GROWTH, SERUM INDICES, FATTY ACIDS, AND MEAT QUALITY OF BROILER CHICKENS SUBJECTED TO LATE FEED RESTRICTION

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ABSTRACT

This study assessed how quantitative feed restriction in the finisher phase affected broiler chickens' performance, serum metabolites, carcass, fatty acids, meat quality, and oxidative status. Two hundred (200) 21-day-old ad libitum fed Arbor Acres broilers were divided into two groups at random and fed ad libitum (AL-100) or 80% ad libitum (AL-80) for 21 days before slaughter. The qualities of the breast meat were observed during a 5-day postmortem chill storage period. Compared to the AL-80 birds, the AL-100 birds exhibited significantly heavier (p<0.05) slaughter and carcass weights as well as abdominal fat. The AL-80 birds had significantly higher (p<0.05) serum glucose levels. AL-80 birds had significantly decreased (p<0.05) serum levels of very-low-density-lipoprotein cholesterol (VLDL-C), triglycerides and total cholesterol compared to AL-100 birds. In comparison to AL-100 meat, the concentrations of alpha-linolenic acid [C18:3n-3] and eicosapentaenoic acid [C20:5n-3] were more in AL-80 meat. AL-100 meat had significantly higher (p<0.05) levels of Linoleic acid [C18:2n-6] and total fatty acids than AL-80 meat. On the 3rd and 5th days postmortem, AL-80 meat had significantly reduced (p<0.05) carbonyl content, drip loss, and malondialdehyde levels than AL-100 meat. In Arbor Acres broilers, a 20% feed restriction improved the amount of omega-3 fatty acids in the breast muscle and decreased the accumulation of abdominal fat and oxidative degradation.

Keywords: Abdominal fat, Carbonyl, Drip loss, Finisher, Malondialdehyde, Triglycerides

INTRODUCTION

The modern day broiler chickens grow quickly because of advancements in genetics, improved management techniques and quality nutrition (Wang *et al*., 2017; Fondevila *et al*., 2020). However, the high incidence of skeletal disorders, metabolic diseases and increased fat accumulation are inextricably linked to the fast growth rate (Demir *et al*., 2004; Davoodi-Omam *et al*., 2019; Fondevila *et al*., 2020). In broilers, increased fat accumulation is a loss of nutritional energy since the fats are removed during processing, which lowers the yield of the carcass. Moreover, high levels of carcass fat may result in consumers rejecting or degrading the carcass (Urdaneta-Rincon and Leeson, 2002; Khurshid *et al*., 2019; Azis and Afriani, 2023). Broilers that are fed *ad libitum* may be more susceptible to the previously listed problems (Demir *et al*., 2004; Van der Klein *et al*., 2017; Wang *et al*., 2017). Therefore, feed restriction has been suggested as a way to lessen these problems (Khetani *et al*., 2009; Van der Klein *et al*., 2017; Wang *et al*., 2017). However, feed restriction may have unfavourable consequences such as chronic hunger, increased aggression, boredom, overdrinking and feeding frustration that could compromise the well-being of the birds (Pishnamazi *et al*., 2008; Prieto and Campo, 2011). Because of their higher metabolic needs and quick growth at this stage, younger birds may be more severely affected by feed restriction (Pishnamazi *et al*., 2008). To ensure that the flock grows rapidly, has an appropriate frame size, and has a consistent body weight, complete feeding of broilers for a few weeks prior to implementing any restriction programs has been recommended

(Pishnamazi *et al*., 2008). Further, broiler chickens have significant fat accumulation during the finisher stage (Wang *et al*., 2017).

The fatty acid profile of animal products has gained attention recently because of its possible implications for human health and product quality (Givens, 2009; Calder, 2015). Numerous studies have investigated the effects of various feed restriction strategies on carcass traits (Demir *et al*., 2004; Połtowicz *et al*., 2015), meat quality (Butzen *et al*., 2013; Połtowicz *et al*., 2015), and growth performance (Demir *et al*. 2004; Połtowicz *et al*., 2015; Davoodi-Omam *et al*., 2019; Fondevila *et al*., 2020). Furthermore, an earlier study investigated the combined effects of 25% feed restriction and dietary fat type on the carcass and meat quality of broilers (Adeyemi *et al*., 2023). However, little is known about how late feed (without fat supplement) restriction affects broiler chickens' oxidative stability and muscle fatty acids. To create a successful feed restriction strategy and enhance the nutritional quality and shelf life of broiler meat, a deeper understanding of how muscle fatty acids and oxidative stability respond to feed restriction in broiler chickens would be beneficial. Determining the impact of late quantitative feed restriction on growth performance, serum indices, carcass, fatty acids, and meat quality in broilers was the aim of this investigation.

MATERIALS AND METHODS

Experimental Birds and Management: In total, 220 mixed-sex Arbor Acres chicks at one-day old were obtained from a commercial hatchery. For 21 days, the chicks were fed broiler starter *ad libitum*. Using a complete randomised design (CRD), 200 broiler chickens weighing 868.0 ± 15.0 g were divided into two groups, each replicated ten times with each replicate having ten birds and subjected to either *ad libitum* feeding (AL-100) or 80% *ad libitum* (AL-80) for 21 days. *Ad libitum* access to clean water was offered during the trial. Floor pens were used to rear the birds. The finisher diet was formulated following the National Research Council (NRC, 1994) and Arbor Acres, Aviagen (Aviagen, 2018) guidelines, and offered as mash. The dietary ingredients and the starter and finisher diets were determined for their chemical composition (Table 1) using the AOAC (2000).

Table 1: The chemical and fatty acid compositions of dietary ingredients and formulated starter and finisher diets

Ingredient (%)	Diets	
	Starter	Finisher
Maize	60.00	58.00
Soybean meal	32.00	10.00
Fishmeal	5.00	0.50
Groundnut cake	0.00	18.00
Maize offal	0.00	6.00
Wheat bran	0.00	5.00
Limestone	1.80	1.20
Toxin binder	0.10	0.10
Enzyme	0.10	0.10
Vitamin-Mineral Premix[1]	0.25	0.25
Salt	0.25	0.25
Lysine	0.30	0.10
Methionine	0.20	0.10
Dicalcium phosphate	0.00	0.40
Total	100	100
Chemical composition (%)		
Dry matter	92.28	92.25
Crude protein	22.78	20.45
Ether extract	2.72	2.90
Crude fibre	3.89	4.42
Ash	3.55	2.80
ME[2] (kcal/kg)	2978	3132
Fatty acids (%)		
Myristic acid [C14:0]	2.07	2.07
Palmitic acid [C16:0]	21.64	21.00
Palmitoleic acid [C16:1n-7]	0.52	0.52
Stearic acid [C18:0]	5.53	5.64
Oleic acid [C18:1]	24.19	23.55
Linoleic acid [C18:2n-6]	44.07	44.59
Alpha-linolenic acid [C18:3n-3]	1.70	1.80
∑SFA[3]	29.17	28.71
∑UFA[4]	70.48	70.46
Total fatty acids (g/kg DM)	2.34	2.47

[1]Vitamin mineral premix contains antioxidant 125 mg, folic acid 1000 mg, Choline chloride 500 mg, Biotin 80 mg, cobalt 240 mg, copper 6 mg, selenium 240 mg, Iodine 1.4 mg, Vitamin A 15,000IU, Vitamin B1 200 mg, Vitamin B2- 600 mg, Vitamin B6 400 mg, Vitamin D3 3000 IU, Vitamin E 3000 IU, Vitamin K 250 mg, Zinc 60 mg, Vitamin B12 20 mg. [2]Metabolizable energy. [3]Saturated fatty acid. [4]Unsaturated fatty acid

The birds were vaccinated against infectious bursal disease on days 7 and 21, and against Newcastle disease on days 14 and 28. They were kept at 35 ± 2°C for the first seven days, after which the temperature was reduced by 3°C per week until it reached 25 ± 2°C, which was then maintained until the end of the trial.

The difference between the final and initial body weights was used to compute body weight gain. To measure feed intake, a weighed quantity of feed was supplied each day, and the weight of the leftover feed was noted in the AL-100 group. Every day, the amount of feed given was modified to consider variations in body weight. There was always some leftover feed in the AL-100 birds' feeding trays every day. The quantity of feed consumed by the AL-100 birds was used as the basis for supplying 80% *ad libitum* to the feed-restricted birds. The feed conversion ratio was calculated using the feed intake and body weight gain data.

Blood Sampling and Determination of the Serum Indices: Blood samples were taken from the birds' wing webs into plain serum vials on day 20 of the trial when the birds were 41 days old. The blood samples were centrifuged for 10 minutes at 3000 rpm, and the supernatant was then collected into tubes for subsequent biochemical assays. The total serum protein was determined using the method of Burtis and Bruns (2015). The Chicken Blood Glucose ELISA kit was used to measure blood glucose (MBS7264406 MyBioSource Incorporated, San Diego, California, USA). Using a Randox Kit Serum Lipids, the serum lipids were measured according to the methods of Qureshi *et al*. (1983).

Slaughter and Carcass Analysis: The birds were euthanized on trial day 21, when they were 42 days old, after an overnight fasting with unlimited access to water. Carcasses were eviscerated manually after scalding and plucking, external offal was removed, carcass cuts and abdominal fat were weighed.

Meat Quality Attributes: Breast muscle was removed from the dressed carcasses, trimmed free of external fat and connective tissues, and evaluated for quality characteristics. Using a pre-calibrated pH meter (Mettler Toledo, China), the pH of the breast muscles was determined. 25 ml of distilled water was used to homogenize a 5 g sample of the breast muscles, and the homogenate's pH was taken. For every sample, three pH readings were obtained. The methods used to determine cooking loss and drip loss followed Adeyemi *et al*. (2023).

Determination of the Fatty Acid Composition: Following the method of Folch *et al*. (1957), total lipid was extracted from crushed meat and feed samples using a mixture of chloroform: methanol (2:1 v/v). The extracted lipids were transesterified to produce fatty acid methyl esters (FAME) by treating them with 14% methanolic BF_3 and 0.66 N methanolic KOH (AOAC, 2000). FAME was separated using a gas chromatograph mass spectrometer (GCMS QP2010SE, Shimadzu, Japan), as described by SHIMADZU (2020).

Determination of Lipid Oxidation: Lipid oxidation was assayed based on the formation of thiobarbituric acid reactive substance (TBARS) (Buege and Aust, 1978). Briefly, 2.5 mL of 20% (v/v) trichloroacetic acid (TCA) was mixed with 0.5 g of pulverized meat sample and centrifuged for 10 minutes at 3500 rpm. Then, the supernatant was mixed with 3 mL of 0.2 g/dL thiobarbituric acid (TBA). The mixture was boiled in water for 30 minutes. Thereafter, 4 mL of n-butyl alcohol was used to extract the resultant chromogen after cooling on ice. The absorbance was measured at 530 nm after the organic phase was separated by centrifugation at 3500 rpm for 10 minutes. The standard used was malondialdehyde (MDA) solution prepared by hydrolyzing 1,1,3,3-tetramethoxypropane. The results were presented as mg MDA/kg meat.

Determination of Protein Oxidation: The protein carbonyl content of the meat samples was quantified using the method of Levine *et al*. (1990). Briefly, 1.0 mL of 20 mM 2, 4-dinitrophenylhydrazine (DNPH) solution was incubated for 60 minutes with 0.1 g of the meat sample. 20% (v/v) TCA was added to precipitate the proteins, which were then re-dissolved in DNPH. After that, 1 mL of 10% (v/v) TCA was used to precipitate the proteins out of the solution. The protein pellet was then rinsed three times with ethanol and ethyl acetate and re-suspended in 1 mL of 6 M guanidine. The absorbance was read at 370 nm. The results were presented as mmol carbonyl/mg protein.

Statistical Analysis: The growth performance, serum metabolites, fatty acids, and carcass data were subjected to a t-test analysis. Meat pH, carbonyl, TBARS, cooking loss, and drip loss data were subjected to a two-way repeated measures ANOVA using the Proc Mixed procedure of SAS. The feeding regimen, storage period, and their interaction were fitted as fixed effects. Least-squares means were separated using the PDIFF option in SAS and adjusted with Tukey's HSD test. The statistical model was: $Y_{ijk} = \mu + \alpha_j + \beta_k + (\alpha\beta)_{jk} + S_i + \epsilon_{ijk}$, where Y_{ijk} = observation in the j-th regimen, k-th time, i-th replicate, α_j = effect of the feeding regimen (AL-100 or AL-80), β_k = effect of the storage day (0, 1, 3, or 5), $(\alpha\beta)_{jk}$ = Interaction effect between feeding regimen and storage day, S_i = random effect of each replicate, accounting for repeated measures over time, and ϵijk = residual error term.

RESULTS

Growth Performance: Compared to the AL-80 birds, the AL-100 birds had significantly higher ($p<0.05$) daily weight gain, final body weight and higher feed conversion ratio (Table 2).

Table 2: Growth performance of broiler chickens subjected to different feeding regimens at the finisher phase

Parameter	Treatments	
	AL-100 (n = 10)	AL-80 (n = 10)
Initial weight (g/bird)	878.00 ± 12.43	878.00 ± 11.64
Final weight (g/bird)	2260.00 ± 30.55*	2080.00 ± 28.00
Weight gain (g/bird/d)	65.81 ± 3.86*	57.23 ± 3.50
Feed intake (g/bird/d)	129.48 ± 2.56*	103.40 ± 3.30
Feed conversion ratio	1.99 ± 0.06*	1.81 ± 0.08

** Significantly different (p<0.05) means along a column using pairwise comparison (t-test), AL-100: Broiler chickens fed ad libitum, AL-80: Broiler chickens subjected to 20% feed restriction*

Serum Metabolites: The AL-80 birds had significantly higher ($p<0.05$) serum glucose levels than the AL-100 birds (Table 3). In comparison to AL-80 birds, AL-100 birds had significantly higher ($p<0.05$) serum total cholesterol, triglycerides and VLDL-C.

Table 3: Serum biochemical parameters of broiler chickens subjected to different feeding regimens at the finisher phase

Parameter (mg/dL)	Treatments	
	AL-100 (n=10)	AL-80 (n=10)
Glucose	183.91 ± 10.24	229.82* ± 9.89
Total protein	12.14 ± 0.93	12.07 ± 0.89
Total cholesterol	264.76 ± 8.21*	238.89 ± 7.45
Triglycerides	277.06 ± 10.23*	225.93 ± 9.21
HDL-C	114.98 ± 12.00	106.28 ± 11.78
LDL-C	94.36 ± 8.22	87.44 ± 7.43
VLDL-C	55.41 ± 5.00*	45.19 ± 4.44

** Significantly different (p<0.05) means along a column using pairwise comparison (t-test), AL-100: Broiler chickens fed ad libitum, AL-80: Broiler chickens subjected to 20% feed restriction, HDL-C: High-density-lipoprotein cholesterol, LDL-C: Low-density-lipoprotein cholesterol, VLDL-C: Very-low-density-lipoprotein cholesterol*

Serum total protein, HDL-C and LDL-C were not significantly higher ($p>0.05$) by feed restriction.

Carcass Traits: The AL-100 birds had significantly heavier ($p<0.05$) slaughter and carcass weights, and abdominal fat than the AL-80 birds (Table 4). Dressing % and retail cuts % were similar between the treatments.

Fatty Acid Composition of Breast Muscle: The concentration of Linoleic acid [C18:2n-6] in AL-100 meat was significantly higher ($p<0.05$) than that of the AL-80 meat. The AL-80 meat had significantly higher ($p<0.05$) concentrations of Alpha-linolenic acid [C18:3n-3] and Eicosapentaenoic acid [C20:5n-3] than the AL-100 meat. The AL-100 meat had higher n-6/n-3 and total fatty acids than the AL-80 meat ($p<0.05$) (Table 5).

Physicochemical Properties of Breast Muscle: Figure 1 depicts the drip loss of breast meat in broilers subjected to varying feeding regimens. Drip loss on the first postmortem day did not differ amongst the treatments. Drip loss in AL-100 meat was significantly higher ($p<0.05$) on days 3 and 5 postmortem than in the AL-80 meat. Drip loss increased as storage increased regardless of feeding regimen.

Table 4: Carcass traits in broiler chickens subjected to different feeding regimens at the finisher phase

Parameter	Treatments	
	AL-100 (n = 10)	AL-80 (n = 10)
Slaughter weight (g)	2260 ± 30.22*	2080 ± 26.67
Carcass weight, CW (g)	1580 ± 20.45*	1424 ± 19.03
Dressing percentage	69.92 ± 2.22	68.47 ± 1.78
Abdominal fat, % CW	0.95 ± 0.05*	0.23 ± 0.03
Prime cuts, % CW		
Drumstick	8.01 ± 0.36	8.43 ± 0.33
Thigh	7.82 ± 0.91	8.40 ± 0.87
Breast	28.41 ± 2.22	28.61 ± 1.87
Back	26.37 ± 1.89	27.18 ± 1.43
Head	4.15 ± 0.34	4.70 ± 0.30
Leg	3.46 ± 0.22	3.38 ± 0.13
Neck	3.81 ± 0.20	4.22 ± 0.24
Wing	5.56 ± 0.25	6.25 ± 0.27

** Significantly different (p<0.05) means along a column using pairwise comparison (t-test), AL-100: Broiler chickens fed ad libitum, AL-80: Broiler chickens subjected to 20% feed restriction*

Table 5: Fatty acids (% of total fatty acids) in breast muscle of broiler chickens subjected to different feeding regimens at the finisher phase

Parameter	Treatments	
	AL-100 (n=10)	AL-80 (n=10)
Lauric acid [C12:0]	0.12 ± 0.01	0.20 ± 0.02*
Myristic acid [C14:0]	1.07 ± 0.07	1.13 ± 0.08
Myristoleic acid [C14:1]	0.22 ± 0.04	0.27 ± 0.05
Palmitic acid [C16:0]	22.35 ± 1.82	23.26 ± 1.76
Palmitoleic acid [C16:1n-7]	0.58 ± 0.02	0.73 ± 0.04
Stearic acid [C18:0]	16.15 ± 1.67	16.77 ± 1.72
Oleic acid [C18:1n-9]	22.64 ± 2.26	24.17 ± 1.93
Linoleic acid [C18:2n-6]	24.46 ± 1.45*	20.39 ± 1.38
Alpha-linolenic acid [C18:3n-3]	1.80 ± 0.08	2.53 ± 0.10*
Arachidonic acid [C20:4n-6]	8.30 ± 0.44	7.75 ± 0.36
Eicosapentaenoic acid [C20:5n-3]	0.67 ± 0.01	1.00 ± 0.02*
Docosapentaenoic acid [C22:5n-3]	0.71± 0.13	0.75 ± 0.15
Docosahexaenoic acid [C22:6n-3]	0.80 ± 0.12	0.93 ± 0.11
Fatty Acid (FA) Sum and Ratios		
ΣSFA	39.69 ± 3.60	41.36 ± 3.87
ΣMUFA	23.44 ± 3.01	25.17 ± 2.90
ΣPUFA	36.74 ± 3.33	33.35 ± 3.02
Σn-6	32.76 ± 3.76*	28.14 ± 3.50
Σn-3	3.98 ± 0.38*	5.21 ± 0.42
n-6/n-3	8.23 ± 0.30*	5.40 ± 0.22
PUFA/SFA	0.93± 0.16	0.82 ± 0.12
Total FA (mg/100 g)	3520.00 ± 26.45*	3250.08 ± 23.65

** Significantly different (p<0.05) means along a column using pairwise comparison (t-test), AL-100: Broiler chickens fed ad libitum, AL-80: Broiler chickens subjected to 20% feed restriction, ΣSFA = (C12:0 + C14:0 + C16:0 + C18:0), ΣMUFA = (C14:1 + C16:1+ C18:1), Σn-3 = (C18:3n-3 + C20:5n-3 + C22:5n-3 + C22:6n-3), Σn-6 = (C18:2n-6 + C20:4n-6) n-6/n-3 = (C18:2n-6 + C20:4n-6) ÷ (C18:3n-3 + C20:5n-3 + C22:5n-3 + C22:6n-3), PUFA/SFA = (ΣPUFA/ΣSFA)*

Figures 2 and 3 show, respectively, the cooking loss and pH of the breast muscle of broilers subjected to different feeding regimens during the finisher period. Meat pH and cooking loss were similar between the treatments. Meat pH on day 0 postmortem was significantly higher (p<0.05) than the pH on other storage days regardless of the feeding regime (Figure 2). Meat pH on days 1, 3, and 5 postmortems was similar. Chill storage did not affect the cooking loss of breast meat (Figure 3).

Lipid Oxidation and Protein Oxidation in Breast Muscle: Figures 4 and 5, respectively, show the TBARS value and carbonyl content in the breast meat of broilers subjected to varying feeding regimens.

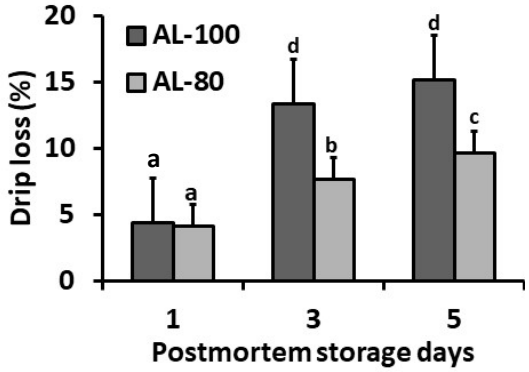

Figure 1: Drip loss (%) in breast muscle of broiler chickens subjected to different feeding regimens at the finisher phase. Error bars with different letters differ significantly (p<0.05). AL-100: Broiler chickens fed *ad libitum*, AL-80: Broiler chickens fed 80% *ad libitum*

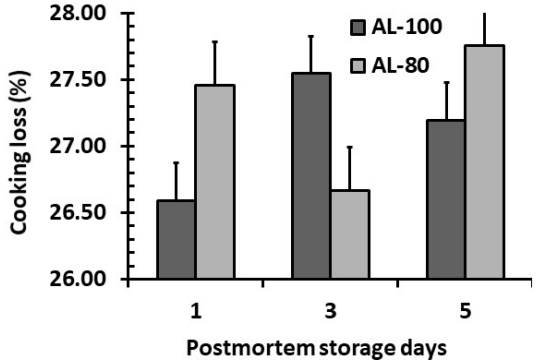

Figure 2: Cooking loss (%) in breast muscle of broiler chickens subjected to different feeding regimens at the finisher phase. AL-100: Broiler chickens fed *ad libitum*, AL-80: Broiler chickens fed 80% *ad libitum*

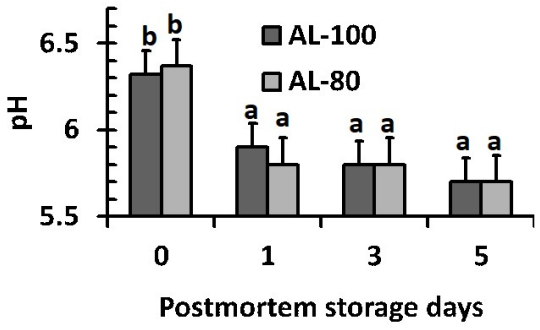

Figure 3: pH of breast muscle of broiler chickens subjected to different feeding regimens at the finisher phase. Error bars bearing different letters differ significantly (p<0.05), AL-100: Broiler chickens fed *ad libitum*, AL-80: Broiler chickens fed 80% *ad libitum*

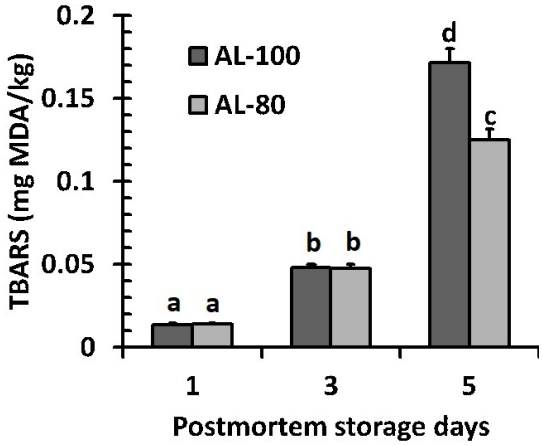

Figure 4: Lipid oxidation (mg MDA/kg) in breast muscle of broiler chickens subjected to different feeding regimens at the finisher phase. Error bars bearing different letters differ significantly (p<0.05). AL-100: Broiler chickens fed *ad libitum*, AL-80: Broiler chickens fed 80% *ad libitum*

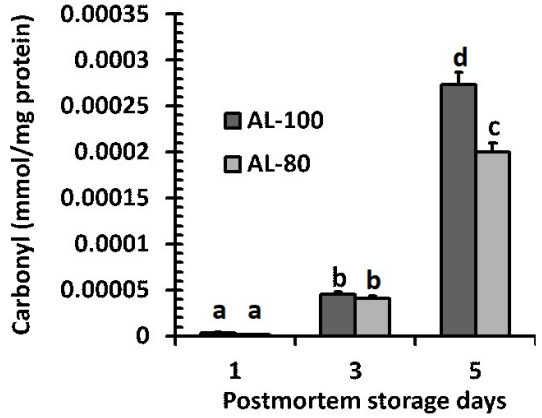

Figure 5: Protein oxidation (mmol carbonyl/mg protein) in breast meat of broiler chickens subjected to different feeding regimens at the finisher phase. Error bars bearing different letters differ significantly (p<0.05). AL-100: Broiler chickens fed *ad libitum*, AL-80: Broiler chickens fed 80% *ad libitum*

Day 1 and Day 3 postmortem TBARS levels and carbonyl content were unaffected by the feed regimens. On the fifth postmortem day, the AL-100 meat had significantly higher (p<0.05) TBARS value and carbonyl content than the AL-80 meat. As postmortem storage advanced, the TBARS value and carbonyl content significantly increased (p<0.05) in both treatments.

DISCUSSION

In broiler chickens, a 20% feed restriction decreased the average weight gain and final body weight. This was because the restricted birds consumed less dietary energy and protein than they required. In similar studies, feed restriction from 21 – 35 days (Boostani *et al*., 2010) and 21 – 42 days (Khetani *et al*., 2009) decreased broiler body weight gain. However, broiler chickens exposed to late quantitative feed restriction showed a non-significant decrease in body weight (Omosebi *et al*., 2014). Furthermore, the final live weight of broilers was unaffected by a 20 and 35% feed restriction (Chodová and Tůmová, 2017).

The feed conversion ratio was lower in the AL-80 birds than the AL-100 birds, despite the AL-100 birds having higher final body weight and weight gain. This result suggests that the AL-80 used in our investigation improved the broilers' feed utilization efficiency. One possible explanation for the lower FCR in the restricted birds may be that their smaller body mass requires less maintenance requirements (Omosebi *et al*., 2014). The results are in line with those of Camacho *et al*. (2004), who found that birds that were subjected to late quantitative feed restriction had higher feed efficiency. Conversely, Połtowicz *et al*. (2015) found that in broilers, a 6-hour/day feed restriction from 4 to 5 weeks did not significantly affect the feed conversion ratio.

Blood metabolites are significant biomarkers for livestock's physiological, nutritional, and overall health (Odhaib *et al*., 2018). Compared to the unrestricted birds, the restricted birds' serum glucose levels were higher. This result implies that the prolonged feed restriction actively tapped into gluconeogenesis (Zhan *et al*., 2007). Furthermore, fasting chickens recycle a substantial amount of glucose carbon (Rideau and Metayer-Coustard, 2012). During fasting, gluconeogenesis produces glucose, which keeps blood sugar levels stable, which is why chickens don't experience hypoglycemia (Zhan *et al*., 2007). This result is consistent with that of Boostani *et al*. (2010), who found that broilers on a 16-hour feed restriction between 21 and 35 days had increased serum glucose levels. The findings of this study, nonetheless, were contrary to those of Jahanpour *et al*. (2013), who found that feed restrictions of either 25 or 50% did not affect broilers' blood glucose. According to Demir *et al*. (2004), serum glucose levels increased in birds with a 25% feed restriction but reduced in birds with a 50% feed restriction. The varying degrees of feed restriction may be the cause of the contradictory blood glucose levels after feeding restriction. Compared to the AL-80 birds, the AL-100 birds exhibited higher serum total cholesterol. This shows that the AL-100 birds' increased fat consumption leads to improved fat metabolism. Boostani *et al*. (2010) observed a reduction in serum cholesterol in birds under a 16-hour feed restriction from 21 to 35 days, which is in line with the findings of this study. The levels of serum HDL-C and LDL-C in broiler chickens were unaffected by feed restriction.

The two main sources of fatty acids that are available for deposition in birds are dietary fat and *de novo* synthesis (Smink *et al*., 2010). The majority of fatty acids in adipose tissue are absorbed from triglycerides and plasma lipoproteins, such as VLDL-C, which the liver synthesizes and packages (Wang *et al*., 2017). As a result, serum triglycerides and VLDL-C are significant indicators of fat accumulation in chicken adipose tissue. The lower serum triglycerides and VLDL-C in the AL-80 may be because the restricted birds used a significant amount of triglycerides to meet their energy requirements during feed restriction (Demir *et al*., 2004). One possible explanation for the elevated blood triglycerides in the unrestricted birds is their increased intake of crude fat.

The heavier slaughter and carcass weights of the unrestricted birds may be explained by the birds' higher availability of nutrients, which is required for tissue accretion. This finding aligns with the findings of earlier research (Pishnamazi *et al*., 2008; Boostani *et al*., 2010). There was no difference in the percentages of prime cuts and dressing percentages between treatments. This implies that the broiler chickens' carcass yield was unaffected by feed restriction. This observation is consistent with that of Połtowicz *et al*. (2015), who found that the dressing % and proportion of prime cuts in broilers were unaffected by a 6-hour feed restriction between 3 – 4 weeks and 4 – 5

weeks. Conversely, Boostani *et al*. (2010) found that broilers with a 16-hour feed restriction between days 21 and 35 had a decreased breast weight.

AL-80 chickens had a 71% reduction in abdominal fat when compared to AL-100 birds. The decreased activity of the rate-limiting enzyme for fatty acid synthesis, hepatic Acetyl-CoA carboxylase, may be the cause of the decrease in abdominal fat (Chow *et al.,* 2014). This may prevent the production of triglycerides in the liver, resulting in a decrease in blood triglyceride levels and a decrease in the body's buildup of fat (Chow *et al.,* 2014). Furthermore, the abdominal fat may have been mobilized to meet the body's energy needs during the feed restriction (Rahimi *et al*., 2015). The reduced total fatty acid content of the restricted broilers' breast meat may be explained similarly. Accordingly, broiler chickens subjected to late quantitative feed restriction showed a decrease in abdominal fat (Boostani *et al*., 2010). However, Połtowicz *et al*. (2015) found that broilers under feed restriction had more abdominal fat.

The quality of the product and human health are significantly impacted by the fatty acid composition of animal products (Givens, 2009). Compared to the AL-80 meat, the AL-100 meat had more linoleic acid but lower lauric, linolenic and eicosapentaenoic acids. The lower lauric acid in the AL-100 meat points to a lower lauric acid *de novo* synthesis, most likely as a result of the higher linoleic acid concentration. The increased phospholipids and neutral lipids in the muscle as a result of the higher total fatty acids may be the cause of the higher concentration of linoleic acids in the AL-100 meat. Similar explanations may be offered for the reduced alpha-linolenic acid concentration in the AL-100 meat. The increase in linolenic acid, the precursor of eicosapentaenoic acid in the AL-80 meat may explain the higher concentration of eicosapentaenoic acid. Consumers may benefit nutritionally and health-wise from the AL-80 meat's increased total n-3 fatty acid content and lower n-6/n-3 fatty acid ratios (WHO, 2003; Givens, 2009; Mandal *et al*., 2014).

The pH and cooking loss of breast muscle were unaffected by feed restriction. The similarity in muscle pH indicates that the feed restriction technique employed in this investigation did not impair postmortem muscle metabolism. Our findings align with those of Połtowicz *et al*. (2015). The breast muscle pH of broilers on day 0 was higher than that of days 1, 3 and 5 postmortems, regardless of feeding regimen. An explanation for the pH decline could be that during postmortem muscle metabolism, muscle glycogen is converted to lactic acid (Adeyemi, 2021). According to Adeyemi *et al*. (2016), the pH stability on days 1, 3 and 5 indicates that postmortem glycolysis was completed within 24 h after slaughter.

On day five postmortem, the AL-80 meat showed reduced values for TBARS, carbonyl, and drip loss. This might result from the AL-80 meat's lower total fatty acid content than the AL-100 meat. The higher levels of total fatty acids, especially unsaturated fatty acids, which promote the susceptibility of the AL-100 meat to oxidative deterioration may explain the findings. The increased drip loss in the AL-100 meat may be caused by an increase in protein oxidation (carbonyl content). The drip loss, carbonyl, and TBARS readings increased during postmortem storage, regardless of feeding regime indicating a decline in oxidative stability.

Conclusions: In broilers, the 20% feed restriction during the finisher stage improved feed efficiency, oxidative stability, and the amount of omega-3 fatty acids in the breast muscle, while reducing body and carcass weights, abdominal fat, and drip loss. Further study to characterize the lipogenic genes and molecular mechanisms responsible for the decrease in fat accretion and enhancement of n-3 fatty acids following feed restriction is suggested.

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