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Residual Yolk Utilization in Fast and Slow-growing Chicks, Subjected to Feed and Water Deprivation

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ABSTRACT

The present study was conducted to characterize the yolk sac utilization in fast and slow-growing chicks, subjected to feed and water deprivation. Two experiments were carried out; using two hundred fifty broiler chicks (Lohmann) in the first experiment and two hundred fifty layer chicks (Bovan) in the second one. Ten recently hatched chicks were immediately selected from each strain at random, individually weighed and then killed. The yolk sac was removed from the abdominal cavity and then weighed. The remaining 240 chicks from both groups were randomly assigned to one of four experimental groups as follows: (A) provided with water but no feed, (B) provided with feed but no water, (C) provided with neither feed nor water and (D) provided with both feed and water. Water and feed deprivation continued for 48 h posthatch. Thereafter, all the groups were provided with normal feed and water. Body weight and yolk sac weight were measured for successive 6 days. Statistical analysis was carried out using general linear model procedure of Statistical analysis system. The obtained data indicated that, there was strain difference between broiler and layer chicks in yolk sac weight at hatch. Nevertheless, with the exception of day 3, the feed and water restriction had no effect on the yolk sac weight and residual yolk utilization. The efficiency of the yolk uptake in broiler chicks was significantly higher compared to layer chicks during the first 2 days posthatch. The finding of this study showed that, broiler and layer chicks, subjected to feed and water deprivation showed striking differences in their efficiency of yolk utilization.

Key words: Broiler and layer chicks, residual yolk, posthatch utilization, feed and water deprivation, body weight

INTRODUCTION

During the parafetal stage, i.e., as the avian embryo prepares for hatching, the yolk sac is internalized (Romanoff, 1960). This action ensures that the hatched chicks will have an adequate nutrient reserve during the first 3-5 days posthatch. This process is an integral part of preciousness in domestic fowl (Freeman and Vince, 1974). The presence of the residual yolk sac during the first 3 days after hatching is critical for the growth and development of chicks (Turro *et al*., 1994). The absorption of the yolk sac precedes initiation of growth by as much as 24 h. On weight basis, approximately 20% of the yolk sac is absorbed before a significant increase in body weight was recorded (Chamblee *et al*., 1992). Removal of the yolk sac affect feed intake negatively, specially during the first 3 days posthatch, chicks with removed yolk sac (deutectomized chicks) get smaller

body size than intact ones (Turro *et al*., 1994). This may continue for the first week of age (Murakami *et al*., 1992; Ali *et al*., 2007). Thereafter, deutectomized chicks compensate for the body weight and show no significant difference from intact ones (Ali *et al*., 2007). Although, it has no significant effect on serum total lipids and serum cholesterol, removal of the residual yolk sac reduces liver total lipids at day 6 posthatch (Ali *et al*., 2007).

Delaying access to feed during early posthatch period has been shown to reduce the body weight gain and the development of the internal organs of chicks, especially the digestive ones and the liver (Gonzales *et al*., 2003; Bhanja *et al*., 2009). This proves the significance of early posthatch access to feed to the ideal growth of the chicks.

This study was conducted to investigate the effect of early posthatch feed and water deprivation on body weight and the rate of the residual yolk utilization in broiler and layer chicks.

MATERIALS AND METHODS

Experimental site and housing: The experiments were conducted in the Premises of Poultry Research Unit, University of Khartoum, Khartoum North Sudan. They were carried out in a naturally ventilated, open sided, deep litter poultry house, with concrete floor and corrugated iron sheet roof. The house was extended East West. It was portioned into 24 equal-sized pens (approximately 1 m^2) and each was provided with one tubular feed trough and one round fountain drinker. The chicks were provided with commercial broiler diet based on Sorghum, with protein supplement of groundnut meal, Seasame meal and imported concentrates. Ration was provided *ad libitum* during the whole period of the experiments under 24 h lighting programme. During the experimental periods (April-May/2008) the ambient temperature ranged from 33-46°C (Sudanese Metrological Department, Shambat).

Experimental plan

Experiment 1: Two hundred fifty meat-type broiler chicks of both sexes (Lohmann), were received from commercial hatchery. Ten recently hatched chicks were immediately selected at random, individually weighed and then killed. The yolk sacs were removed from the abdominal cavity and weighed using sensitive electrical balance (Sartorius-1216MP). The remaining chicks (240) were randomly assigned to one of the four experimental treatments; (A) provided with water but no feed, (B) provided with feed but no water, (C) provided with neither feed nor water and (D) provided with both feed and water. Each treatment consisted of 6 replicates of 10 chicks per each. Water and feed deprivation continued for 48 h. Thereafter, all the groups were provided with feed and water.

After 24 h, ten chicks from each experimental group were randomly selected weighed, killed and their yolk sacs were removed and weighed. The same procedure was repeated after 48 and 72 h etc., until the end of the experimental period (6 days).

Experiment 2: Recently hatched two hundred fifty male commercial layers chicks (Bovan males) were used in this experiment. Feeding and management as well as the experimental procedure were similar to that described for experiment 1.

Data collection and statistical analysis: The data of the body weight and yolk sac weight were recorded for individual chicks throughout the experimental period. The pooled data collected from both experiments, were subjected to analysis of variance (ANOVA). Duncan's Multiple Range test was conducted when significant differences among treatments existed.

RESULTS AND DISCUSSION

Body weight: The data for the body weight (g) of the two strains are shown in Table 1; it shows that there was strain difference between broiler and layer chicks in the body weight during the first six days posthatch. Moreover, the deprivation of both water and feed for two days posthatch had significantly reduced the body weight in both strains. The chicks deprived from both water and feed showed a delay in body weight by almost 4 days compared to the control chicks, which were provided with both water and feed.

The findings of the present study indicated that feed and water deprivation during the first 48 h posthatch reflect striking differences on the body weight, residual yolk sac weight and the efficiency of yolk utilization.

They reflected that feed and water deprivation decreased the body weight of both strains of chicks. Gonzales *et al.* (2003) found that delaying access to feed for 36 h after hatching impaired body weight and weight gain of broiler chicks for 42 days. Recently, Bhanja *et al.* (2009) showed that chicks fed within 24 h after hatch gain a significant ($p<0.05$) higher weight at 5 weeks of age than those get access to feed after 48 h posthatch. Noteworthy, keeping chicks for 48 h posthatch without feeding significantly decreases the weight of some vital internal organs like liver, pancreas and the duodenum (Bhanja *et al.*, 2009). Nevertheless, Murakami *et al.* (1992) suggested that low body weight chicks at early age eat without growing.

Yolk sac weight and utilization: Table 2 shows the data of the yolk sac weight (g) for both strains of chicks during the six days posthatch; it indicated that broiler chicks showed a high yolk

Table 1: Effect of feed and water restriction for 48 h posthatch on body weight (g) of broiler and layer chicks

	Type of the strain		Treatment			
Day	Broiler	Layer	A	B	C	D
1	41.20^{a}	26.75^{b}	33.02^{b}	33.02^{b}	36.74^{a}	34.08^{b}
2	40.43^{a}	29.49^{b}	31.43^{b}	34.08^{b}	41.54^{a}	34.15^{b}
3	48.34^{a}	34.14^{b}	38.76^{b}	39.44^{c}	45.86^{a}	41.81^{b}
4	49.60^{a}	34.91^{b}	40.26^{b}	41.27^{a}	44.51^{a}	42.70b^{a}
5	58.26^{a}	35.05^{b}	40.97^{b}	49.57^{a}	52.43^{a}	47.36^{c}
6	56.50^{a}	34.74^{b}	42.23^{b}	48.30b^{a}	52.84^{a}	45.36b^{c}

Within the same raw means with the same letter(s) are not significantly different at the 5% probability level. Values are means of 60 chicks/ treatment. A: Deprived from both feed and water, B: Provided with water only, C: Provided with feed and water and D: Provided with feed only

Table 2: Mean yolk sac weight (g) for broiler and layer chicks after 48 h posthatch of feed and water deprivation

	Type of the strain		Treatment			
Day	Broiler	Layer	A	B	C	D
1	2.82^{a}	1.65^{b}	2.34^{a}	2.13^{a}	2.24^{a}	2.42^{a}
2	1.77^{a}	1.37^{b}	1.55^{a}	1.64^{a}	1.44^{a}	1.71^{a}
3	1.14^{a}	0.71^{b}	1.06^{b}	0.81^{ba}	0.90^{ba}	0.95^{ba}
4	0.82^{a}	0.61^{b}	0.73^{a}	0.77^{a}	0.65^{a}	0.71^{a}
5	0.55^{a}	0.38^{b}	0.51^{a}	0.51^{a}	0.42^{a}	0.44^{a}
6	0.49^{a}	0.35^{b}	0.41^{a}	0.42^{a}	0.35^{a}	0.34^{a}

Within the same raw means with the same letter(s) are not significantly different at the 5% probability level. Values are means of 60 chicks/ treatment. A: Deprived from both feed and water, B: Provided with water only, C: Provided with feed and water and D: Provided with feed only

sac weight than layer chicks. Moreover, the differences among treatments on the yolk sac weight were not significant ($p<0.05$) during the 6 days-experimental period, with the exception of day 3, in which it was found to be significant ($p<0.05$). Noteworthy, there was strong direct correlation between body weight and yolk sac weight for layer chicks ($R^2 = 0.94$) and less correlation was expressed by broiler chicks ($R^2 = 0.76$), as it has been shown in Fig. 1 and 2, respectively. On the other hands, the correlation between days posthatch and the percentage of the absorption of the residual yolk was shown in Fig. 3. In comparison to layer chicks, the broiler chicks showed high efficiency in the absorption of the residual yolk during the first 2 days posthatch. Nevertheless, at day 3, almost 80% of the residual yolk was absorbed in both strains.

The initiation of growth of newly hatched chicks is correlated directly with absorption of the yolk from the residual yolk sac. Removal of the residual yolk sac at hatch was a sufficient growth impediment (Murakami *et al*., 1992; Turro *et al*., 1994; Ali *et al*., 2007). According to O'Sullivan *et al*. (1991), 30% of the nutrient requirements for the rapid growth after hatch is supplied by the residual yolk.

The present data showed that the broiler chicks got higher yolk sac weight than the layer chicks at hatch. The average of yolk sac weight for broiler chicks was estimated to be 5.67 g compared to layer chicks (average 3.37 g). These data did not agree with the study of Nir *et al*. (1933), that the weight of vitelline residue is not affected by genetic background. Nevertheless, some studies (Gonzales *et al*., 2008) might show some consistency with the present data, that heavy strains of chicks got heavy residual yolk sacs. This might be attributed to the fact that broiler chicks got higher yolk sac weight to meet the necessary nutrients for rapid posthatch growth. Interestingly, the present data high-lighted that the broiler chicks had higher efficiency in yolk utilization during the first 48 h posthatch compared to layer chicks. Yamauchi *et al*. (1992) reported that the

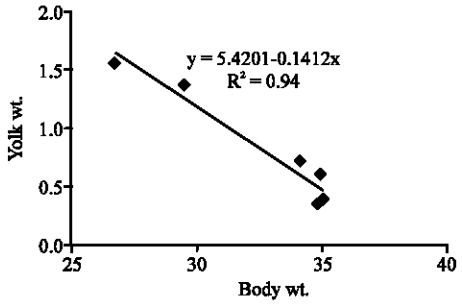

Fig. 1: The correlation between body weight (g) and the yolk weight (g) in layer chicks

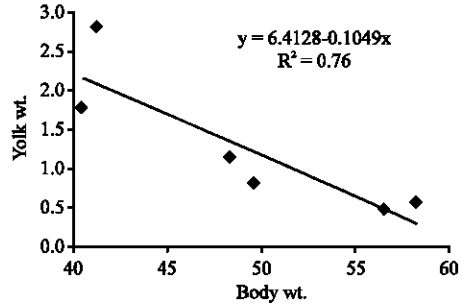

Fig. 2: The correlation between body weight (g) and the yolk weight (g) in broiler chicks

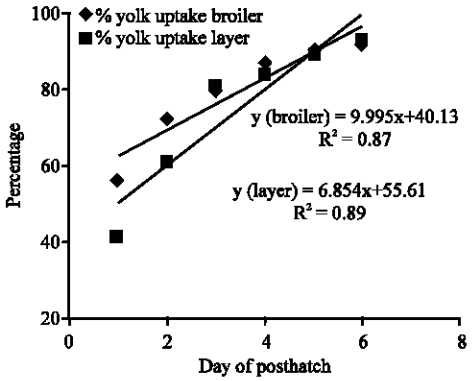

Fig. 3: The correlation between days posthatch and the percentage of yolk uptake in broiler and layer chicks

epithelial cells lining the yolk sac in broiler chicks proved greater absorptive area and more active functioning villi than in layer chicks. This might be related to the faster growth rate of broiler compared to layer chicks.

The efficiency of the yolk utilization was not affected by water and feed deprivation during the first 2 days posthatch. This could be in consistence with the findings of both Anthony *et al.* (1989) and Murakami *et al.* (1992), who suggested that the absorption of the residual yolk is independent of the feed intake. Although, it was not significant, it seems that the efficiency of the yolk sac utilization during the third day posthatch decreased. This might be due to the completion of the development of the digestive enzyme during the first 3 days posthatch (Nitsan and Ben-Avraham, 1988) hence, they could be contributed in the digestion of residual yolk up the 3rd day posthatch. Noteworthy, early feeding after hatch appears to enhance the transport of yolk through the yolk stalk directly into the intestine (Noy and Sklan, 1998; Speake *et al.*, 1998).

The overall results of this study indicated that, the newly hatched broiler and layer chicks subjected to feed and water deprivation showed striking differences in the efficiency of yolk utilization. It could be concluded that the residual yolk has crucial roles in complementing the nutrient absorbed to ensure rapid growth of chicks posthatch. Accordingly, the residual yolk supplies almost enough nutrients to maintain the body composition of starved chicks for at least 2 days posthach under Sudan condition (high ambient temperature).

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