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Effect of Residual Yolk Sac on Growth, Liver Total Lipids and Serum Total Lipids in Broiler Chicks

¹O.H.A. Ali, ²E.A. Elzubeir and ¹H.M. Elhadi

¹Department of Physiology, Faculty of Veterinary Medicine,

²Department of Poultry Production, Faculty of Animal Production, University of Khartoum, Sudan

Abstract: Two experiments were conducted to investigate the effect of the residual yolk sac on growth and total lipids in serum and liver of newly hatched broiler chicks. In each experiments 36 one day old broiler chicks (Lohmann) were allocated to three groups according to the status of the residual yolk sac; deutectomized (surgical ablation of the residual yolk sac, Y), sham operated (S) or intact chicks (I). Y chicks, when compared to S or I chicks, exhibited significant reduction in body weight gain during the 1st week of age. Feed intake was not significantly affected by removal of residual yolk sac. Removal of the residual yolk sac had no effect on serum total lipids and serum cholesterol during 8 days post-hatch and dietary fat absorption for 15 days. Significant interaction between age and removal of residual yolk sac was observed for liver total lipids. Furthermore, the results showed that the liver total lipids, serum total lipids and serum cholesterol were significantly lower at day 8 compared to day 2. The results of this study indicated that removal of the residual yolk sac had no effect on serum total lipids, serum cholesterol, dietary fat absorption and liver weight. However, it reduced the growth of the chicks for the first week of age, after which the chicks compensate for this reduction. The removal of the residual yolk sac showed significant interaction with age for liver total lipids.

Key words: Residual yolk sac, broiler chicks, growth, liver total lipids, dietary fat absorption

INTRODUCTION

The biological role of the yolk sac is not restricted to the embryonic life in avian, but it extends to the post-hatch life. It is internalized in the abdominal cavity of the embryonic chicks towards the end of the incubation period (Romanoff, 1960). During the embryonic development, transfer of nutrients from the yolk to the circulation takes place by endocytosis (Lambson, 1970). However, close to hatch the yolk can be also transported to the intestine through the yolk stalk (Esteban *et al.*, 1991; Noy *et al.*, 1996). The importance of the Residual Yolk Sac (RYS) in initiation of growth in broilers was demonstrated by Chamblee *et al.* (1992) and Turro *et al.* (1994). The body weight gain is greater for chicks with intact yolk sac and sham operated ones compared to deutectomized chicks in the heavy weight line, but not the light weight line, demonstrating a differential response by fast and slow growing chicks to removal of the residual yolk sac (Turro *et al.*, 1994). Feed intake has been found to be reduced by removal of the residual yolk sac during the first 3 days post-hatch (Turro *et al.*, 1994). From the previous findings, it appears that further studies are necessary to demonstrate other biological functions of RYS. Therefore, the present study was conducted to

obtain further information about the role of RYS in growth and to see its effect on the concentration of the total lipids in serum and liver of broiler chicks (Turro *et al.*, 1994).

MATERIALS AND METHODS

Experimental animals and feeding: Commercial one day old unsexed Lohman broiler chicks were used in this study. They were kept in a brooder house where water and feed were provided ad libitum. The experimental diet was formulated according to the specifications of NRC (1994).

Surgical removal of the residual yolk sac (Deutectomy): Deutectomy was carried out according to the procedure described by Turro *et al.* (1994).

Experimental plan: Two experiments were conducted in this study. In each experiment the chicks were assigned to 3 experimental groups according to the status of the RYS as follows:

Deutectomized chicks: In this group the RYS was removed surgically within 3 h post-hatching.

Sham operated chicks: In this group 5 mm surgical incision was made in the abdomen within 3 hours post-hatching. The incision was made in the same level of the umbilicus and just to the right side of it and it was sutured using cat gut.

Intact chicks: In this group neither surgical operation nor incision was performed.

Experiment I: In this experiment, growth and fat absorption were investigated in the three groups. Thirty six chicks were individually marked and randomly distributed among the experimental groups (12 chicks per group).

Experiment 2: Thirty six chicks were employed in this experiment. They were allocated to the three above mentioned groups (12 chicks per group) to determine liver weight, liver total lipids, serum cholesterol and serum total lipids.

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

Statistical analysis: Data were subjected to Analysis of Variance (ANOVA) using Statistical Analysis System (SAS) Oregon State University Computer programme. Data were presented as Mean±Standard error of the means.

RESULTS

Body weight gain and feed intake: Table 1 shows that after the 1st week of age the body weight gain of deutectomized chicks was not significantly different when compared to body weight gain of sham operated or intact chicks. Table 2 shows that feed intake was not significantly affected by removal of the residual yolk sac.

Serum total lipids and serum cholesterol: Table 3 shows that there was no significant difference in both serum total lipids and serum cholesterol among the different experimental groups.

Liver total lipids: A significant interaction between age and status of the residual yolk sac was observed for liver total lipids. They were significantly decreased in response to both the status of the residual yolk sac and days posthatch, but not by the status of the residual yolk sac

Table 1: Effect of residual yolk sac on body weight gain (g) of newly hatched broiler chicks from week 1 to 5

Week	Status of residual yolk sac		
	Deutectomized	Sham operated	Intact
1	29.6±1.2 ^a	44.6±2.3 ^b	49.8±1.8 ^b
2	90.8±3.4 ^a	127.2±6.8 ^a	119.6±4.1 ^{ab}
3	192.0±8.5 ^a	221.6±5.9 ^a	222.0±3.8 ^a
4	298.0±4.6 ^a	311.6±5.2 ^a	328.8±7.4 ^a
5	367.1±14.1 ^a	370.3±18.3 ^a	349.4±12.2 ^a

^{ab}: Values within the same row, with the same superscript(s) are not significantly different at 5% probability, SEM: Standard error of the means

Table 2: Effect of residual yolk sac on feed intake (g) of newly hatched broiler chicks from week 1 to week 5

Week	Status of residual yolk sac		
	Deutectomized	Sham operated	Intact
1	105.6±7.5 ^a	118.4±8.7 ^a	127.8±4.8 ^a
2	206.6±10.7 ^a	217.2±14.6 ^a	253.0±10.1 ^b
3	501.6±15.3 ^a	493.3±13.2 ^a	508.8±16.4 ^a
4	694.7±17.7 ^a	723.4±22.1 ^a	730.6±25.4 ^a
5	978.7±26.8 ^{ab}	952.5±21.3 ^a	1037.8±22.1 ^b

^{ab}: Values within the same row, with the same superscript(s) are not significantly different at 5% probability, SEM: Standard error of the means

Table 3: Effect of residual yolk sac on serum concentrations^a of total lipids and cholesterol in newly hatched broiler chicks

Week	Status of residual yolk sac		
	Deutectomized	Sham operated	Intact
Serum total lipids (mg dL ⁻¹)	862.00±21.15 ^a	955.17±31.23 ^a	969.37±34.56 ^a
Serum cholesterol (mg dL ⁻¹)	240.52±18.63 ^a	215.62±16.79 ^a	230.82±17.43 ^a

^a: Values within the same row, with the same superscript(s) are not significantly different at 5% probability, *: Values are means of the concentration of serum total lipids and cholesterol at days 2, 4, 6 and 8, SEM, Standard error of the means

Table 4: Effect of residual yolk sac and age on the concentration of liver total lipids (mg g⁻¹) in newly hatched broiler chicks

Status of residual yolk sac	Days post-hatch			
	2	4	6	8
Deutectomized	129.2±12.3a ^a	98.6±5.2ba ^c	79.6±3.7a ^{bcd}	60.6±4.1a ^d
Sham operated	128.6±8.6a ^a	119.6±9.1a ^a	132.4±11.6bc ^a	69.8±3.8ac ^b
Intact	133.4±6.4a ^a	81.6±8.8b ^{bc}	111.6±5.4ac ^{bc}	93.0±6.2bc ^c

^{abcd}: Values within the same row, with the same superscript(s) are not significantly different at 5% probability, ^{abcd}: Values within the same column, with the same letter(s) are not significantly different at 5% probability, SEM, Standard error of the means.

alone. Table 4 shows that the concentrations of liver total lipids were not significantly different at day 2 in the three groups. At day 8 liver total lipids were significantly lower in comparison to liver total lipids at day 2 in the 3 groups. In deutectomized chicks, liver total lipids at day 6 showed a significant decrease when compared to liver total lipids at day 2. Nevertheless, in sham operated and intact chicks, the concentrations of the liver total lipids at day 6 were not significantly different compared to those at day 2.

Table 5: Effect of residual yolk sac on dietary fat absorption (%) in newly hatched broiler chicks

Status of residual yolk sac	Fat absorption (%) ^a
Deutectomized	86.6±1.4 ^a
Sham operated	87.9±1.3 ^a
Intact	86.8±0.9 ^b

^a: Values within the same superscript(s) are not significantly different at 5% probability, ^bValues are means of fat absorption in day 2, 4, 6, 8 and 15. SEM, Standard error of the means

Dietary fat absorption: Table 5 shows that fat absorption in the deutectomized chicks was not differ significantly from fat absorption in intact and sham operated chicks.

DISCUSSION

During the 1st week of age, deutectomized chicks gained less body weight compared to sham operated and intact chicks. Thereafter, the three experimental groups grew at a similar rate. The differences in feed intake among the different experimental groups were not significant. The trend of reduction and increase in body weight gain observed in this study is partially in the line with the findings of Chamblee *et al.* (1992) and Murakami *et al.* (1992).

Although it has been shown that RYS contains large amount of lipids (Romanoff, 1960), removal of the RYS in this study had no effect on the concentrations of serum total lipids and serum cholesterol during 8 days post-hatch, which was opposite to what could be expected. This might be due to the presence of stored fat in the liver during embryonic life, especially during the last seven days of incubation. Yafei and Noble (1988) reported that at 15th and 19th days of incubation period consequentially there is a large accumulation of lipids as droplet 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. It seems that the stored fat in the liver during the embryonic life is used to maintain the level of the serum total lipids and serum cholesterol at a threshold upon which the chick can depend during the early post-hatch life. The present findings showed a significant interaction between days post-hatch and removal of the RYS for the concentration of liver total lipids. The liver total lipids of deutectomized chicks at day 6 is significantly lower when compared to liver total lipids at day 2. Meanwhile, in the other two groups liver total lipids at day 6 were not significantly different when compared to liver total lipids at day 2. Day 6 may represent the end of the course of the residual yolk absorption. Noteworthy, Noble and Ogunyemi (1989) reported that during embryonic development the liver appears to play a major role as depository for performed

lipids from the yolk, however, after hatching it rapidly displays a synthetic capacity of its own that soon outweighs the large contribution to lipid accumulation within the chick still being made by the yolk. Another explanation for keeping serum total lipids and cholesterol in deutectomized chicks at a level equals to the other two groups could be achieved by increasing the efficiency of dietary fat absorption, which an explanation was not supported by this study.

The present study indicated that the RYS plays a critical role in growth of broiler chicks during the 1st week of age, thereafter, the chicks could compensate for body weight gain.

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REFERENCES

- AOAC, 1984. Association of Official Agricultural Chemists. Official Methods of Analysis 14th Edn. Washington DC, USA.
- Chamblee, T.N., J.D. Brake, C.D. Schultz and J.P. Thaxton, 1992. Yolk sac absorption and initiation of growth in broiler. *Poult. Sci.*, 71: 1811-1816.
- Esteban, S., J. Rayo, M. Moreno, M. Sastre, R. Rial and J. Tur, 1991. A role played by the vitelline diverticulum in the yolk sac resorption in young post hatched chickens. *J. Comp. Physiol. B.*, 160: 645-648.
- Folch, J., M. Lees and H.S. Stanley, 1957. A simple method for isolation and purification of total lipids from animal tissues. *J. Biol. Chem.*, 226: 497-499.
- Frings, S.C.S., W.F. Ted, T.D. Ralph and A.Q. Cecelia, 1972. Improve determination of total serum lipids by the sulfo-phosphoamillin reaction. *Clin. Chem.*, 18: 673-674.
- Kim, E. and M. Goldberg, 1969. Serum cholesterol assay using a stable liebrman-Burchard reagent. *Clin. Chem.*, 15: 1171-1179.
- Lambson, R.O., 1970. An electron microscopic study of the entodermal cells of the yolk sac of the chick during incubation and after hatching. *Am. J. Anat.*, 129: 1-20.
- Murakami, H., Y. Akiba and M. Horiguichi, 1992. Growth utilization of nutrients in newly-hatched chick with or without removal of residual yolk. *Growth Dev. Aging.*, 56: 75-84.

- NRC, 1994. Nutrient Requirements of Poultry, 9th Edn. National Academic of Science, National Research Council, Washington, DC.
- Noble, R.C. and D. Ogunyemi, 1989. Lipids changes in the residual yolk and liver of the chick immediately after hatching. *Biol. Neonate.*, 56: 228-236.
- Noy, Y., Z. Uni and D. Sklan, 1996. Utilization of yolk in the newly hatched chick. *Br. Poult. Sci.*, 37: 987-995.
- Romanoff, A.L., 1960. The Extraembryonic Membranes in the Avian Embryo, Structural and Functional Development. The MacMillan Company. New York, pp: 1041-1140.
- Turro, I., E.A. Dunnington, Z. Nitsan, M. Picard and P.B. Siegal, 1994. Effect of yolk sac removal at hatch on growth and feeding behaviour in lines of chickens differing in body weight. *Growth Dev. Aging*, 58: 105-112.
- Yafei, N. and R.C. Noble, 1988. An electron microscope study of yolk lipid uptake by the chick embryo with particular reference to low hatchability in young parent stock. *Br. Poult. Sci.*, 29: 887.