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Effects of Quantitative Feed Restriction on Serum Triacylglycerol, Cholesterol and Growth Related Hormones in White Pekin Ducks

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Abstract: This study was conducted to evaluate the effect of feed restriction on some biochemical parameters-related to growth in white Pekin duck. Therefore, fifty white Pekin ducks were allocated into two equal groups as *ad libitum* and feed restriction group, in which each one was arranged in five replicates. The birds were allowed to free feed access from 1st to 7th days and from 15th to 49th days of age and there was feed restricted from 8th to 14th days. The results indicated that feed restriction induced significant increase in serum corticosterone and significant decreases in serum triacylglycerol, cholesterol, duck growth hormone 1 and chicken insulin-like growth factor 1. It has been concluded that even if the feed restriction spares some economic feeding costs but it retards the growth of white Pekin ducks that retardation have been evidenced by the significant decreases in serum duck growth hormone 1 and chicken insulin-like growth factor 1.

Key words: Feed Restriction · Corticosterone · Duck Growth Hormone 1 · Chicken Insulin-Like Growth Factor 1

INTRODUCTION

Poultry production represents an important sector especially in the developing countries to meet household food demands and as additional sources of incomes [1]. The Food and Agriculture Organization of the United Nations (FAO) estimated the global population of domestic chickens and ducks at over 18 billion and 1 billion, respectively [2]. The poultry industry is dominated by commercial farms while in developing countries; production consists of village or backyard poultry, which is often extensive [3]. Poultry sector in Egypt is one of the major sources of animal protein supply [4]. Poultry production plays a major role in providing a large and cheap source of animal protein in Egypt, beside pure Egyptian breeds there were some local developed strains that established for both meat and egg production [5]. Duck meat production constitutes around 4.3% of the overall poultry meat available in the world [6]. The world production of duck meat was 3.78 million tons in 2008 and will continue to grow at a rate in excess of three percent per annum [7]. Current feeding strategies in growing Pekin ducks should aim at higher body weight gain, breast meat yield, better feed conversion ratio (FCR) and lower fat content of carcasses[8].

Feed represents 70% of the total costs in poultry production [9]. Therefore, different feed regimes were conducted in different research where the full feeding or feed restrictions were beneficial for ducks. *Ad libitum* feeding have led to increase of growth rates poultry; unfortunately this high growth rate is associated with increased body fat deposition, high mortality and high incidence of metabolic and skeletal disorders which have negative impact on broilers [10]. Therefore, there is a critical need to increase efforts to reduce some of these problems and reduced feed cost [11]. Quantitative feed restriction has been found to reduce body weights [12] and delay sexual maturity [13]. Feed restriction, which is denying the fast growing birds a full access to nutrients that are required for their normal growth and development, is categorized into quantitative and qualitative feed restriction [14]. The potential of feed restriction programs as management tools related to decreasing the incidence of metabolic disease, carcass fat deposition, reduce maintenance requirements and improvement of feed efficiency in broiler chickens production [15]. Also can be lead to economical saving in cost of feeding in broiler chicken production, thus may be usefulness for commercial broiler chicks production farms [16].

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Our study aimed to investigate the effects of both *ad libitum* and quantitative feed restriction on white Pekin ducks through determination of triacylglycerol (TAG), cholesterol, corticosterone, duck growth hormone 1 (GH1) and chicken insulin-like growth factor 1 (IGF-1).

MATERIALS AND METHODS

Birds and Experimental Design: Fifty white Pekin ducklings were obtained from the French company, El-Sadat city, Egypt were used and housed in clean and well-ventilated open-sided house with concrete floor that had been previously disinfected by fumigation using formaldehyde gas produced by mixing formalin 40% with potassium permanganate powder at a ratio of 2:1. The birds were randomly allocated into two groups of twenty-five birds as *ad libitum* and feed restriction groups in which each group was arranged as five replicates. Ducklings were floor brooded at 33°C at the bird´s level during first three days of age and then temperature reduced gradually till room temperature at 14 days of age. The house was provided by electric heaters in addition to incandescent lamps, fresh and clean wheat straw litter was used along a 24 hours constant light. The ingredient and chemical analysis of the basal diet were presented in Table (1) and (2), respectively [17].

Skip-a-day deprivation of feed is a quantitative method applied by removing feed for 24 hour periods during the starter period. All ducks were allowed to free access to feed from 1st to 7th days and 15th to 49th days of age, water provided at all time. Ducks were feed restricted from 8th to 14th days of age i.e. *ad libitum* feeding for a day followed by starvation for a day [18].

Table 1: Ingredient composition (%) of the basal diet.

Ingredient	Composition (%)
Ground yellow corn	63.1
Soya bean meal (44% CP)	28.2
Corn gluten meal (60% CP)	4.3
Vegetable oil *	0.6
Dicalcium phosphate **	1.8
Ground limestone	1.1
Common salts	0.4
Mineral and Vitamin Premix	0.3
Lysine	0.1
Methionine	0.1

* Vegetable oil composed of soybean oil, cottonseed oil and sunflower oil.

**Dicalcium phosphate contains 18% phosphorus, 23% calcium.

Table 2: The calculated chemical analysis (%) of the basal diet on DM basis.

Nutrients	(%)
ME Kcal/Kg diet	2655.47
Crude protein	20.36
Ether extract	3.387
Crude fiber	3.4
Calcium	0.999
Available phosphorus	0.469
Sodium	0.173
Manganese (mg/Kg)	192.77
Lysine	1.066
Methionine	0.452
Methionine + cystine	0.798

Biochemical Analysis: Blood samples were collected from the wing vein at 7th, 14th and 49th days of experiment. Blood samples were centrifuged at 3000 RPM for 5 min to separate clear sera. Collected serum samples were subjected to biochemical analysis of TAG [19] and cholesterol [20]. In addition, chicken corticosterone, GH1 and IGF-1 ELISA kits were purchased from Cusabio (http://www.cusabio.com/). The UNICO 2100 UV-Spectrophotometers, ELx800 Absorbance Microplate Reader and other laboratory equipment aids were used for biochemical study.

Statistical Analysis: The obtained data was statistically analyzed by t-test by SAS software 1996 [21].

RESULTS

The effects of feed regime either *ad libitum* or restricted feed on serum TAG, cholesterol, corticosterone, GH1 and IGF-1 of Pekin ducks were showed in Tables (3& 4) in which feed restriction induced a significant decrease ($P<0.05$) in serum TAG and cholesterol at 14th days (The end of feed restriction period of experiment) when compared with *ad libitum* group. In contrary, the levels of corticosterone the stress biomarker were significantly increase ($P<0.05$). Meanwhile, the levels of serum GH1 and IGF-1 were significant decrease ($P<0.05$) at 14th day in relation to control one (Table, 4).

DISCUSSION

Diet restriction decreased the concentrations of plasma lipids [22] and reduced the basal metabolism [23]. The turnover of adipose tissue TAG is responsive to changes in macronutrient intake in which fasting

Table 3: Mean values of serum TAG and cholesterol levels in *ad libitum* and feed-restricted groups of white Pekin ducks

	TAG (mg/dl)			Cholesterol (mg/dl)		
Groups	7th day	14th day	49th day	7th day	14th day	49th day
Ad libitum	93±4.19[a]	104.5±2.53[a]	102.29±2.61[a]	173.37±5.82[b]	169.84±9.09[a]	179.3±0.46[b]
Feed restricted	91±3.72[a]	68.13±0.13[b]	99.83±6.58[a]	175.79±7.32[b]	134.95±4.41[b]	176.4±2.55[b]

Means within the same column carrying different letters are significantly different between groups ($p<0.05$)

Table 4: Mean values of serum corticosterone, GH1 and IGF-1 levels in *ad libitum* and feed-restricted groups of white Pekin ducks

	Corticosterone (ng/ml)			GH1 (ng/ml)			IGF-1 (pg/ml)		
Groups	7th day	14thday	49thday	7th day	14thday	49th day	7th day	14thday	49thday
Ad libitum	52.66±7.08[a]	68.04±4.55[b]	77.68±7.02[a]	73±3.92[a]	84.73±4.81[a]	102.55±3.81[a]	151.18±0.11[a]	151.27±0.13[a]	151.1±0.07[a]
Feed restricted	56.12±5.64[a]	112.68±3.82[a]	76.09±7.01[a]	70.27±5.3[a]	34.78±3.93[b]	93.15±4.79[a]	151.2±0.19[a]	137.19±0.08[b]	151.02±0.09[a]

Means within the same column carrying different letters are significantly different between groups ($p<0.05$

increases lipolysis [24]. Dietary restriction had increases in AMP-activated protein kinase, an enzyme that stimulates glucose uptake and fatty acid oxidation while decreasing lipid synthesis [25]. Nutrient restriction induced a greater decrease in the plasma glucose that, coupled with increase in fat mobilization from adipose tissue, was sufficient to meet the nutrient needs for animal [26]. Fat mobilization induces a body weight loss whereas the concentrations of plasma phospholipids, total cholesterol and low-density lipoprotein decreased [27]. Total plasma lipids, triacylglycerols, cholesterol and high-density lipids were lower in the feed restricted chickens [28].

Corticosterone is a 21-carbon steroid hormone of the corticosteroid type produced in the cortex of the adrenal glands in rodents and other non-human animals, which act primarily as glucose sparing through the increment of lipid oxidation and protein degradation [29]. Feed restriction resulted in higher corticosterone [30]. Corticosterone both inhibits protein synthesis and degrades protein that pronounced by a slower feather growth and an extended period of poor flight [31]. The catabolic effects of glucocorticoids on muscle protein metabolism are well known. It is generally agreed that glucocorticoids inhibit muscle protein synthesis and stimulate muscle protein breakdown [32]. Once in the nucleus, the glucocorticoid receptor activates the expression of two target genes, encoding REDD1 and KLF15 [33] that finally induces branched-chain amino acid degradation in muscles [34]. Glucocorticoids modulate the secretion of GH [35] and directly inhibit growth hormone effects at target tissues by inhibiting IGF-1 and other growth factors. The effects of stress on the growth axis may account for the delay in growth [36, 37].

Growth primarily involves cell proliferation, but also may result from cell hypertrophy. The primary hormones involved with growth are GH, triiodothyronine (T_3) and IGF-1 [38]. Feed restriction induces changes in mRNA expression of the GH/IGF-I and thyroid hormone receptors[39] and changes the growth hormone-insulin-like growth factor-1 [40]. The continuous exposure to glucocorticoids has a continuous catabolic effect that associated with reduced weight gain and nitrogen retention [41]. The greater sensitivity of the intestine to the catabolic actions of corticosterone may be related to the interaction of corticosterone with IGF-I. Intestinal tissue is especially sensitive to the anabolic action of IGF-1 [42].

CONCLUSION

From the obtained data we can conclude that, the feed restriction induced a great stress on white Pekin ducks during growth period which evidenced by the significant increase in serum corticosterone and significant decreases in serum TAG, cholesterol, GH1 and IGF-1.

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