995) and Tottori *et al.* (1997), who reported significant improvement in the feed efficiency ratio of restricted birds. .

Table 2: Effect of feed restriction on growth performance of broilers

Parameters	T_1	T_2	T_3	T_4	SEM
Initial weight (g/bird)	580	570	565	570	91.07
Final live weight (g/bird)	2005^{a}	1990^{a}	1950^{a}	1800^{b}	82.09
Daily gain (g/bird)	50.89^{a}	50.71^{a}	49.46^{ab}	43.93^{b}	6.09
Total feed intake (g/bird)	3580^{a}	3300^{b}	3100^{bc}	2710^{c}	230.08
Daily feed intake (g/bird)	127.86^{a}	117.85^{a}	110.81^{ab}	96.79^{b}	20.12
Feed gain: ratio	2.51^{a}	2.32^{a}	2.42^{ab}	2.20^{b}	0.20

[a,b]Means along the same row with different superscripts are significantly different ($p < 0.05$).
SEM = standard error of mean. T1 = a*d libitum* feeding; T2 = two hours feed restriction; T3 = four hours feed restriction; T4 = six hours feed restriction.

Carcass Characteristics and Internal Organs: The effect of feed restriction on carcass characteristics of broilers is as shown in Tables 3 and 4. Six hours feed restriction significantly ($p > 0.05$) reduced dressing percentage compared to *ad libitum* feeding, two hours and four hours restriction which were similar. In similar manner, abdominal fat was negatively influenced by feed intake this time by both four and six hours feed restriction. There were no significant ($p > 0.05$) differences in all the cut-parts. This result is a reflection of poor energy supply to the birds to be able to deposit muscle and fat. Lower level of abdominal fat deposited by birds restricted by four and six hours is an indication of inadequate energy supply. Fat deposition could only occur when the energy supply is in excess of body need and the excess is converted to fat. This result however contradicted the report of Scott (2002) that

feed restriction led to higher fat deposition. These results were in agreement with the work of Okonkwo *et al.* (2011).

Table 3: Effect of feed restriction on carcass characteristics of broilers

Parameters (%)	T_1	T_2	T_3	T_4	SEM
Dressed weight	68.78[a]	68.37[a]	65.09[ab]	62.69[b]	5.08
Breast weight	35.59	35.40	35.23	34.38	2.03
Back cut	22.94	22.29	22.96	24.59	3.04
Wing	15.50	15.07	15.50	16.90	2.01
Thigh	18.20	18.18[a]	18.98	18.24	2.76
Drumstick	16.77	17.07	17.36	16.19	2.88
Abdominal fat	1.28[a]	1.05[a]	0.53 [b]	0.66[b]	0.22

[a,b]Means along the same row with different superscripts are significantly ($p < 0.05$)different.
SEM = standard error of mean. T1 = *ad libitum* feeding; T2 = two hours feed restriction; T3 = four hours feed restriction; T4 = six hours feed restriction.

Feed restriction for six hours produced ($p < 0.05$) bigger liver and kidney; smaller gizzard and intestine compared to *ad libitum* feeding and other restriction periods. Feed restriction could have induced stress causing enlargement of the liver and the kidney. Another possibility of smaller gizzard produced by birds restricted by six hours could have emanated from less grinding activity of the gizzard which has been reported to influence the size of gizzard (Oluyemi and Roberts, 2000). Smaller intestine obtained during six hours feed restriction could also be opined to have resulted from low content of digesta and digesta flow. This could have caused the intestine to shrink. There were no differences ($p > 0.05$) in other internal organs. This result concurred with the result of El-Sagheer and Makled (2005) who reported that prolong withdrawal of feed above four hours could negatively affect the size and weight of the intestine.

Economic Benefit: The effect of feed restriction on the economic efficiency of broilers is presented in Table 5. Feed cost per bird was highest in group of birds subjected *ad libitum* and two hours feed restriction compared to those on fours and six hours feed restriction. This was because the birds had more access to the feed. Feed cost per weight gain was least in six hours feed restriction and highest in *ad libitum* feeding due to the influence of their feed: gain ratio. The results showed that feed restriction for six hours resulted in decreased revenue and gross prifit margin despite the lower feed cost. This was due to lower dressed carcass weight. This disagrees with the results of Pasternak and Shalev (1983). Nevertheless, this could depend on the pattern of feed restriction. Proudfoot and Hulan (1982) reported that birds subjected to initial feed restriction and later *ad libitum* feeding made higher profit than the control birds. This could be a good reason for this result. In the present study, feed restriction was carried out to the end of the experiment.

Table 4: Effects of feed restriction on internal organs of broiler chickens

Parameters (%)	T_1	T_2	T_3	T_4	SEM
Gizzard	2.44[a]	2.27[a]	2.16[a]	1.03[b]	.0.60
Heart	0.86	0.89	0.85	0.83	0.40
Liver	2.55[b]	2.61[b]	2.45[b]	3.56[a]	0.88
Kidney	0.79[b]	0.86[b]	0.88[b]	1.50[a]	0.46
Pancreas	0.45	0.40	0.40	0.41	0.08
Spleen	0.08	0.09	0.08	0.09	0.07
Intestine (empty)	7.02[a]	6.88[a]	6.15[a]	5.67[b]	1.44

[a,b]Means along the same row with different superscripts are significantly ($p < 0.05$) different.
SEM = standard error of mean. T1 = *ad libitum* feeding; T2 = two hours feed restriction; T3 = four hours feed restriction; T4 = six hours feed restriction.

Table 5: Effect of feed restriction on economic benefit broiler.

Parameters (₦)	T_1	T_2	T_3	T_4	SEM
Av. cost/kg feed	100	100	100	100	
Total feed cost/bird	483[a]	450[ab]	420b[c]	381[c]	52.22
Feed cost/kg weight gain	251	232	242	220	-
Revenue/bird	1060[a]	1050[a]	1000[a]	900[b]	74.19
Gross margin	577[a]	600[a]	580[a]	519[b]	50.03

[a-c]Means along the same row with different superscripts are significantly different ($p < 0.05$).
SEM = standard error of mean; T1 = *ad libitum* feeding; T2 = two hours feed restriction; T3 = four hours feed restriction; T4 = six hours feed restriction.

CONCLUSION AND RECOMMENDATION

- Continuous daily feed restriction on broilers for six hours during the finisher phase depressed growth, lowered dressing percentage liver, kidney and resulted in poor economic benefit.
- Two hours of feed restriction on broiler finishers is recommended and could be employed considering the marginal economic benefit it recorded over *ad libitum* feeding and four hours feed restriction.

REFERENCES

Abaza, M.I., Shehata, M.A., Shoieb, M.S. and Hassan, I.I. 2008. Evaluation of some natural feed additives in growing chick's diets. *International Journal of Poultry. Science.* 7(9): 872 - 879.

Bender, D.A. and Mayes, P.A. 2006. Gluconeogenesis and the control of Blood glucose. In: Harper's Illustrated Biochemistry. 27th ed. Murray, R.K., Granner, D.K. and Rodwell, V.W. (eds). McGraw Hill. New Delhi, India. pp 167 - 176

Deaton, J.W. 1995. The Effect of Early Feed Restriction on Poultry Performance. *Poultry Science.* 74:1280-1286.

El-Sagheer, M. and Makled, M.N. 2005. Effect of Duration of Feed Withdrawal Versus *ad libitum* Feeding During High Environmental Temperature on Broiler Chicken Performance. *Egypt Poultry Science.* 25:333-350.

Lee, K.H. and Leeson, S. 2001: Performance of Broilers fed Limited Quantities of Feed or Nutrients During Seven to Fourteen Days of Age. *Poultry Science*, 80:446-454.

Ndelekwute, E.K., Uzegbu, H.O., Amaefule, K.U., Okereke, C.O., and Umoh, B.I. 2014a. Effect of organic acids fed through drinking water on carcass and

internal organs of broiler chickens. *Nig. J. Anim. Prod. 41(1): 60 -67.*

Ndelekwute, E.K., Obi, J.I., Ekanem, N.J. and Mbaba, E.N. 2014b. Assessment of Effect of Dietary Streptomycin and Formic Acid on Carcass, Internal Organs and Economics of Broiler Chickens. *Nigeria Journal of Agriculture, Food and Environment.* 10(2); 15 -20.

NRC. 1994. Nutrient Requirement for poultry. 9th ed. National Academy press. Washington DC, USA.

Okonkwo, A.C., Isaac, L.J., Usoro, O.O., Usoro, N. U. and Williams, M. E. 2011. Effect of Feed Restriction on the Performance and Carcass Characteristics of Broilers. *Proc. of the 36th Conf. of Nig. Soc. for Anim. Prod.,* 13th – 16th March, 2011, pp. 445-447.

Olomu, J.M. 2000. Protein and Energy Nutrition of Poultry in Nigeria. *Nigerian Branch, World Poultry Science Association*, pp. 41-59.

Oluyemi J.A. and Roberts F.A. 2000. Poultry Production in Warm Wet Climate. 2nd ed. Spectrum Books Ltd. Ibadan, Nigeria. 210.

Pasternak, H. and Shalev, B.A. 1983. Genetic-Economic Evaluation of Traits in a Broiler Enterprise Reduction of Food Intake due to Increased Growth Rate. *British Poultry Science,* 84:531-536.

Proudfoot, F.G. and Hulan, H.W. 1982. Effect of Reduced Feeding Time Using all Mash or Crumble Pellet Dietary Regimes on Chicken Broiler Performance Including the Incidence of Death Syndrome. *Poultry Science,* 61:750-754.

Rahjhan, S.K. 2001. Animal Nutrition in the Tropics. Vikas Publishers, New Delhi, India.

Scott, M.L., Hili, N.F., Parson, E.H. (Jr.) and Buckner, J.H. 1969.. Studies on duck nutrition. 7: Effect of dietary energy protein relationships upon growth, feed utilization and carcass composition in market ducking. *Poultry Science.* 38: 497 - 507.

Scott, T.A. 2002. Evaluation of Lighting Programs, Diet Density and Short-term Use of Mash as Compared to Crumbled Starter to Reduce Incidence of Sudden Death Syndrome in Broiler Chickens to 35 days of age. *Canadian Journal of Animal Science*, 82:375-383.

Steel, R.G.D. and. Torrie, J.H. 1980. Principles and Procedures of statistics. McGraw Hill Int. books Co. Sydney

Tottori, J., Yamaguchi, R., Murakawa, Y., Sato, M., Uchida, K. and Takeyama, S. 1997. The Use of Feed Restriction for Mortality Control of Chickens in Broiler Farm. *Avian Diseases,* 41:433-437.

Urdaneta, M. and Leeson, S. 2002. Quantitative and Qualitative Feed Restriction on Growth Characteristics of Male Broiler Chickens. *Poultry Science.* 81:679-688.

Zubair, A.K. and Leeson, S. 1996. Compensatory Growth in the Broiler Chickens: A Review. *World Poultry Science*, 52:189-201. .