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Effect of Post-hatch Nutrient Intubation on Performance, Intestinal Growth, Meat Yield and Immune Response in Broiler Chickens

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ABSTRACT : The response of broiler chicks to intubation of nutrients (starch, casein, soybean oil or their combinations) into the crop immediately after hatch was evaluated for performance, intestinal development, meat yield and immune competence up to 35 d of age. A control group with no access to feed and two test groups fed either inert material (sawdust) or starter diet for the initial 24 h after hatch were compared with nutrient intubated groups (n = 7). A total of 300 broiler chicks were equally distributed to 10 dietary groups with 6 replicates of 5 chicks each. After 24 h of hatch, all groups were fed *ad libitum* the starter (0-21 d) and finisher diets (22-35 d). Results indicated that post-hatch intubation of starch into the crop significantly ($p\leq 0.05$) improved body weight (at 14 and 35 d of age), ready-to-cook meat yields, weights of breast muscle and small intestine segments, cell-mediated immune response, ND titers and weight of bursa compared to chicks starved or fed sawdust during the initial 24 h after hatch. However, chicks with access to feed immediately after hatch or intubation of starch, soybean oil, starch+casein, starch+soybean oil or starch+casein+soybean oil exhibited similar positive effects. Intubation of casein either alone or in combination with soybean oil was superior to the starved or sawdust fed groups, but inferior to other groups for all the parameters studied. It was concluded from the study that intubation of starch individually or in combination with casein and/or soybean oil effectively circumvented the negative effects of post-hatch starvation for 24 h. Among the nutrients intubated, carbohydrate (starch) was better utilized by the chicks than protein (casein) or fat during the initial post-hatch period.
(**Key Words :** Post-hatch Nutrient Intubation, Performance, Intestinal Growth, Meat Yield, Immune Response, Broiler Chickens)

INTRODUCTION

The importance of early feeding of newly hatched chicks on their performance was adequately demonstrated by several studies (Jin et al., 1998; Noy and Sklan, 1999; Madsen et al., 2004). However, in commercial poultry operations chicks hatch over two days and are transferred from the hatcher when majority of them have hatched. Following the release of chicks, they are vent sexed, vaccinated, boxed and transported to farms. Thus, in practice, newly hatched chicks spend substantial time without access to feed or water (48-72 h), causing poor viability and slow growth (Madsen et al., 2004). Delayed feeding was found to be the main factor affecting growth in broiler chicken (Pinchasov, 1991). In a study conducted by Noy and Sklan (1999), it was observed that post-hatch deprivation of feed and water for 48 h reduced body weight of broilers by 7.8% over those fed immediately after hatch. In neonate broilers, minimizing the post-hatch holding time and providing early access to feed is desirable to initiate not only growth, but also the development of intestines (Moran, 1985), pancreas (Jin et al., 1998) and immune system (Madsen et al., 2004). It was therefore, hypothesized that if nutrients could be intubated into crop, it may stimulate the growth of gastrointestinal tract even during the transportation of chicks from hatchery to farm, since feeding chicks in transit may not be practically possible. Studies conducted earlier examined the beneficial effects of a single nutrient supplementation/intubation, particularly that of carbohydrate because yolk sac is rich in fat and protein (Noy and Pinchasov, 1993; Vieira and Moran Jr, 1999; Sklan, 2003). However, in the current study starch, casein and fat representing carbohydrate, protein and fat sources, respectively and their combinations were intubated into the crop of chicks soon after hatch, and compared with those starved for 24 h or fed inert material (saw dust) considering parameters related to performance, intestinal growth, meat yield and immune response.

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MATERIALS AND METHODS

Stocks and experimental design

Broiler chicks (300) of either sex procured from a cross of synthetic broiler lines were used in this study. They were weighed individually, wing banded and vaccinated (Marek's disease vaccine) in the hatchery and transported immediately to the nearby biological shed without any loss of time. The chicks were randomly distributed to 10 test groups with 6 replicates of 5 each, and housed in battery brooders in open sided sheds. Each unit of battery brooder had three tiers with 2 cells of equal dimensions (60 cm×75 cm×45 cm for 5 chicks) per tier. Necessary care was taken to maintain equal number of males and females in each dietary group. Incandescent lights were used to maintain brooder temperature initially at 34±1°C up to 7 d of age and gradually reduced to 26±1°C by 21 d, after which the chicks were maintained at room temperature. The treatments considered were: i) no feed for 24 h ii) feed offered immediately after placement iii) inert material (saw dust) iv) intubation of starch (S-0.8 ml) v) casein (C-0.6 ml) (nutrients mixed with de-ionized water, 50:100 wt/vol.) vi) soybean oil (SO-0.4 ml) and their combinations as vii) S+C viii) S+SO ix) C+SO and x) S+C+SO. A constant level of metabolizable energy (1.7 kcal/chick) was administered to chicks in all the seven test groups by regulating the quantity of nutrients and intubated into the crop using an automatic repeating pipette. The ME values considered for starch, casein and soybean oil, respectively were 4.3, 5.86 and 8.5 kcal/g. After 24 h, each of the test groups received *ad libitum* starter (0-21 d) and finisher (22-35 d) mash diets, which respectively contained 2,900 kcal ME/kg with 22% CP and 3,000 kcal ME/kg with 20% CP (Table 1). The proximate composition of starter and finisher diets was estimated (AOAC, 1995).

Table 1. Ingredient and nutrient composition of experimental diets (%)

Ingredient	Starter (0-21 d)	Finisher (22-35 d)
Maize	56.22	58.42
Soybean meal	38.60	35.62
Dicalcium phosphate	1.88	1.62
Shell grit	0.72	0.68
Salt	0.30	0.40
DL-methionine	0.21	0.20
Choline chloride 50%	0.10	0.06
Vegetable oil	1.62	2.66
Vitamin premix[x]	0.05	0.04
Mineral premix[x]	0.10	0.10
Toxin binder	0.20	0.20
Nutrient composition		
ME (kcal/kg)[1]	2,900	3,000
Protein (%)[2]	21.96	20.04
Lysine (%)[1]	1.21	1.07
Methionine (%)[1]	0.53	0.50
Av. phosphorous (%)[2]	0.46	0.42
Calcium (%)[2]	0.91	0.84

[x] Supplies per kg diet: Vitamin A, 16,500 IU; vitamin D_3, 3,200 ICU; vitamin E, 12 mg; vitamin K, 2 mg; vitamin B_1, 1.2 mg; vitamin B_2 10 mg; vitamin B_6, 2.4 mg; vitamin B_{12}, 12 μg; niacin, 18 mg; pantothenic acid, 12 mg; Mn, 90 mg; Zn, 72 mg; Fe, 60 mg; Cu, 10 mg; I, 1.2 mg.
[1] Calculated composition.
[2] Estimated composition.

Parameters measured

Performance parameters : Individual body weights of broilers were recorded after release of the hatch, after 3, 7, 10, 14, 21 and 35 d of age. Feed intake was recorded replicatewise at the end of 21 and 35 d. The average feed consumption of each replicate was calculated based on the number of survival days. The ratio between feed intake and weight gain was determined to report the feed conversion efficiency (FCR).

Carcass traits : At the end of 35 d, one bird representing the mean body weight of each replicate was fasted over night and sacrificed by cervical dislocation. They were dressed for recording the weights of ready-to-cook yield, giblets (liver, heart and gizzard), abdominal fat pad and breast meat. The composition of breast meat for moisture, protein, fat (AOAC, 1995) and serum cholesterol (Zlatkis et al., 1953) was estimated. The weights of bursa and spleen were recorded. The small intestine segments namely the duodenum; jejunum and ileum were separated and weighed after the 3rd and 21st d to examine the influence of post-hatch dietary treatments on their growth.

Immune response

The *in vivo* cell mediated immune (CMI) response to phytohaemagglutinin-P (PHA-P) was studied at 18 d of age. The thickness of web between 3 and 4 inter digital space of left and right feet was measured using micrometer. The web of right foot was injected with 100 μg of PHA-P suspended in 0.1 ml of phosphate buffer saline (PBS), while the left foot (control) was injected with 0.1 ml of PBS. The web swelling was measured in both feet after 24 h of injection. The cell mediated response was determined by subtracting the skin thickness of first measurement from the second and the values of left from right foot (Corrier and De Loach, 1990). Further, the humoral immune (HI) response was determined by inoculating 0.5 ml sheep red blood cells (SRBC-0.5%) intravenously at 15 d of age, and the antibody titers were measured after 5 d of post-inoculation by collecting blood from brachial vein and following the micro-titer haemagglutination method (Wegmann and Smithies, 1966). The weights of lymphoid organs (bursa and spleen) were recorded from the sacrificed birds at the end of experimental period and expressed as percent live weight. The mangemental practices adapted in this study were in conformity with the norms of Institute Ethical Committee.

Statistical analysis

Data collected on various parameters were subjected to one-way analysis of variance in a completely randomized design as per the methods of Snedecor and Cochran (1989). The mean values of treatments were compared ($p\leq0.05$) using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Growth at different age intervals

The body weight of broiler chicks varied during the entire experimental period due to post-hatch intubation of nutrients (Table 2). Chicks offered saw dust instead of nutrients, gained significantly ($p\leq0.05$) higher weight at 3 d of age compared to those deprived of feed for 24 h post-hatch. However, the chicks starved of feed or provided sawdust during the initial 24 h recorded similar body weights at 7 d, but were significantly ($p\leq0.05$) lower than all other groups at 7, 10 and 14 d of age. The chicks intubated with casein (C) or casein+soybean oil (C+SO) were significantly ($p\leq0.05$) heavier at the end of 7, 10 and 14 d of age than the birds starved initially or offered saw dust, but lower than rest of the groups. The same trend in growth continued up to 35 d of age. The final growth pattern in different test groups showed that the birds offered no feed or fed saw dust were inferior to C or C+SO< feed, S, SO, S+C, S+SO and S+C+SO. These findings were consistent with the studies that administered solutions of glucose, starch and soybean oil to chicks after hatch (Moran, 1990; Noy and Pinchasov, 1993), suggesting that intubation of nutrients was as effective as offering feed immediately after hatch for consistently promoting growth up to 35 d of age, while feeding inert material had only a transient effect. In the present study, enhanced growth performance due to intubation of nutrients can be attributed to early stimulation of the digestive system (Noy and Pinchasov, 1993), early secretion of enzymes (Noy and Sklan, 1997) or the synergetic effect of both (Vieira and Moran, 1999). It was also observed that C alone or in combination with SO did not provide the same advantage in growth as that of other nutrient groups, indicating that protein utilization in chicks was limited during early post-hatch period. When carbohydrate was fed in combination with fat, significantly ($p\leq0.05$) better growth was produced than the combination of fat and protein, implying that carbohydrate was better utilized than fat during initial post-hatch period (Moran, 1990). However, the feed conversion efficiency was not altered at the end of 21 or 35 d of age due to post-hatch intubation of nutrients.

Meat yield measures

Post-hatch intubation of one or more nutrients significantly ($p\leq0.05$) enhanced the average weight of ready-to-cook yield and breast meat of broiler chickens at 35 d of age compared to birds deprived of feed or fed starvation or offering saw dust during the initial 24 h after hatch (Table 3). Chicks deprived of feed or offered saw dust during the first 24 h post-hatch failed to achieve the ready-to- cook meat yield and breast meat equivalent to those fed nutrients/feed early (Wyatt et al., 1985; Nir and Levanon, 1993; Noy and Sklan, 1997). It was possible that early nutrient inadequacies resulted in decreased growth of skeletal muscle and broilers could not compensate for the loss in growth that occurred during early stage (Vieira and Moran, 1999). However, the weights of giblet and

Table 2. Effect of single post-hatch intubation of nutrients on body weight (g) of broiler chicks at different time intervals up to 14 d of age

Nutrients offered	0-d	3-d	7-d	10-d	14-d
No feed (24 h)	44.4	56.9^{d}	111^{c}	169^{c}	253^{c}
Starter feed	44.9	80.2^{a}	140^{a}	210^{a}	295^{a}
Saw dust	44.7	64.9^{c}	110^{c}	171^{c}	259^{c}
Starch (S)	44.7	77.0^{a}	139^{a}	208^{a}	299^{a}
Casein (C)	44.7	73.9^{b}	124^{b}	188^{b}	278^{b}
Soybean oil (SO)	43.8	78.7^{a}	136^{a}	214^{a}	297^{a}
S+C	44.9	76.3^{b}	137^{a}	208^{a}	295^{a}
S+SO	45.2	78.2^{a}	138^{a}	211^{a}	298^{a}
C+SO	44.9	70.1^{a}	125^{b}	186^{b}	276^{b}
S+C+SO	44.3	78.1^{a}	140^{a}	209^{a}	292^{a}
SEM	0.28	1.81	1.57	2.25	2.91

$^{a\text{-}d}$ Means within a column carrying the same superscripts were not statistically significant ($p\leq0.05$).

Table 3. Influence of single post-hatch intubation of nutrients on body weight, FCR (feed intake/ weight gain), weight of ready-to-cook yield (RC %), breast muscle (%), giblet and abdominal fat (%) in broilers at 35 d of age

Nutrient offered	Body weight (g)	FCR	R-C yield	Breast muscle	Giblets	Abd.fat
No feed (24 h)	1,261^{c}	2.06	72.3^{b}	14.3^{b}	5.13	1.81
Starter feed	1,442^{a}	2.04	73.5^{a}	15.4^{a}	5.26	1.60
Saw dust	1,241^{c}	2.04	71.9^{b}	14.2^{b}	5.11	1.65
Starch (S)	1,428^{a}	2.00	73.6^{a}	15.5^{a}	5.29	1.60
Casein (C)	1,349^{b}	1.98	73.6^{a}	15.2^{a}	5.18	1.46
Soybean oil (SO)	1,464^{a}	1.98	73.3^{a}	15.5^{a}	5.15	1.67
S+C	1,438^{a}	1.97	73.7^{a}	15.4^{a}	5.15	1.66
S+SO	1,433^{a}	2.01	73.5^{a}	15.3^{a}	5.25	1.60
C+SO	1,353^{b}	1.96	73.4^{a}	15.3^{a}	5.30	1.68
S+C+SO	1,423^{a}	1.99	73.8^{a}	15.3^{a}	5.25	1.58
SEM	9.85	0.03	0.23	0.18	0.11	0.12

$^{a-c}$ Means within a column carrying the same superscripts were not statistically significant ($p\leq0.05$).

abdominal fat did not vary with post-hatch feeding or intubation of nutrients. The composition of breast muscle showed that the percent water (75.98-76.38±0.22), protein (19.88-20.10±0.22), fat (2.68-2.78±0.08) and cholesterol (70.29-72.24±1.04 mg/100 g) contents was relatively uniform in all the dietary groups and post-hatch feeding or intubation of nutrients did not influence the composition of meat.

Weight of small intestine segments

Growth of duodenum, jejunum and ileum was evaluated on the basis of their weights at 3 and 21 d of age. Chicks intubated with nutrients into the crop or offered access to feed or saw dust soon after hatch significantly ($p\leq0.05$) improved the weight of small intestine segments at 3 d of age compared to those starved during initial 24 h period (Figure 1). The percent weight of duodenum (1.78), jejunum (2.84) and ileum (2.90) calculated over body weight was significantly ($p\leq0.05$) poor at 3 d of age in chicks deprived of post-hatch feed for 24 h, compared to those offered saw dust, feed, carbohydrate, protein or fat. However, the percent weight of duodenum (2.01-2.05), jejunum (3.14-3.25) and ileum (3.18-3.26) did not differ significantly among the groups that were fed initially, irrespective of the nature of nutrient offered. Feeding sawdust produced transient mechanical stimulation of the GI tract, which could not last for 21 d. Development of gastro-intestinal tract plays an important role in the growth

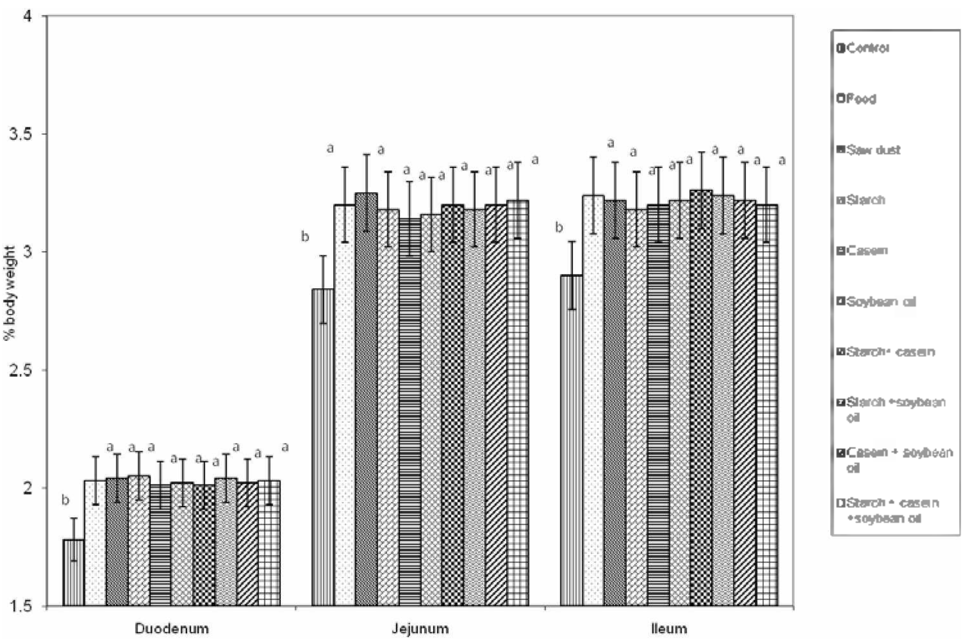

Figure 1. Effect of single post hatch intubation of nutrients on growth of small intestinal segments. $^{a-b}$ Means carrying the same superscripts were not statistically significant ($p\leq0.05$).

Table 4. Effect of post-hatch intubation of nutrients on cell mediate immune (CMI) response to PHA-P (thickness index), humoral immunity (HI-antibody titers-log_2), ND titers and weight of spleen and bursa (% live weight) in broilers at 5 weeks of age

Nutrient offered	CMI response to PHA-P injection	HI response to SRBC inoculation	ND titers	Spleen weight	Bursa weight
No feed (24 h)	0.31[b]	6.16	3,898[b]	0.13	0.05[b]
Starter feed	0.53[a]	6.66	4,020[a]	0.17	0.14[a]
Saw dust	0.34[b]	6.83	3,884[b]	0.17	0.06[b]
Starch (S)	0.51[a]	6.50	4,014[a]	0.15	0.12[a]
Casein (C)	0.53[a]	6.83	4,028[a]	0.16	0.16[a]
Soybean oil (SO)	0.55[a]	6.66	4,014[a]	0.14	0.16[a]
S+C	0.53[a]	6.50	4,018[a]	0.16	0.16[a]
S+SO	0.52[a]	6.50	4,022[a]	0.15	0.14[a]
C+SO	0.56[a]	7.33	4,034[a]	0.16	0.16[a]
S+C+SO	0.54[a]	6.50	4,038[a]	0.16	0.15[a]
SEM	0.04	0.13	10.24	0.01	0.01

[a-b] Means within a column carrying the same superscripts were not statistically significant ($p\leq0.05$).

of chick during early stages (Nir et al., 1996) because immediate access to nutrients stimulated the production of digestive enzymes (Noy and Pinchasov, 1993). Post-hatch deprivation of feed for 24 h delayed the development of jejunum (Bigot et al., 2003). Similar findings were also recorded in our study.

Immune response

Deprivation of feed or offering of saw dust for 24 h after hatch significantly ($p\leq0.05$) reduced the CMI response to PHA-P, HI response to ND vaccine and bursa weight compared to all other nutrients tested (Table 4). Dibner (1999) reported that restricting the availability of nutrients during early life affected the development of immune system, which was also seen in our findings. It was observed that fasting chicks stimulated the secretion of corticosteroids, which inhibited the immune cell proliferation resulting in low immune response (Dibner et al., 1998). Appropriate nutrition and access to exogenous nutrients immediately after hatch accelerated the development of immune system. However, in our study the antibody titers to SRBC inoculation and weight of spleen were not affected by feed deprivation for initial 24 h, though numerically they were inferior to other groups. Feeding saw dust instead of starter diet did not support CMI response to PHA-P, antibody titer to ND vaccination and weight of bursa, just as the chicks under initial starvation. Intubation of nutrients into crop or offering feed soon after hatch produced higher ($p\leq0.05$) CMI response, antibody titer to ND vaccination and weight of bursa over the former two groups. Direct access to feed and intubation of nutrients exhibited similar immune response and growth of bursa.

The present study revealed that post-hatch intubation of starch improved the final body weight by 11.7% over the birds starved initially for 24 h. Access to feed or intubation of nutrients immediately after hatch exhibited similar effect on growth, leading to higher ready-to-cook yield, breast weight, initial intestinal weight and better immune response. Individually intubation of starch was as effective as its own combination with casein and soybean oil, and better than casein. It appeared that broiler chicks utilized carbohydrate (starch) better than fat while protein utilization was relatively poor.

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