



Asian Journal of
Poultry Science

ISSN 1819-3609



Academic
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Changes in the Concentrations of Liver Total Lipids, Serum Total Lipids and Serum Cholesterol During Early Days Post-hatch in Broiler Chicks

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ABSTRACT

Two experiments were conducted in this study to investigate the changes in the concentrations of liver total lipids, serum total lipids and serum cholesterol (Experiment 1) and the efficiency of the dietary fat absorption (Experiment 2) during the early days post-hatch in broiler chicks. The liver total lipids decreased significantly ($p < 0.05$) from day 2 to 8. Depending on the status of the residual yolk sac (deutectomized or intact residual yolk sac), the concentration of the liver total lipids exhibited different strength of correlation with post-hatch days. A stronger correlation was expressed by deutectomized ($r^2 = 0.98$) compared to sham operated chicks ($r^2 = 0.53$). The serum total lipids decreased significantly ($p < 0.05$) over 8 days post-hatch. This reduction was strongly correlated with days post-hatch in both deutectomized and sham operated chicks ($r^2 = 0.88$ and 0.91 , respectively). Moreover, the 2 groups did not show significant difference ($p < 0.05$) from each other over the mentioned period. The serum cholesterol decreased significantly ($p < 0.05$) over 8 days post-hatch. Since it showed significant ($p < 0.05$) increase at day 4 compared with other post-hatch days, the correlation between days post-hatch and serum cholesterol was low ($r^2 = 0.70$).

Key words: Broiler chicks, days post-hatch, liver total lipids, serum total lipids, serum cholesterol

INTRODUCTION

The early days post-hatch is considered to be critical period for the growth of broiler chicks, during which critical changes in the absorption capacity and metabolism occur. By the 5th day post-hatching about 85% of the gross weight and 90% of the lipids associated with the yolk complex are absorbed (Noble and Ogunyemi, 1989). Yafei and Noble (1988) reported that at 15th and 19th days of incubation period consequentially there is a large accumulation of lipids as droplets within the cytosol of the liver due to the increase in the engulfment of the yolk lipid droplets by the yolk sac membrane without extracellular digestion. Moreover, a considerable amount of cholesteryl esters accumulates within the liver tissues during embryonic development and it arises from synthesis in the yolk sac membrane (Noble *et al.*, 1984).

Feeding regime modulates the efficiency of the residual yolk utilization. Providing feed immediately after hatching enhances the rate of yolk utilization which is shown to be through the yolk stalk into the intestine (Noy and Sklan, 2001).

Noteworthy, the activity of the lipase enzyme is low at hatch and it increases with age; it is found to be 20 fold at day 21 post-hatch compared to day 4 post-hatch (Noy and Sklan, 1995).

The predominant alterations in the relative composition of the liver lipids occurred in the first week after hatching and may be accounted for by the decreasing yolk utilization and adaptation to ingested food (Desmeth, 1981).

The present study was conducted to investigate the changes in the concentrations of liver total lipids, serum total lipids, serum cholesterol and the efficiency of the dietary fat absorption in broiler chicks during the early days post-hatch.

MATERIALS AND METHODS

Experimental animals and feeding: The experiments of this study were conducted during the period of 7th November-20th December 2008 in the premises of poultry research unit, university of Khartoum, Khartoum North, Sudan. Sixty commercial one-day-old unsexed broiler chicks (Lohman) were used in this study. They were kept in a brooder house, where water and feed were provided *ad libitum* and light through out the day. The experimental diet was formulated according to the specifications of NRC (1994).

Experimental plan: Two experiments were conducted in this study. The first one was carried out using 40 one-day old broiler chicks which were assigned equally into two groups; deutectomized and sham operated chicks. Five chicks were randomly chosen from each group at day 2, 4, 6 and 8 post-hatch and blood sample was taken from each for determination of serum total lipids and serum cholesterol and liver was excised for determination of liver total lipids. In the second experiment, 20 chicks were employed to find out the efficiency of the dietary fat absorption over 8 days post hatch.

Surgical removal of the residual yolk sac: Surgical ablation of the residual yolk sac (Deutectomy) was carried out according to the procedure described by Turro *et al.* (1994) and it was done within 4 h post-hatch.

Sham operation: In this group 5 mm surgical incision was made in the abdomen within 4 h post-hatching. The incision was made in the same level of the umbilicus and just to the right side of it, then it was sutured using catgut.

Chemical analysis: Serum total lipids and serum cholesterol were determined using the methods described by Frings *et al.* (1972) and Kim and Goldberg (1969), respectively. The fat contents in feed and excreta were determined according to AOAC (1984). Liver total lipids were measured according to the method described by Folch *et al.* (1957).

Statistical analysis: Data were analyzed by two way ANOVA using SAS program. The interaction between the two factors (status of the residual yolk sac and days post-hatch) was tested. The mean separation was carried out to determine significance difference among the factors.

RESULTS AND DISCUSSION

The concentration of liver total lipids during 8 days post-hatch: The concentration of the liver total lipids during 8 days post-hatch decreased significantly ($p < 0.05$) from day 2 to day 8 (Fig. 1). Nevertheless, this concentration showed a significant sharp increase ($p < 0.05$) at day 6, after which it decreased sharply at day 8. Noteworthy, deutectomized chicks did not show this

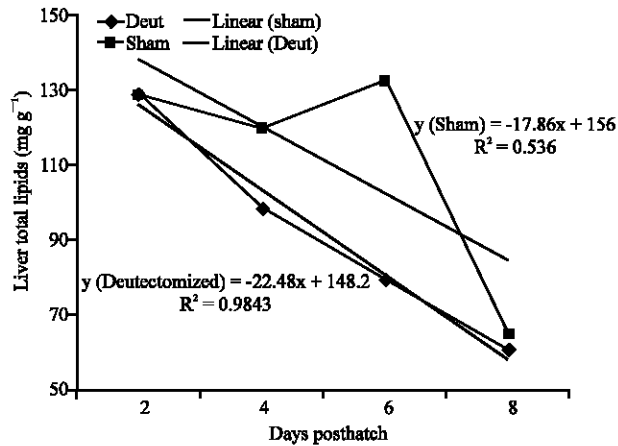


Fig. 1: Effect of age on the concentration of liver total lipids (mg g⁻¹ tissues) in sham operated and deutectomized chicks

increase at day 6. The concentrations of the liver total lipids in the deutectomized chicks were significantly correlated ($r^2 = 0.98$) with days post-hatch (Fig. 1). However, the sham operated ones did not exhibit strong correlation ($r^2 = 0.54$, Fig. 1), indicating that the increase at day 6 might be due to the fat absorbed from the residual yolk sac. This might confirm the significance of the residual yolk sac during the early days post-hatch in the regulation of liver fats content and hence, fat metabolism (Noy and Sklan, 1998).

The concentrations of serum total lipids and serum cholesterol during 8 days post-hatch: The concentrations of both serum total lipids and serum cholesterol decreased significantly ($p < 0.05$) from day 2 to 8 (Fig. 2). The reduction in the concentration of serum total lipids was almost linear. However, the reduction in the concentration of serum cholesterol was not; it showed a significant ($p < 0.05$) increase at day 4 compared to day 2. Thereafter, it decreased significantly ($p < 0.05$) at day 6 and day 8 compared to day 2 and 4. A relatively stronger correlation ($r^2 = 0.92$) between the concentration of serum total lipids and days post-hatch has been observed (Fig. 2).

Nevertheless, the concentration of the serum cholesterol was less correlated ($r^2 = 0.70$) with days posthatch (Fig. 2).

Interestingly, the deutectomized chicks and sham operated ones did not show significant difference ($p < 0.05$) from each other in neither the concentrations of the serum total lipids nor the serum cholesterol (Fig. 3, 4). This could be due to increase in the efficiency of dietary fat absorption in deutectomized chicks which might compensate for the fat absorbed from the residual yolk.

Since, there was no significant difference ($p < 0.05$) between the sham operated and deutectomized chicks in dietary fat absorption (Fig. 5), another source should be existed to compensate for the fat in the residual yolk. From Fig. 1, it was obvious that the liver might take this task. It seems that the liver of deutectomized chicks released sufficient amount of fat, from the stored large accumulated droplets of lipids during the last stage of pre-hatchery period (Yafei and Noble, 1988), into the blood to maintain the level of the serum total lipids at the physiological value. Since the absorption of glucose and carbohydrates during this period is very low (Noy and Sklan, 2001), the high concentration of serum total lipids at the early days post-hatch might be of significance for the high level of metabolic rate during early days post-hatch for maintaining the body temperature.

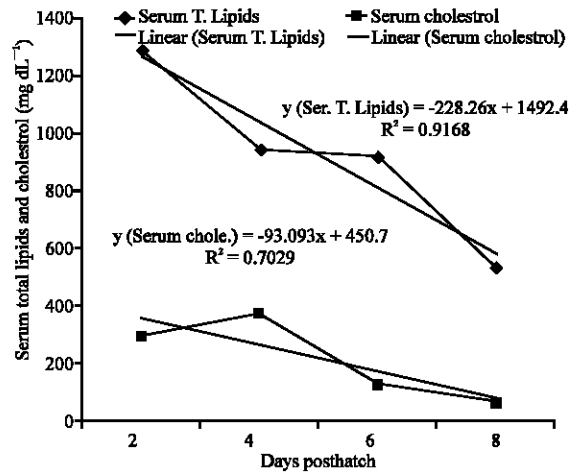


Fig. 2: Effect of age on the concentrations (mg dL⁻¹) of serum total lipids and serum cholesterol

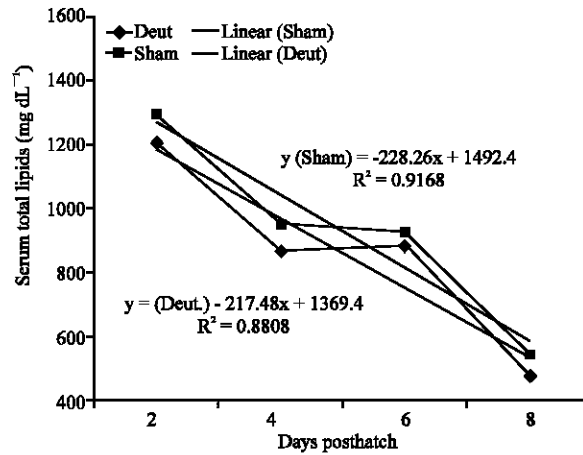


Fig. 3: The correlation between the concentrations of serum total lipids (mg dL⁻¹) and age in deutectomized (Deut.) and sham operated chicks (Sham)

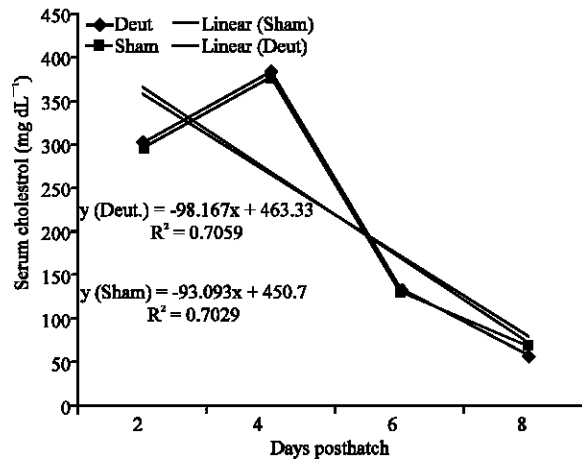


Fig. 4: The correlation between the concentrations of serum cholesterol (mg dL⁻¹) and age in deutectomized (Deut.) and sham operated chicks (Sham)

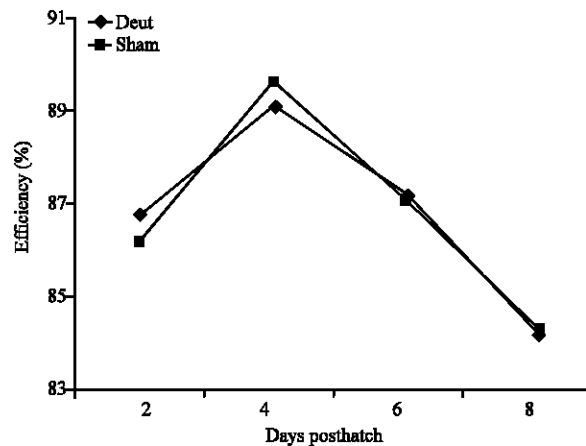


Fig. 5: Changes in the efficiency of dietary fat absorption (%) during 8 days post-hatch in deutectomized and sham operated broiler chicks

This study indicated that the liver might have a crucial role during the early days post-hatch by maintaining the physiological level of the serum total lipids during this critical period.

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