

# COMPENSATORY GROWTH AND FAT PARAMETERS ON BROILER FASTED IN EARLY LIFE

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## ABSTRACT

The experiment was carried out to investigate the effect of feed withholding in the very early life of bird on its compensatory growth capacity and fat parameters. A total of 60 mixed-sexes of one day old Ross chicks were used in the experiment conducted with completely randomized design of 2 different feeding times after hatching, i.e.: T1: given access to feed and water *ad libitum* immediately after hatching until 35d of age; and T2: withheld from feed (fasted) but not from water for 48h after hatching and then fed *ad libitum* until d35. The birds were weighed at the start of experiment and weekly thereafter, and DWG was then calculated. Feed intakes and FCR were also recorded weekly. At d36, abdominal fat was taken out from 2 birds per pen and was weighed. Breast meat (skinless) from the same birds was also sampled for total FA analysis. Final BW (d35) and total feed consumption of early-fasted birds were 1935.17±43.90 kg and 2745.55±47.48 kg and those of unfasted birds were 2019.00±50.85 kg and 2910.84±128.10 kg, respectively. FCR of early-fasted and unfasted birds at d35 were 1.42±0.03 and 1.45±0.07. The magnitude difference of DWG between early-fasted and unfasted birds was 27% at d7, whereas at d35 the difference was only 4.5%. Abdominal fat percentage to live BW of early-fasted birds was 1.65±0.09% (male) and 1.60±0.10% (female) and that of unfasted birds was 2.00±0.19% (male) and 1.89±0.38% (female). Total FA contained in meat of early-fasted and unfasted birds were 0.82±0.10 and 0.85±0.10 g/100gDM. Overall, BW and feed consumption of early-fasted birds were significantly lower ( $P<0.05$ ) than unfasted birds. DWG, FCR, abdominal fat and total FA contained in meat were not significantly different ( $P>0.05$ ) between early-fasted and unfasted birds. In conclusion, holding birds without feed following hatch (under practical conditions) may limit the compensatory growth capacity of birds in the later age. Fasting applied in the very early life of broiler leads to impairment of cell hyperplasia resulting in permanent stunting. Abdominal fat and total FA contained in meat might not be affected by fasting for 48h after hatching. The degree or duration of feed withholding (for 48h after hatching) might not sufficient to reduce adipocyte proliferation or the number of precursor adipocytes.

*Keywords: Abdominal Fat, Broiler, Compensatory Growth, Early Life, Fasting, Total FA*

## INTRODUCTION

The continued genetic selection leads to greatly increase in growth rate of broiler (Havenstein *et al.*, 2003) manifested primarily in the first 4 weeks post hatch (Yu and Robinson, 1992). Consequently it results in reducing the rearing period necessary for broiler to reach the same live weight (Garden and Singleton, 2008). Because of this continuous decline, one day of fasting corresponds to an even increasing period in the lifetime of the chicks (Gonzales *et al.*,

2003). Nevertheless, following hatch under practical conditions, feed is often offered only 48h or more post hatch (Noy and Sklan, 1999). Holding birds without feed for 48h evidently decreases initial growth until after feed ingestion (Sklan and Noy, 2000). Conversely, early feeding post hatch leads to improved early growth (Garden and Singleton, 2008).

Compensatory growth is a phenomenon observed in animals given free access to feed following a period of restricted feeding that result in increased growth. In general, although feed

restriction reduces growth performances, compensatory growth in re-feeding period will be attained to accelerate growth to reach the weight of animals (Hornick *et al.*, 2000; Pinheiro *et al.*, 2004). The study of Gonzales *et al.* (2003), however, suggested that the level of growth recovery which occurs after feed restriction depends on the physiological state of animals and time dependent. Thus it becomes of great interest to investigate whether feed deprivation occurred in the very early life of birds can influence their capacity of compensatory growth at later stage.

Apart from the negative effect of fasting (in early life) upon initial growth, feed restriction in general can reduce body fat (Yu and Robinson, 1992; Zhong *et al.*, 1995). Taken together, it was therefore also noteworthy to evaluate the effect of fasting applied, specifically, in early life of broiler on fat parameters of broiler.

## MATERIALS AND METHODS

### Animals and diets

Sixty mixed-sexes of one day old Ross chicks were used in the experiment conducted with completely randomized design of 2 different feeding times after hatching, i.e.:

T1: Given access to feed and water *ad libitum* immediately after hatching until d35

T2: Withheld from feed (fasted) but not from water for 48h after hatching and then fed *ad libitum* until d35

The chicks were sexed, weighed and allotted into 12 wire floors pens with 5 chicks (app. 2 male and 3 female) in each pen situated in a semi closed house system. The diet was equivalent to commercial chick starter crumbles from d0 to d35 and was similar for the 2 groups (Table 1).

### Data collection

At h0 and h48 (before being fed for the fasted groups) all chicks were weighed individually as well as at d35, whereas at d7, 14, 21 and 28 the birds were weighed as a pen group. Feed intakes were recorded weekly for each pen (at d7, 14, 21, 28 and 35). Estimates of weekly feed intake were made by subtracting the total weekly residue weight from the total weight of feed offered for that week. Daily Weight Gain (DWG) was calculated by dividing the weight difference between 2 consecutive weighing by 7 (number of days in the week). Feed Conversion Ratio (FCR) was derived as feed consumed divided by weight gained. At d36 (before being

fed), 2 birds (male and female) per pen were weighed before being slaughtered and eviscerated. Abdominal fat (considered as the fat from the proventriculus surrounding the gizzard down to the cloaca and adjacent to the abdominal muscle) was taken out and weighed. Abdominal fat was then expressed as percent of live BW. At the same time, breast meat (skinless) from the same birds (male only) was sampled and stored at -80°C for total fatty acids (FA) analysis.

The total FA contained in meat was determined based on methodology described by Bligh and Dyer (1959) with some modifications. It was performed with an HP-6890 gas chromatograph equipped with an autosampler, FID, and fused-silica capillary column (30 m x 0.25 mm x 0.2 µm film thickness). The sample (1µl) was injected with helium as a carrier gas onto the column programmed for ramped oven temperatures (initial temperature was 110°C held for 1.0 min, then ramped at 15°C/min to 190°C and held for 5 min, then ramped at 5°C/min to 230°C and held for 5 min). Inlet and detector temperatures were held at 220°C. Peak areas and percentages were calculated using a Hewlett-Packard ChemStation software. FA methyl esters were identified by comparison with retention times of authentic standard. The total FA contained in meat was reported as weight percentages.

### Statistical analysis

All data were presented as the mean ± the

Table 1 Composition of the Experimental Diets

Ingredients	Composition (g/kg)
Yellow corn	56.23
Soy Bean Meal (SBM)	24.50
Meat Bone Meal (MBM)	6.00
Corn Gluten Meal (CGM)	3.00
Palm Kernel Meal (PKM)	1.50
Distiller Dried Grain Soluble (DDGS)	0.90
Others*	7.87
Calculated nutrient content:	
Metabolisable Energy (MJ/100 kg)	1243.00
Crude protein (N x 6.25)	20.80
Total fat (%)	5.92

<sup>A+B</sup> Consisted of amino acids, vitamins, mineral-mix and other substances that was concealed by the company

standard error of the mean. The BW, DWG, feed consumption, FCR, abdominal fat percentage to live BW and total FA contained in meat were analyzed using a Paired t-test. Analysis was carried out using SPSS 15.0 for Windows. A P-value of less than 0.05 was considered statistically significant.

## RESULTS AND DISCUSSION

### Compensatory Growth

The results of the present study showed that holding birds without feed in early life resulted in decreased initial growth. As a result, BW of the early-fasted birds was lower ( $P < 0.05$ ) than unfasted birds (Table 2). This condition persisted throughout the experiment (until harvest time at d35, Figure 1). Provision of feed immediately after hatching improves the digestive and absorptive capacity of the intestine (El-Husseiny *et al.*, 2008) and stimulates the skeletal muscle growth (Halevy *et al.*, 2000). By contrast, feed withholding for 48h after hatching reduces satellite cell mitotic activity in early life which eventually contributes to retarded growth at later age (Halevy *et al.*, 2000).

At the end of 7 days of rearing, the DWG of early-fasted birds was 27% lower than that of unfasted birds (Table 2). At the following weeks the magnitude difference of DWG between early-fasted and unfasted birds tended to be smaller and smaller (Figure 2), e.g. at the end of d35 the magnitude difference was only 4.5%. The insignificant differences ( $P > 0.05$ ) of DWG in the next coming weeks (after week 1) between the 2 feeding times and the smaller magnitude difference of DWG particularly at d35 compared to d7 indicated that compensatory growth did

exist. However, the compensatory growth capacity of early-fasted birds was probably limited as significant differences ( $P < 0.05$ ) upon BW between the 2 groups still persisted throughout the experiment (Table 2). Gonzales *et al.* (2003) suggest that the level of growth recovery, which occurs after feed deprivation, depends on the physiological state of the animals and time dependent. When feed deprivation is applied in the very early stages of development, cell hyperplasia (increased cell production in a normal tissue or organ) will be impaired. Reduction in cell number (cell production) results in permanent stunting, whereas reduction in cell size results in recovery of normal stature after re-feeding (Winick and Noble, 1966). Feed deprivation applied too early (just after hatching) therefore might explain the limited capacity of compensatory growth in early-fasted birds.

Mahyuddin (2004) suggested that one of the biological factors causing compensatory growth is an enhanced feed efficiency. In extreme definition by consuming a similar or even less amount of feed, compensatory growth-birds will grow faster than normal birds. In this present experiment, the amount feed consumed by early-fasted birds was less ( $P < 0.05$ ) than that of unfasted birds (Table 3, Figure3). In parallel with feed consumption, BW of early-fasted birds was lower ( $P < 0.05$ ) compared to unfasted birds throughout the experiment (Table 2, Figure 1). The FCR between the 2 groups was also not significantly different (Figure 4) except for d7 (fasting 48h after hatching resulted in shorter feeding period). In respect to these facts and the insignificant differences upon DWG between the 2 groups (after week 1), it is therefore, again, tempting to assume that there was a physiological catch-up

Table 2. Body Weight (BW) and Daily Weight Gain DWG) of Birds

	BW of birds (g)		DWG of birds (g)	
	Unfasted birds	Early-fasted birds	Unfasted birds	Early-fasted birds
d2	70.27 ± 0.39 <sup>a</sup>	43.67 ± 0.33 <sup>b</sup>	12.13 ± 0.19 <sup>a</sup>	-1.82 ± 0.17 <sup>b</sup>
d7	231.37 ± 0.12 <sup>a</sup>	183.83 ± 0.48 <sup>b</sup>	26.48 ± 0.45 <sup>a</sup>	19.50 ± 0.08 <sup>b</sup>
d14	530.43 ± 8.90 <sup>a</sup>	466.83 ± 5.24 <sup>b</sup>	42.72 ± 1.07	40.42 ± 0.76
d21	978.83 ± 15.75 <sup>a</sup>	884.50 ± 15.93 <sup>b</sup>	64.04 ± 1.02	56.98 ± 4.02
d28	1492.17 ± 38.70 <sup>a</sup>	1376.50 ± 30.40 <sup>b</sup>	62.18 ± 8.46	70.34 ± 3.06
d35	2019.00 ± 50.85 <sup>a</sup>	1935.17 ± 43.90 <sup>b</sup>	67.07 ± 7.58	64.03 ± 11.20

<sup>a-b</sup>Mean followed by different superscripts within the same row indicates statistically different ( $p < 0.05$ )

Table 3. Feed Consumption and Feed Conversion Ratio (FCR) of Birds

	Feed consumption (g)		FCR	
	Unfasted birds	Early-fasted birds	Unfasted birds	Early-fasted birds
d7	198.00 ± 3.38 <sup>a</sup>	142.80 ± 1.66 <sup>b</sup>	0.86 ± 0.01 <sup>a</sup>	0.78 ± 0.01 <sup>b</sup>
d14	584.07 ± 12.80 <sup>a</sup>	507.13 ± 6.29 <sup>b</sup>	1.10 ± 0.03	1.09 ± 0.01
d21	1341.33 ± 26.24 <sup>a</sup>	1260.22 ± 43.57 <sup>b</sup>	1.37 ± 0.02	1.43 ± 0.07
d28	2286.58 ± 69.59 <sup>a</sup>	2045.44 ± 51.35 <sup>b</sup>	1.54 ± 0.08	1.49 ± 0.04
d35	2910.84 ± 128.10	2745.55 ± 47.48	1.45 ± 0.07	1.42 ± 0.03

<sup>a-b</sup>Mean followed by superscripts within the same row indicates statistically different (p<0.05)

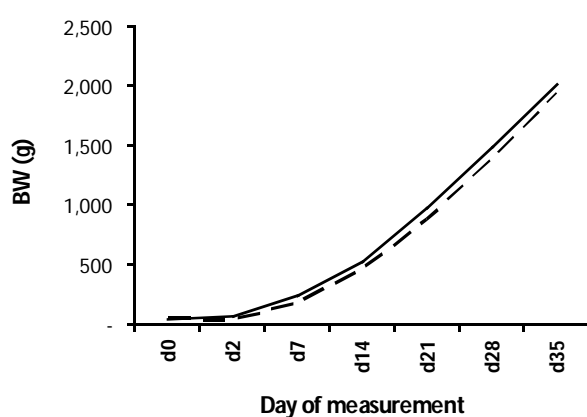


Figure 1. Body Weight of Birds (g)  
— (unfasted birds), - - - (early-fasted birds)

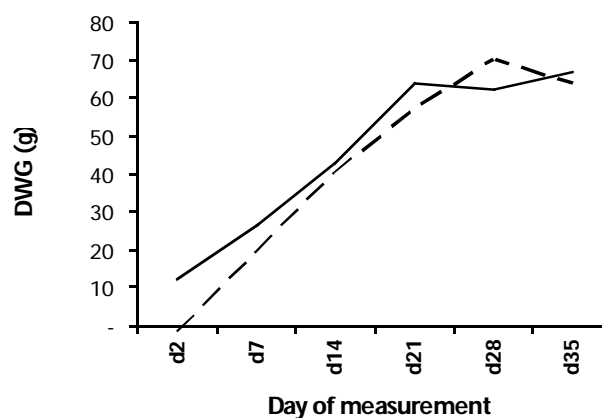


Figure 1. Daily Weight Gain of Birds (g)  
— (unfasted birds), - - - (early-fasted birds)

effort to reach the weight as determined by their genetic potential at a particular age but this effort seems to be limited in our experiment.

### Abdominal fat

Our study revealed that there was no significant difference ( $P>0.05$ ) upon the percentage of abdominal fat (to live BW) between early-fasted and unfasted either in male or female broilers (Table 4). This finding was in accordance with Saki (2005) and El-Husseiny *et al.* (2008). In contrast to our study, it is generally accepted that feed withholding (fasting) can lower the abdominal fat level of broiler (Yu and Robinson, 1992). Reduced abdominal fat is attributed by the reduction of adipocyte volume that may be due to decreased lipogenesis (Zhong *et al.*, 1995). The absence effect of fasting applied in early life of broiler on the percentage of abdominal fat (to live BW) in our present experiment might suggest that the degree or duration of feed withholding was

insufficient to reduce adipocyte proliferation or that if such effect did occur was counteracted by adipocyte hypertrophy when adequate amounts of feed were offered during the realimentation period (Attia *et al.*, 1998).

Females usually have more abdominal fat in their carcasses than male chickens (Nikolova *et al.*, 2007). However, no significant differences ( $P>0.05$ ) upon abdominal fat percentage between male and female broiler could be observed in our experiment. These circumstances can be explained as fasting and refeeding (thereafter) may increase the size of abdominal fat pad of male broiler (Beane *et al.*, 1979). In contrast to male, most studies reported that feed restriction is followed by a reduction of abdominal fat of female broiler (Yu and Robinson, 1992).

### Total FA contained in meat

No significant difference ( $P>0.05$ ) of total FA contained in broiler meat between early-fasted

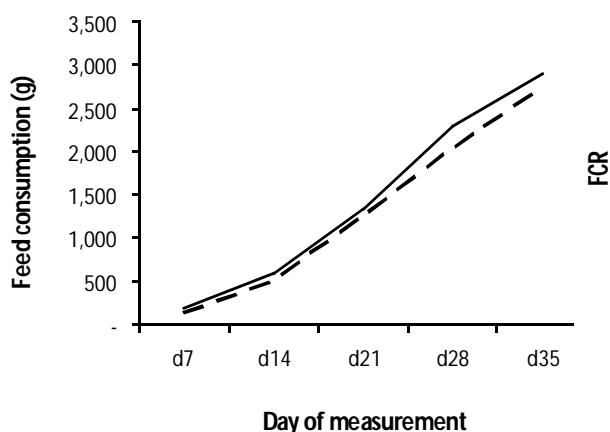


Figure 3. Feed Consumption (g)  
 – (unfasted birds), - - - (early-fasted birds)

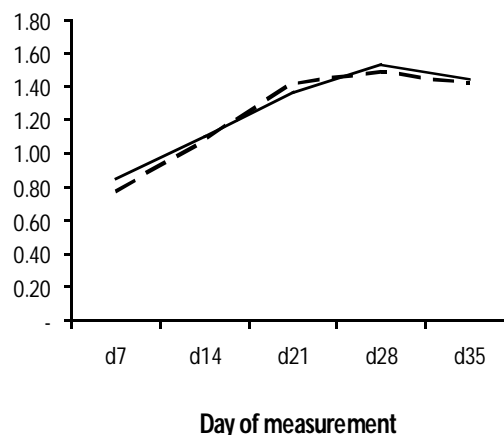


Figure 4. Feed Conversion Ratio of Birds  
 – (unfasted birds), - - - (early-fasted birds)

Table 4. Abdominal Fat Percentage to Live BW and Total FA Contained in Meat of Broiler

	Abdominal Fat Percentage to Live BW (%)		Total FA Contained in Meat (g/100 gDM)
	Male	Female	
Unfasted birds	2.00 ± 0.19	1.89 ± 0.38	0.85 ± 0.10
Early-fasted birds	1.65 ± 0.09	1.60 ± 0.10	0.82 ± 0.10

and unfasted birds could be observed in our study. Our finding is slightly different with Zhong *et al.* (1995). They suggest that fasting can lower the rate of lipogenesis resulting in reduced FA contained in broiler meat. With respect specifically to fasting in early life, it is subjected to reduce the number of precursor adipocytes and thus reduce the potential for lipid deposition (Pym, 1987). FA deposition in meat (carcass) itself can be exogenous (diet) and endogenous (lipogenesis) origin. Considering the fact that chicks at hatch have suboptimal absorption of FA from the diet (Krogdahl, 1985; Cobb, 2003), FA deposition in unfasted birds that was previously expected to be higher did not occur in our study. Godridge (1973) reported that while the increase of Acetyl-Coenzyme A carboxylase (ACC) and fatty acid synthetase (FAS), the enzymes required for lipogenesis, activities are not observed in early-fasted chicks, the increase of ACC and FAS are observed in unfasted chicks. However, when fasted chicks are subsequently fed, the activities level of ACC and FAS are elevated as in the case of unfasted chicks (Teraoka and Numa, 1975). On

these backgrounds, the insignificant differences of total FA contained in meat between early-fasted and unfasted birds therefore could be expected.

## CONCLUSION

Holding birds without feed following hatch (under practical conditions) may limit the compensatory growth capacity of birds in the later age. Feed deprivation applied in the very early stages of development (just after hatching) leads to impairment of cell hyperplasia resulting in permanent stunting. Abdominal fat content and total FA contained in meat of broiler might not be affected by fasting for 48h after hatching. The degree or duration of feed withholding (for 48h after hatching) may not sufficient to reduce adipocyte proliferation or the number of precursor adipocytes.

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