Effects of starter feeding time on body growth and viscera development of newly hatched chicks

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ABSTRACT

The experiment was conducted to investigate the effects of starter feeding time on body growth and viscera development of newly hatched chicks. A total of 1080 Yangzhou chicks with similar weight derived from 1800 eggs were selected in this experiment. These chicks were randomly assigned to six groups (1, 2, 3, 4, 5 and 6) according to six feeding schedules (fasting for 12, 24, 36, 48, 60, 72 hours posthatch), with 3 replicates per group and 60 chicks (30 males and 30 females) per replicate. After fasting, all birds were fed a crumbled starter feedstuff ad libitum until 6 days of age. At 0, 1, 2, 3, 4, 5 and 6d posthatch, eight chicks (4 males and 4 females) per replicate of each experimental group were randomly selected and individually weighed. Yolk sac, liver, heart, pancreas, bursal and small intestine of each chick were taken out and weighed; the length of small intestine, moreover, was measured. Results showed that food deprivation reduced body weight (BW) of experimental chicks; furthermore BW decreased more and more with a prolonged fasting time. At 6 d of age, the BW of the former five groups was higher than that of the Group 6 (P<0.05). At the same time, the growth of viscera apparatuses was influenced by different starter feeding times. There was a significant effect of fasting for 72h posthatch on BW, small intestine weight and length, liver, heart, pancreas and bursal weight. The viscera weights of the former three groups (fasting for 12-36h) were, respectively, more than that of latter three groups (fasting for 48-72h) in different ages (P<0.05). Results of the present study demonstrated that the feasible starter feeding time should be within 36h posthatch, and the maximum fasting period could not exceed 60h posthatch.

Key words: Chick, Starter feeding time, Viscera development, Growth performance.

RIASSUNTO

INIZIO DEll’ALIMENTAZIONe DEI PULCINI DOPO LA SCHIUSA:
INCREMENTO PONDERALE E SVILUPPO DELL’APPARATO DIGERENTE

L’esperimento è stato condotto al fine di determinare l’effetto dell’epoca di inizio dell’alimentazione sul l’incremento ponderale e sullo sviluppo dell’apparato digerente nei pulcini dopo la schiusa. Per la prova...
sperimentale sono stati scelti 1080 pulcini di razza Yangzhou, di peso omogeneo, derivanti da 1800 uova. Gli animali sono stati assegnati in maniera random a sei gruppi sperimentali (1, 2, 3, 4, 5 e 6) diversi per piano alimentare (digiuno per 12, 24, 36, 48, 60, 72 ore dopo la schiusa), con tre repliche per gruppo e 60 pulcini (30 maschi e 30 femmine) per replica. Dopo il digiuno gli animali sono stati alimentati ad libitum fino a 6 giorni di età con un mangime di avviamento sbriciolato. Ai giorni 0, 1, 2, 3, 4, 5, e 6 dopo la schiusa sono stati scelti a random 8 pulcini (4 maschi e 4 femmine) per ogni repliche di ciascun gruppo e pesati individualmente. Sono stati rilevati su ogni animale il peso del sacco vitellino e di fegato, cuore, pancreas e borsa di Fabrizio, nonché il peso e la lunghezza dell’intestino tenue.

I risultati evidenziano che il tempo di digiuno ha ridotto in maniera proporzionale il peso dei pulcini utilizzati nell’esperimento. Al 6° giorno di età il peso corporeo dei pulcini appartenenti ai primi 5 gruppi sperimentali è stato maggiore rispetto al 6° gruppo (P<0,05). Anche lo sviluppo dell’apparato digerente, rilevato al 6° giorno di età, è stato influenzato dalla diversa epoca di inizio dell’alimentazione. Il digiuno di 72 ore dopo la schiusa ha esercitato un’influenza significativa sul peso corporeo, su peso e lunghezza del piccolo intestino, su peso di fegato, cuore, pancreas e borsa di Fabrizio. Il peso dell’apparato digerente dei primi tre gruppi (che avevano osservato il digiuno per 12-36 ore) è stato significativamente più alto rispetto agli altri tre gruppi (digiuno di 48-72 ore) in ogni fascia di età considerata (P<0,05). I risultati dimostrano che l’alimentazione dovrebbe iniziare entro le 36 ore dopo la schiusa e che il tempo di digiuno non dovrebbe superare le 60 ore.

Parole chiave: Pulcini, Inizio alimentazione starter, Sviluppo dell’apparato digerente, Performance di accrescimento.

Introduction

The major aim of broiler breeding over the past 50 years has been to improve growth rate. The fast growth of broilers has resulted in reducing the rearing period necessary for broilers to reach the same live weight. Due to this continuous reduction, 1d of fasting corresponds to an ever increasing period in the lifetime of a chick. The first week following hatching currently represents nearly 20% of a broiler’s life; growth in the first few days, or even hours, is becoming an essential component of the efficient achievement of market body weight (Wolanski et al., 2006). Moreover, the chick’s weight at six and seven weeks of age has a linear relationship with their weight in the first week of rearing (Pezeshkian, 2002).

Chick growth before exogenous feeding depends on the nutritional elements absorbed from the residual yolk sac. This yolk, enclosed in the abdominal cavity, is the first nutrient source for the hatchlings. Early feeding after hatching, compared with delayed feeding, appears to stimulate yolk utilization (Noy and Sklan, 1998b; Speake et al., 1998). Early feeding can significantly affect early growth, leading to increased weight gains that persist through broiler production (Noy and Sklan, 1999b; Sklan and Noy, 2000; Henderson et al., 2008). In addition, early posthatch feeding is more important to the development of the gastrointestinal system. Early in development, the relative growth rate is the highest due to the marked increase in the weight of the gastrointestinal tract (Nitsan et al., 1991). However in hatchlings, development of the gastrointestinal tract and maturation of the secretion of digestive enzymes are impaired when feed is restricted (Noy and Sklan, 1999a; Sklan and Noy, 2000). Moreover, weight of 42 or 49-d-old birds subjected to some type of early posthatch feed restriction rarely equals those of birds fed ad libitum. Variations in environmental temperature, nutritional levels employed, amount of feed intake in the period after feed restriction, genetic line, sex and severity of restriction are some of the causes for the observed differences (Yu and Robinson, 1992). Recently,
more attention has been given to the effect of feeding time on performances of chicks, but the physiological basis remains to be elucidated (Noy and Pinchasov, 1993; Noy and Sklan, 1998a; Sklan and Noy, 2000; Bigot et al., 2001; Franco et al., 2006).

The aim of this experiment was to study the effects of starter feeding time on body growth through evaluation of viscera development in different starter feeding times during the first seven days posthatching of chicks.

**Material and methods**

**Experimental design and bird management**

A total of 1080 chicks with similar weight derived from 1800 eggs, produced by the same flock of Yangzhou Chicken breeders of 48 weeks of age, were selected in this experiment. After removal from the hatcher, chicks were winged-sexed, vaccinated for Marek’s and Gumboro diseases and transported to the experimental house. These chicks were randomly assigned to six groups (1, 2, 3, 4, 5 and 6) according to six feeding schedules (fasting for 12, 24, 36, 48, 60, 72 hours posthatch), with 3 replicates per group and 60 chicks (30 males and 30 females) per replicate.

Group 1 received feed and water 12h posthatch. The other groups received water, but were fed only 24, 36, 48, 60 or 72h posthatch. Afterward, all birds were fed a crumbled starter feedstuff formulated according to National Research Council (1994) recommendations *ad libitum* until 6 days of age.

Chicks were reared in a broiler experimental facility built to house up to 60 chicks per pen (12 birds/m²). During the total experiment period, birds received 24h of light and housing temperature was maintained at 32°C.

**Growth performance and yolk sac utilization**

At 0, 1, 2, 3, 4, 5 and 6d posthatch, eight chicks (4 males and 4 females) per replicate of each experimental group were randomly selected, individually weighed and euthanized by CO₂. Yolk sac, liver, heart, pancreas, bursal and small intestine of each chick were taken out and weighed; the length of small intestine was also measured.

**Statistical analysis**

The data were analyzed by one-way analysis of variance and linear regression. Statistical analysis was run on the SPSS software package (2003). Statements of significance were based on P<0.05 unless otherwise stated.

**Results**

**Growth and yolk sac resorption**

Food deprivation reduced the body weight (BW) of the experimental chicks; furthermore the BW decreased more and more with prolonged fasting time (Table 1). On the other hand, the BW of chicks increased after feeding. From 1 d to 6 d, there were distinct differences between the six groups. At 4d, the BW of the groups fed before 48h posthatch was more than that of those fed after 48h posthatch (P<0.05). On the 6 d of age, there were significant differences between the former five groups (fasting for 12-60h) and the latter group (fasting for 72h)(P<0.05).

After hatching, the yolk sac in chicks reduced continually. Furthermore, starter feeding made the yolk sac decrease faster. At 2 d of age, yolk sac weight of Groups 1 and 2 was lower than those of Groups 5 and 6 (P<0.05). Finally, at 6 d of age, yolk sac weight of the Group 1 was the lowest, and that of the Group 6 was highest, but there was no significant difference between them.
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Organ development

Intestinal Growth. The small intestine weight of the birds in all six groups increased continuously during the experiment. The earlier the feeding was given, the more rapidly the small intestine weight increased (Table 2). At 2 and 3 d of age, small intestine weights of the Groups 1 and 2 were more than those of the Groups 5 and 6. Later, at 5 d of age, small intestine weight of the Group 1 was the highest, while that of the Group 6 was the lowest (P<0.05).

Small intestine length of the all groups continuously increased over the course of the experimental period, even among the birds that fasted (Table 2). During the first two days, the increased rate of the 3, 4, 5 and 6 groups was slower than that of the former two groups (P<0.05). At 6 d of age, small intestine length of chicks in the former five groups was almost identical, while that of the 6 group was the shortest (P<0.05) (Table 2).

Other organ growth. The liver weight of the first three groups, fasting for 36 h posthatch, increased continuously, but that of the latter three groups improved slowly within the 3rd d of age. From the 4th d of age, the liver weight of chicks in Group 5 increased more rapidly than that of chicks in Group 6. As a result, the liver weight of Group 6 was significantly lower (P<0.05) than the others (Table 3).

The heart weight of all six groups showed a similar trend of the liver weight within the 3rd d of age. At 6 d of age, heart weights

Table 1. Effects of starter feeding time on body weight and yolk sac weight of chicks.

| Age | Body weight (g) | Yolk sac weight (g) |
|-----|-----------------|-------------------|
|     | 12h             | 24h               | 36h               | 48h               | 60h               | 72h               |
| 0d  | 41.2±1.2        | 41.2±1.2          | 41.2±1.2          | 41.2±1.2          | 41.2±1.2          | 41.2±1.2          |
| 1d  | 41.0±2.1        | 39.9±1.8          | 37.8±2.1          | 37.9±1.8          | 37.0±1.4          | 37.2±1.2          |
| 2d  | 41.5±2.1        | 41.2±3.2          | 40.5±1.3          | 38.1±2.2          | 35.5±2.0          | 35.2±1.1          |
| 3d  | 44.6±1.3        | 44.9±3.2          | 41.5±2.9          | 39.6±2.4          | 39.0±2.9          | 38.5±2.4          |
| 4d  | 47.7±4.9        | 46.6±4.3          | 47.0±6.7          | 43.3±2.7          | 44.6±4.6          | 39.0±2.2          |
| 5d  | 50.2±7.3        | 49.8±5.5          | 50.1±6.1          | 49.9±3.4          | 49.7±4.1          | 44.1±3.4          |
| 6d  | 53.3±6.5        | 51.9±5.7          | 51.1±4.2          | 50.5±5.4          | 50.3±3.7          | 45.8±2.1          |

\[a,b,c\] Means followed by different letters within the column are statistically different (P<0.05).
Effects of different chicks’ feeding time

The pancreas weight (Table 4) within the 3rd d of age showed that the earlier the chicks were fed, the heavier the pancreas was. In particular, the pancreas of Group 1, which was fed earlier, remained the heaviest within the 3rd d of age, while the pancreas weight of the 4, 5 and 6 groups was always lower. After the 3 d of age, the pancreas weight of Group 5 increased rapidly and tended to reach that of the former four experimental groups. Although the pancreas weight of animals of Group 6 increased too, it remained significantly lower than that of the other groups (P<0.05).

Discussion

The birds with early access to feed had improved growth performance (Noy and Sklan, 1999a; Batal and Parsons, 2002). The beneficial effect of early feeding of chicks posthatch on growth performance was...
Yang et al. also observed in the present experiment. It could easily be established that when the fasting time was more than 60h posthatch, BW, small intestine length, liver weight, pancreas weight and bursal weight were lower than those of the former five groups (fasting for 12-60h) on the 6th day. On the other hand, liver weight, heart weight, pancreas weight and bursal weight of the former three groups (fasting for 12-36h) were, respectively, more than those of latter three groups (fasting for 48-72h) at different ages. Thus it could be concluded that the maximum fasting period should not exceed 60h posthatch, and the feasible feeding time should be within 36h posthatch.

In fact, postponing feeding not only affects the BW of the birds but also affects viscera development. A variety of reports had demonstrated (Gonzales et al., 2003; Saki, 2005) that delayed feeding retarded maturation of systems that began developing after hatching. This was particularly evident in the digestive and metabolic system, including liver, pancreas and other viscera.

The initial growth of chicks after hatching was concentrated on viscera development and viscera growth all along whether the birds were fed or not. In addition, the growth rate of viscera was more rapid than that of the body. Furthermore, even if BW of chicks declined, the viscera weight increased all the while, especially the small intestine (Figures 1). In addition, from the change of organ to body weight ratio (%BW), it was easy to find that the growth of the

| Table 3. Effects of starter feeding time on liver and heart weight of chicks. |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Age | Liver weight (g) | Heart weight (g) |
| 12h | 24h | 36h | 48h | 60h | 72h | 12h | 24h | 36h | 48h | 60h | 72h |
| 0d | 0.945±0.077 | 0.945±0.077 | 0.945±0.077 | 0.945±0.077 | 0.945±0.077 | 0.945±0.077 | 0.248±0.053 | 0.248±0.053 | 0.248±0.053 | 0.248±0.053 | 0.248±0.053 | 0.248±0.053 |
| 1d | 1.079±0.086 | 1.151±0.094 | 1.103±0.045 | 1.132±0.035 | 1.095±0.105 | 1.123±0.085 | 0.282±0.068 | 0.282±0.057 | 0.266±0.024 | 0.255±0.037 | 0.251±0.068 | 0.241±0.084 |
| 2d | 1.319±0.144b | 1.382±0.186a | 1.273±0.153a | 1.209±0.131b | 1.116±0.111b | 1.169±0.084b | 0.309±0.081a | 0.295±0.058a | 0.293±0.039a | 0.265±0.032b | 0.256±0.031b | 0.261±0.038b |
| 3d | 1.333±0.093a | 1.405±0.165a | 1.328±0.127a | 1.292±0.174b | 1.293±0.231b | 1.192±0.109b | 0.311±0.056a | 0.304±0.062a | 0.333±0.051a | 0.293±0.069b | 0.291±0.055b | 0.288±0.026b |
| 4d | 1.547±0.154a | 1.491±0.222b | 1.506±0.260b | 1.436±0.216c | 1.509±0.219b | 1.218±0.269d | 0.340±0.199 | 0.329±0.086 | 0.366±0.087 | 0.324±0.056 | 0.331±0.063 | 0.322±0.041 |
| 5d | 1.732±0.369 | 1.609±0.244 | 1.659±0.235 | 1.578±0.315 | 1.637±0.115 | 1.311±0.199 | 0.379±0.059 | 0.369±0.134 | 0.390±0.095 | 0.354±0.081 | 0.373±0.034 | 0.347±0.045 |
| 6d | 1.835±0.480a | 1.693±0.275a | 1.672±0.205a | 1.632±0.189a | 1.689±0.245a | 1.431±0.241b | 0.424±0.086a | 0.413±0.092a | 0.411±0.109a | 0.419±0.124a | 0.398±0.039b | 0.389±0.062b |

*a,b,c,d* Means followed by different letters within the column are statistically different (P<0.05).
pancreas and bursal was prominent after hatching in addition to the intestine. That is to say, the digestive and the immune systems were much more important to newly hatched chicks.

In the immediate posthatch period, yolk was used for maintenance (Anthony et al., 1989) and for intestinal growth (Noy and Sklan, 1999a). This requirement possibly led birds to use their body reserves to supply the nutritional requirement for survival, which resulted in body weight reduction. According to the research, late administration of feed to the chicks, such as group 6 chicks, caused a negative effect on performance at 6 d posthatch due to an inadequate use of the yolk sac, which seemed to be related to inadequate development of the gastrointestinal tract (Kuhn et al., 1996; Noy and Sklan, 1998b, 2001). The fact that the broiler chicks did not grow very well during the first week of life would result in negative effects until the end of their rearing (Uni and Ferket, 2004).

The results also showed that the yolk weight of early fed chicks decreased more rapidly than that of the later fed birds. It seemed that the presence of exogenous material in the gastrointestinal tract stimulated release of yolk through the yolk stalk and the development of the gastrointestinal tract. In addition, the peristaltic movements of the intestine might also have enhanced the secretion of yolk into the intestine. What is more, these intestinal

| Age | Pancreas weight (g) | Bursal weight (g) |
|-----|---------------------|-------------------|
|     | 12h | 24h | 36h | 48h | 60h | 72h | 12h | 24h | 36h | 48h | 60h | 72h |
| 0d  | 0.038±0.007 | 0.038±0.007 | 0.038±0.007 | 0.038±0.007 | 0.038±0.007 | 0.038±0.007 | 0.051±0.037 | 0.051±0.037 | 0.051±0.037 | 0.051±0.037 | 0.051±0.037 | 0.051±0.037 |
| 1d  | 0.087±0.028 | 0.093±0.029 | 0.087±0.012 | 0.080±0.035 | 0.074±0.015 | 0.071±0.085 | 0.061±0.086 | 0.058±0.094 | 0.054±0.035 | 0.052±0.012 | 0.053±0.005 | 0.055±0.024 |
| 2d  | 0.135±0.059 | 0.125±0.042 | 0.115±0.029 | 0.098±0.034 | 0.091±0.016 | 0.081±0.015 | 0.163±0.031 | 0.152±0.063 | 0.136±0.041 | 0.109±0.037 | 0.114±0.042 | 0.112±0.031 |
| 3d  | 0.209±0.079 | 0.192±0.052 | 0.183±0.063 | 0.186±0.038 | 0.185±0.039 | 0.127±0.026 | 0.238±0.074 | 0.232±0.078 | 0.253±0.205 | 0.239±0.056 | 0.245±0.062 | 0.189±0.040 |
| 4d  | 0.309±0.087 | 0.305±0.066 | 0.308±0.042 | 0.300±0.087 | 0.308±0.055 | 0.201±0.029 | 0.309±0.087 | 0.305±0.066 | 0.308±0.042 | 0.300±0.087 | 0.308±0.055 | 0.201±0.029 |

a,b,cMeans followed by different letters within the column are statistically different (P<0.05).
movements resulted in increased amounts of yolk ingested in the proximal small intestine after hatching. Studies reported that the presence of solid exogenous material could improve the growth performance whether the material is nutritional or non nutritional (Noy and Sklan, 1999a).

In a commercial hatchery, the average starter feeding time is between 24h and 36h posthatch. So the chicks that hatched early would remain in a hatcher until the time when a large portion of the eggs had hatched. During this period, early hatched chicks, having no food and water, were in an adverse condition because of the prolonged fasting period and potential dehydration (Tweed, 2005). Once the hatchling was pulled, other procedures such as sex determination and sorting, vaccinations, comb dubbing and transport were performed which further increased the fasting period (Batal and Parsons, 2002). According to the research, the chicks should be fed when they reached the farm, in any case, within 60 hours posthatch.

**Conclusions**

The results obtained in this experiment prompt the following considerations:

- BW, small intestine length, liver weight, pancreas weight and bursal weight were lower than those of the former five groups (fasting for 12-60h) when the fasting time was more than 60h posthatch;
- BW, liver weight, heart weight, pancreas weight and bursal weight of the former three groups (fasting for 12-36h) were, respectively, more than those of latter three groups (fasting for 48-72h) at different ages;
- according to BW and viscera growth, it could be concluded that the maximum fasting period should not exceed 60h posthatch, and the feasible feeding time should be within 36h posthatch.

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