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Effect of Post Hatch Feed Deprivation on Yolk-sac Utilization and Performance of Young Broiler Chickens

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ABSTRACT : An experiment was conducted to study the effect of post-hatch feed deprivation on yolk sac utilization and subsequent performance of young broiler chickens (280) up to 35 days of age. The experimental treatments included access to feed at 8 h intervals after hatch, up to 48 h (0, 8, 16, 24, 32, 40 or 48 h). Water was offered *ad libitum* to all the groups immediately after placement. Results indicated that chicks with access to feed immediately after hatch used up the residual yolk more quickly. Access to feed between 8-24 h post-hatch, supported faster utilization of residual yolk compared to those chicks that remained unfed for 40-48 h ($p<0.05$). Further, deprivation of feed up to 24 h did not alter the lipid and protein contents in residual yolk, but fasting of chicks beyond 24 h (32, 40 and 48 h) led to retention of higher lipid and lower protein content in the yolk sac ($p<0.05$). At 7 days of age, the weights of proventiculus and gizzard were not affected by feed deprivation up to 48 h. However, the liver, pancreas and jejunum recorded significantly ($p<0.05$) heavier weights in chicks that were fed during the initial 24 h period compared to delayed feeding (32-48 h). Chicks fed within 24 h after hatch gained significantly ($p<0.05$) higher weight at 5 weeks of age than those that received feed between 32 and 48 h. Feed deprivation for 48 h was more detrimental to growth than 24-40 h. This study revealed the significance of early post-hatch feeding (<24 h) on faster utilization of yolk sac nutrients and optimum development of intestines and organs, culminating in improved weight gain (>10.5%) of broilers at 5 weeks of age. (**Key Words** : Post Hatch Feed Deprivation, Yolk-sac Utilization, Performance, Broiler Chickens)

INTRODUCTION

The modern breeds of broiler chicken have been selected over several years for fast growth, and at present weigh around 2.2 kg at 35-40 days of age. The magnitude of growth indicates that each day during the growing period is important to achieve the target growth. However, in commercial poultry operations, the chicks are held in the hatchery over a 2-day period (21st and 22nd day of incubation) and are taken out of the incubator only when majority of chicks clear the shell. Following the release of chicks from incubator, the preparatory practices like sexing, vaccination and packaging are carried out before the birds are transported to the farms. Thus, in practice, the post-hatch chickens often spend substantial time in the hatchery without access to feed and water, which causes poor viability and reduction in growth (Madsen et al., 2004).

In the process of hatching, yolk is utilized by the chick either through endocytosis of its contents into circulation or by transportation through yolk stalk into small intestine (Sklan, 2003). The residual yolk is normally used up within 4 days after hatching (Noy and Sklan, 1999) and the recent studies indicated that residual yolk was used up more quickly by the chickens that had access to feed immediately after hatch than those fasted for 48 h. However, scanty information in literature is available on the alterations in residual yolk composition, in response to early feeding. Noy and Sklan (1999) reported that chickens without access to feed and water for 48 h after hatch decreased body weight by 7.8% compared to chickens fed immediately after hatch. The reduction in growth and increase in early mortality, were primarily due to inaccessibility to food and water that were associated with dehydration and shortage of available energy (Vieria and Moran, 1999). However, the information available on early post-hatch nutrition on the status of yolk utilization and its impact on growth and related parameters is scanty. Therefore, an experiment has been planned with the primary objective of evaluating the role of post-hatch feeding on utilization of yolk sac nutrients and performance of broilers up to 5 weeks of age.

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MATERIALS AND METHODS

Stocks and husbandry

A total of 280 chicks hatched from eggs that weighed between 59-62 g, produced by a single flock of synthetic broiler breeder hens (age 44 wk) were used in this study. Eggs after collection were stored in cold storage (14-15°C) for 5 days. On 6th day, all the eggs were brought to room temperature and kept in the incubator (35°C) for 18 days and setter for 3 days. On 22nd day, immediately after hatching, the chicks were weighed individually and randomly distributed to 7 test groups with 8 replicates of 5 chicks each, and placed in wire floored battery brooder pens. The brooder temperature was maintained by using incandescent electric bulbs at 34±1°C up to 7 days of age, which was gradually reduced to 26±1°C by 21 days of age. Thereafter, the chicks were reared at room temperature (25-27°C) with an average humidity of 50-60% during entire rearing period. All the birds were kept under uniform management conditions throughout the experimental period and protected following routine vaccination schedule. The experimental treatments included access to feed at 8 h intervals up to 48 h after hatch i.e. 0, 8, 16, 24, 32, 40 or 48 h. Water was provided *ad libitum* to all the groups immediately after placement. The starter (0-3 wk) and finisher (4-5 wk) diets (based on maize-soybean meal) contained 2,900 kcal ME/kg with 22% CP and 3,000 kcal ME/kg with 20% CP, respectively. The Institute Animal Ethics Committee approved the experimental protocol.

Yolk-sac utilization

Immediately after release from the hatchery and prior to placement, 6 chicks (3 from each sex) were randomly picked up, weighed and euthanized to measure yolk residue. Similarly, at the end of 24, 48 and 72 h of placement, 6 chicks from each group were weighed and euthanized to measure the yolk residue, if present. Total lipid and protein contents were determined in the residual yolk after 72 h. placement following the methods of AOAC (1995) and expressed as mg per gram residual yolk.

Gastrointestinal tract and organ development

At 7 days of age, 6 chicks were utilized for assessing the relative growth of gastrointestinal tract and organ development. The chicks were killed by cervical dislocation and the weights of proventiculus, gizzard, liver, pancreas and small intestine (duodenum, jejunum and ileum) were recorded and expressed as percent live weight. The length of each segment of small intestine (duodenum, jejunum and ileum) was also measured.

Body weight changes and feed intake

Individual body weight of chicks and feed intake of each group were recorded at weekly intervals throughout the experimental period. Feed conversion ratio during the respective weeks and the overall period was calculated as the ratio between unit feed intake and unit weight gain.

Statistical analysis

Data were subjected to statistical analysis under completely randomized design employing one-way analysis of variance (Snedecor and Cochran, 1989). The means of different treatments were compared with Duncan's multiple range tests (Duncan, 1955). Significance was considered at $p<0.05$ level.

RESULTS

Residual yolk utilization

The effect of post-hatch feed deprivation on residual yolk utilization is presented in Table 1. The average yolk weight immediately after hatch was 6.53 g, which was reduced after 24 h to 3.44 g in chicks that had access to feed soon after hatch. However, the residual yolk was significantly high (5.51 g) in chicks that were deprived of feed during the initial 24 h. At 48 h post-hatch, the residual yolk was further reduced to 1.50 and 1.38 g, respectively in chicks that accessed feed either immediately or 8 h after hatch. In contrast, the weight of residual yolk (2.79 g) was

Table 1. Effect of post-hatch feed deprivation intervals (h) on the changes of absolute and relative weights of yolk sac at 24, 48 and 72 h of age, and the utilization of yolk lipid and protein by chicks at 72 h of age

Post-hatch feed deprivation (h)	Absolute wt (g) of yolk sac			Yolk sac wt/body wt (%)			Yolk nutrients (mg/g)	
	24 h	48 h	72 h	24 h	48 h	72 h	Lipid	Protein
0	3.44^{b}	1.50^{b}	0.84^{c}	6.88^{b}	2.62^{b}	1.39^{c}	274^{c}	252^{a}
8	3.27^{b}	1.38^{b}	1.05^{b}	6.96^{b}	2.89^{b}	1.95^{b}	278^{c}	248^{a}
16	2.99^{b}	1.88^{ab}	1.21^{b}	6.00^{b}	3.69^{ab}	2.16^{b}	276^{c}	250^{a}
24	5.54^{a}	2.29^{ab}	1.52^{b}	12.52^{a}	4.18^{ab}	2.24^{b}	280^{c}	247^{a}
32	-	2.36^{ab}	1.43^{ab}	-	4.53^{ab}	2.55^{ab}	299^{b}	229^{b}
40	-	2.48^{ab}	1.83^{a}	-	4.50^{ab}	2.76^{a}	295^{b}	232^{b}
48	-	2.79^{a}	1.96^{a}	-	5.19^{a}	3.10^{a}	321^{a}	209^{c}
SEM	0.27	0.15	0.12	0.66	0.26	0.21	2.4	2.3
p value	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

[a, b, c] Means with different superscripts in a column differ significantly.

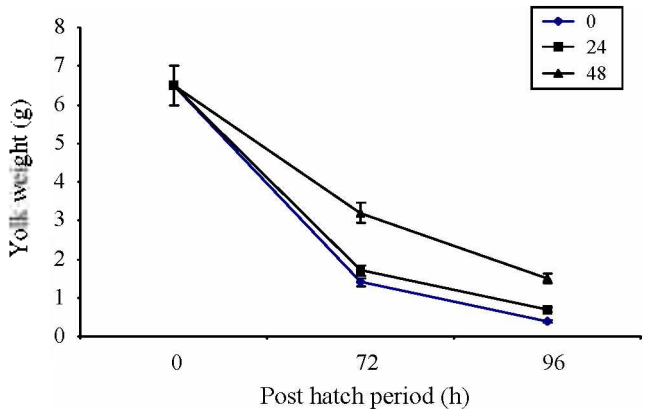

Figure 1. Relative reduction of yolk weight up to 96 h of age, as influenced by post-hatch feeding intervals (0, 24 or 48 h) in broiler chicks.

significantly high in chicks deprived of feed for 48 h after hatch. In all other groups that received feed after 16, 24, 32 or 40 h, the weight of residual yolk remained intermediate. At 72 h, the residual yolk sac was significantly lighter in chicks that were fed immediately compared to those fasted for 48 h. Chicks with access to feed between 8 and 24 h also utilized residual yolk faster than those that deprived of feed for 40-48 h post-hatch. Lipid and protein content in residual yolk was not altered by feed deprivation during the initial 24 h. However, higher lipid and lower protein content was observed in the residual yolk of birds that were deprived of feed beyond 24 h and the maximum intensity of this trend was recorded in birds fasted for 48 h. The remaining yolk weight was reduced to 0.4 g by 96 h in chicks fed immediately after hatch, while the same weighed 0.7 and 1.5 g after 96 h in chicks held without feed for 24 and 48 h, respectively (Figure 1).

Gastrointestinal tract and organ development

At 7 days of age, the relative weights of proventiculus and gizzard were not influenced by post-hatch feed deprivation up to 48 h, but the liver, pancreas and jejunum weights were significantly higher in chicks fed during the initial 24 h period, compared to delayed feeding between 32-48 h after hatch (Table 2). Ileum was significantly heavier in chicks fed immediately compared to those

Table 2. Effect of post-hatch feed deprivation on the development of gastrointestinal tract, liver and pancreas in broiler chicken at 7 days of age

Post-hatch feed deprivation (h)	Proventiculus (g)	Gizzard (g)	Liver (g)	Pancreas (g)	Percent wt of intestinal segments		
					Duodenum	Jejunum	Ileum
0	1.27	7.65	6.09[a]	0.53[a]	1.85	3.65[a]	3.88[a]
8	1.38	7.47	6.06[a]	0.48[a]	2.08	3.64[a]	3.30[ab]
16	1.28	7.90	6.07[a]	0.48[a]	2.15	3.61[a]	3.55[ab]
24	1.39	7.58	5.98[a]	0.49[a]	1.90	3.78[a]	3.15[ab]
32	1.32	7.25	5.09[b]	0.38[b]	1.64	3.05[b]	3.13[ab]
40	1.35	7.98	5.03[b]	0.38[b]	1.89	3.06[b]	2.99[ab]
48	1.47	7.97	5.08[b]	0.39[b]	1.90	2.89[b]	2.88[b]
SEM	0.03	0.12	0.13	0.01	0.05	0.14	0.11
p value	NS	NS	0.05	0.05	NS	0.05	0.05

[a, b] Means with different superscripts in a column differ significantly.

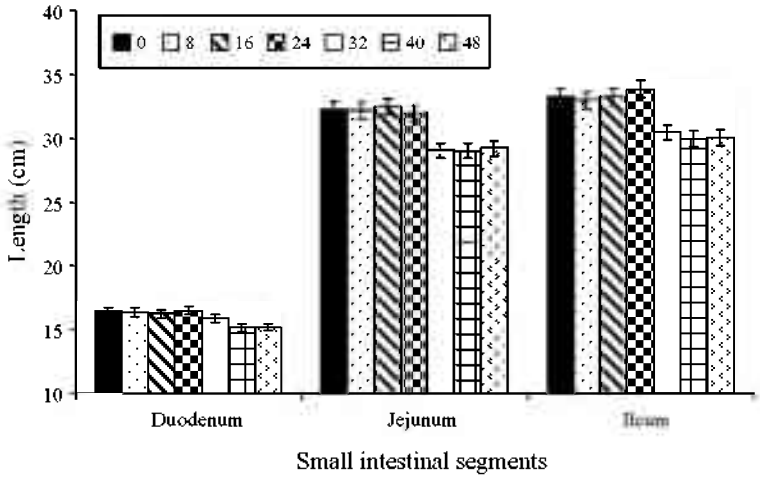

Figure 2. Effect of post-hatch feed deprivation at 8-hourly intervals from the point of hatch till 48 h on the length of small intestine segments of broiler chickens at 7 days of age.

deprived of feed for 48 h. In all other groups the relative weight of ileum was intermediate. The small intestinal segments like jejunum and ileum were significantly longer in chicks fed during the first 24 h period compared to 32-48 h after hatch (Figure 2).

Performance of broiler chicken

The effect of early feeding on weekly body weight gain of broiler chickens from day-old to 5 weeks of age is presented in Table 3. Deprivation of feed for 24 h or beyond significantly reduced weight gain of broiler chicks at the end of 1st week. Feed deprivation up to 48 h was more detrimental to growth in broiler chicks than 24 h deprivation. The same trend was observed in the 2nd week also. However, chicks offered feed immediately after hatch or deprived up to 24 h gained similar weight at the end of 3rd week. Deprivation of feed beyond 24 h (32-48 h) could not compensate the growth at 3 weeks of age. The same trend continued during the subsequent experimental period. At 5 weeks of age, the chicks fed during 0-24 h after hatch gained significantly higher weight than those that had access to feed between 32 and 48 h after hatch. Feed deprivation for 48 h was more detrimental to growth than 24- 40 h. Feed intake (data not given) was not influenced by the duration of post hatch feed deprivation.

DISCUSSION

The results of the present study indicated that the residual yolk was used up by chicks that had access to feed immediately after hatching. Yolk utilization was more rapid in the fed chicks than the fasted chicks, suggesting that transfer of yolk was facilitated by intestinal motility of fed chicks. Concomitant to the findings of the present study, Noy et al. (1996) reported more rapid utilization of yolk in the fed chicks than the fasted chicks. The phenomenon of partitioning of yolk utilization between the transport to circulation and small intestines in post-hatch chicks was affected by the absence of feed (Noy and Sklan, 2001). During embryonic development, though the transfer of nutrients from yolk is directed to circulation by endocytosis (Lambson, 1970), close to the hatch, the yolk is transported to intestine through yolk-stalk (Esteban et al., 1991; Noy et al., 1996). The activity of higher yolk utilization in fed chicks could be due to anti-peristaltic movement of yolk from yolk-stalk to the duodenum, which was perhaps stimulated by the presence of feed in the gut (Noy et al., 1996). Another important finding of the present study was faster utilization of yolk lipid by the fed chicks than the fasted chicks. Chicks with access to feed within 24 h of hatch-utilized lipid faster than those deprived of feed beyond 24 h. This observation was in line with the findings of Noble and Cocchi (1990). The findings of the present study also suggested that for the newly hatched chicks energy (but not the protein) could be a limiting nutrient and thus, they needed immediate source of external energy to sustain growth (Noy and Sklan, 2001).

Progression from embryonic state to independent life is aided by the chick's ability to digest and absorb nutrients from its feed. The liver, pancreas and small intestine developed rapidly after hatching, emphasizing their importance to the newly hatched chicks. The results of present study revealed that the development of gastrointestinal tract and organs was directly related to feed intake. During the immediate post-hatch growth period (0-72 h), the weight of proventiculus, gizzard, liver, pancreas and small intestine increased more rapidly in relation to body weight in the chicks fed immediately after hatch compared to those fasted for longer duration. This finding was in agreement with Maiorka et al. (2003) wherein the authors studied the effect of feed deprivation for 24, 48 and 72 h post hatch and suggested the need to feed chicks immediately after hatch to ensure proper development of gastrointestinal tract, liver and pancreas (Noy and Sklan, 2001). Similarly, birds that had access to feed immediately after hatch exhibited more rapid development of the intestine during immediate post-hatch period (Uni et al., 1998; Geyra et al., 2001).

Table 3. Effect of early feeding on body weight gain and feed conversion ratio of broiler chicken (0-5 wks)

Post-hatch feed deprivation (h)	Day old chick wt (g)	0-7 d		0-21 d		0-35 d	
		Body wt gain (g)	Feed conversion ratio	Body wt gain (g)	Feed conversion ratio	Body wt gain (g)	Feed conversion ratio
0	47.3	138^{a}	0.87^{a}	652^{a}	1.55	1,442^{a}	1.74^{b}
8	46.4	133^{ab}	0.88^{a}	653^{a}	1.44	1,429^{a}	1.90^{ab}
16	45.9	132^{ab}	0.86^{a}	652^{a}	1.45	1,432^{a}	1.88^{ab}
24	46.7	125^{b}	0.87^{a}	644^{a}	1.45	1,437^{a}	1.90^{ab}
32	45.8	121^{b}	0.92^{b}	627^{b}	1.43	1,367^{b}	1.90^{ab}
40	46.5	114^{bc}	0.94^{b}	626^{b}	1.41	1,363^{b}	1.94^{ab}
48	47.3	106^{c}	0.96^{b}	622^{b}	1.45	1,305^{c}	2.01^{a}
SEM	0.22	1.24	0.003	4.74	0.02	5.51	0.02
p value	NS	0.05	0.05	0.05	0.05	0.05	0.05

^{a,b,c} Means with different superscripts in a column differ significantly.

The extensive changes that occur in the morphological development of the gut at hatch include the differentiation of enterocytes and crypts, as well as the manifold enlargement of absorptive surface of the intestines. Early access to feed stimulates the growth of intestines and their absorptive capacity, as new enterocytes with digestive-absorptive capacity are generated from the crypts of Liberkuhn (Moran, 1985). Though, preferential growth of small intestine occurs in the presence and absence of feed, the absolute and relative growth of intestines remained slow in the absence of exogenous feed (Sklan, 2001). Similar findings were also observed in our study. It was further confirmed that broilers selected for higher growth rate needed exogenous feed soon after hatch, and its absence in the gut resulted in impaired development with consequence of poor functioning of small intestines. Thus, feed deprivation caused delay in morphological development and enterocyte maturation resulting in initial lower performance of broilers with possible repercussions on the final performance at market age (Geyra et al., 2001).

Results of the present study revealed that feed deprivation up to 24 h after hatch had a transient detrimental effect on growth of broiler chickens, as they needed 21 days for compensation of initial loss in growth. However, feed deprivation beyond 24 h (32-48 h) had a long-term adverse effect on growth of broiler chicken. Broiler chicks deprived of feed for 32-48 h after hatch could not compensate for the loss in growth even at marketable age. The feed conversion ratio (35 d) was also poorer in the birds those were deprived of feed for initial 48 h of hatch than those accessed to feed immediately. Previous experiments with newly hatched broiler chicks subjected to fasting for 6 to 96 h after placement showed a negative effect of fasting on the final performance at 35 d of age, particularly when fasting period was prolonged beyond 24 h (Noy and Sklan, 1998; Vieria and Moran, 1999; Gonzales et al., 2003; Madsen et al., 2004). Noy and Sklan (1999) fed chicks solid or semi-solid feed and a non-nutritional bulk substance (sawdust) within one hour of clearing the shell. Consumption of any of these materials increased body weight of chicks except the transient effect of saw dust and the small effect of water alone (Noy and Sklan, 1998). At marketing age, all birds that had early access to nutrients post-hatch were 8-10% heavier than those held without feed or just received water (Gonzales et al., 2003). In this study also, chicks fed immediately after hatch gained 10.5% more weight than those deprived of feed for 48 h.

Feed availability was essential to enhance body and muscle weight in neonate chicks and, it was reported that no compensatory growth was observed during the first 6 days of life to make up for the loss in body weight gain or muscle weight caused by early fasting, and similar findings were observed in the present study as well. Gonzales et al. (2003) reported that the level of growth recovery that occurred after a period of feed deprivation depended on the physiological status of the animal. When feed restriction was applied in early stages of the development, cell hyperplasia was impaired to remain irreversible during subsequent stage of life. Probably, this could be the reason that prolonged feed deprivation (32-48 h) in the newborn broiler chicks is harmful for growth.

In conclusion, our study revealed the significance of early post-hatch feeding (<24 h) on faster utilization of yolk sac nutrients, optimum development of intestines and organs culminating in better weight gain (>10.5%) of broilers at 5 weeks of age.

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