Do broiler chicks possess enough growth potential to compensate long-term feed and water depravation during the neonatal period?

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Abstract

Broiler performance to the end of the rearing period may be negatively influenced by delayed access to feed and water immediately after hatch. This study was conducted with 320 Ross 308 broiler chicks, to evaluate the influence of delayed access to feed and water during the neonatal period (0, 16, 32 and 48 h) on performance and gastrointestinal (GIT) growth. The experiment was conducted as a complete randomized design (four replicate, each with 20 chicks). The results showed that extending post-hatch deprivation of feed and water had a significant negative impact on bird performance. Broilers deprived for 48 h had lower body weights, average daily gains and feed intakes compared to the control and to a lesser extent to the other treatments. Average daily gain, daily feed intake and feed conversion ratio were mostly significantly affected by feed and water deprivation regimens during the first week of the rearing period. At marketing age, the negative impact of severe feed and water deprivation on the birds' performance was substantially decreased, though birds with a 48 h delayed access to feed and water had lower average daily gains and feed intakes compared to the control. Birds mortality rate (%) was not affected by feed and water deprivation during the neonatal period. The results also indicated that the relative weights of the jejunum, ileum and liver of birds getting access to feed and water only at 48 h after arrival were significantly lower when compared to the other groups. The broiler carcass characteristics, abdominal fat percentage at 42 days of age, and gastrointestinal measurements at 21 and 42 days of age were not influenced by the different treatments. In conclusion, the results of this experiment confirmed that immediate access to feed and water after placement will ensure the optimal performance of broiler chicks at market age, and that broiler chicks do not have enough potential to fully compensate for growth retardation caused by long-term deprivation of feed and water during the neonatal period.

Keywords: Broiler, fasting, feed deprivation, gastrointestinal, performance

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Introduction

Body weight gains of broiler chickens have been improved substantially during the last decades. Consequently, modern broiler chicks are able to increase their weight approximately 50 fold within 40 days of hatching (Noy & Sklan, 1998; Sklan, 2003). It has been shown that relying solely on residual yolk as a nutrient source in the first 24 - 72 h would appear to waste valuable resources and produce less than optimum production results (Dibner *et al*., 1998). On the other hand, appropriate nutrition and access to feed and water close to hatching not only stimulate development of the gastrointestinal and immune system, but also increase the absorption surface area and thus enhance nutrient assimilation. This contributes to muscle growth and finally results in performance benefits well after the neonatal feeding period (Dibner *et al*., 1998; Noy & Sklan, 1998; Vieira & Moran, 1999).

Under practical conditions, 48 or more hours could pass from hatching until placement when chicks can gain full access to feed and water. During this deprivation period, chicks may lose weight at an approximate rate of 7.8% in 48 h due in part to moisture loss as well as yolk utilization (Noy & Sklan, 1999).

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Recent studies (Noy & Sklan, 1998; 2002; Sklan, 2003; Uni *et al.*, 2003) demonstrated that the immediate access of birds to feed and water during this critical period increases subsequent performance in both chicks and poults via different mechanisms, including improved nutritional maturity of the bird, stimulation of yolk sac utilization, increased intestinal development and long-term metabolic effects.

Little research has been undertaken on the long-term effects of feed and water deprivation during the neonatal period on broiler performance up to marketing age. On the other hand, assessment of ability of broiler chicks to compensate short-term delayed access to feed and water is critical for broiler farm managers. Therefore, the objective of this experiment was to evaluate the effects of delayed access to feed and water for up to 48 hours on broiler chick performance.

Materials and Methods

Three hundred and twenty day-old Ross 308 broiler chicks were obtained from a local commercial hatchery approximately two hours after clearing from the shell. The birds were of mixed sex with approximately the same ratio of males to females. The age of the broiler breeder flock was 32 weeks. The study was carried out at the Animal Science Department of the University of Kurdistan, Kurdistan, Iran. The birds were transported to the facility within 30 min. Chicks were randomly allocated to four treatments so that the mean weight of each group was approximately the same. Each treatment was replicated four times (20 chicks per pen) in a complete randomized design. The chicks were housed throughout the experiment on floor pens (1.25 × 1.4 m) containing wood shavings. Light was provided continuously for the first day

Table 1 Composition (g/kg) and calculated analysis of basal diets

	Growth periods		
	Starter	Grower	Finisher
Ingredient			
Maize	572.9	603.1	660.1
Soyabean meal	347.9	299.1	246.0
Fish meal	30.0	30.0	30.0
Soyabean oil	14.6	34.8	32.7
Dicalcium phosphate	11.5	12.0	11.7
$CaCo_3$	11.9	9.5	9.3
Salt	3.1	3.1	3.0
Vitamin premix[1]	2.5	2.5	2.5
Mineral premix[2]	2.5	2.5	2.5
L-Lysine	1.7	1.9	1.4
DL-Methionine	1.5	1.5	0.7
Calculated nutrient content			
ME (MJ/kg)	12.18	12.87	13.08
Crude protein (g/kg)	222	203	184
Met+cys (g/kg)	8.8	8.5	7.6
Methionine (g/kg)	5.3	5.2	4.6
Lysine (g/kg)	13.3	12.1	10.2
Calcium (g/kg)	9.7	8.8	8.5
Non-phytate P (g/kg)	4.4	4.4	4.2

[1] Provides per kg of diet: 9000 I.U. vitamin A; 2000 I.U. vitamin D_3; 18 I.U. vitamin E; 2 mg menadion; 1.8 mg thiamine; 6.6 mg riboflavin; 30 mg niacin; 3 mg pyridoxin; 15 mcg vitamin B_{12}; 100 mg D-pantothenic acid; 1 mg folic acid; 0.1 mg biotin; 500 mg choline chloride; 100 mg antioxidant.

[2] Provides per kg of diet: 100 mg manganese; 84.7 mg zinc; 50 mg iron; 10 mg copper; 1 mg iodine; 0.2 mg selenium.

post hatching, after which a 23L : 1D lighting schedule was maintained for the duration of the experiment. Temperature was maintained between 30 and 32 °C at the beginning of the rearing period and was gradually decreased every two to three days to 22 °C at the end of the rearing period. In this experiment the chicks were fed a maize- soyabean meal diet *ad libitum* (Table 1). The feed was provided at different times post-hatch, *viz*. immediate access to feed and water, or 16, 32 and 48 h delayed access to feed and water; assigned as treatments. Care and management of the chicks were in accordance with commercial guidelines and protocol approved by the ethical committee for animal experimentation of the University of Kurdistan.

The maize-soyabean meal-based starter (up to 21 d), grower (22 - 35 d) and finisher (36 - 42 d) diets were formulated to meet or exceed the requirements of NRC (1994) for all nutrients (Table 1). The experiment was conducted for 42 d. Birds were weighed as a group on arrival. At 11, 16, 21, 28, 35 and 42 days of age, all birds were weighed by pen, and feed intake was recorded at the same time for the determination of the feed conversion ratio (FCR) per pen. Mortality was recorded daily and feed consumption data were corrected for body weight of mortality. Average body weight, daily gain and FCR were determined for each period and for the overall experiment. At 3, 21 and 42 days of age four birds from each treatment were selected randomly for assessment of gastrointestinal development. These chicks were weighed, killed by cervical dislocation and the abdominal cavity was opened. The yolk sac (at 3 d), proventriculus, gizzard, liver and small intestine were separated, and the weights of the yolk sac, liver (without gallbladder), proventriculus, pancreas and gizzard (after digesta removal) were recorded and their weights (%) relative to body weight were determined. At 42 days of age, the carcass characteristics (percentage of processed and unprocessed carcass, breast, thighs, drums, abdominal fat) of four birds, which had been used for gastrointestinal measurements, were determined.

Data were analyzed according to General Linear Model (GLM) procedure of SAS (SAS institute, 2001) as a CRD experiment. Significant differences among treatments were determined at $P < 0.05$ by Duncan's new multiple range tests.

Results and Discussion

Table 2 The effect of post-hatch delayed access to feed and water on live weight and average daily gain in broiler chicks

SEM	Delayed access (h) to feed and water				
	48	32	16	0	
				Body weight (g)	
0.287	38.1	38.2	37.4	38.3	0 d
6.000	138.3^{c}	168.9^{b}	177.5^{b}	197.6^{a}	11 d
9.419	245.9^{c}	290.0^{b}	301.8^{ab}	329.7^{a}	16 d
13.289	416.8^{b}	480.0^{a}	490.8^{a}	529.0^{a}	21 d
19.834	767.6^{b}	860.5^{ab}	862.5^{ab}	923.7^{a}	28 d
26.403	1257.6^{b}	1341.8^{ab}	1385.3^{ab}	1450.4^{a}	35 d
33.531	1787.1^{b}	1904.2^{ab}	1966.3^{ab}	1994.3^{a}	42 d
				Average daily gain (g)	
0.588	8.7^{c}	11.6^{b}	12.5^{b}	14.4^{a}	1 – 11 d
0.817	21.5	24.2	24.9	26.4	12 - 16 d
1.048	32.8	36.3	37.9	39.8	17 – 21 d
1.690	70.2	78.1	74.3	78.9	22 - 28 d
1.412	70.0	69.5	74.7	75.2	29 – 35 d
1.430	75.7	76.4	83.0	77.7	36 - 42 d
0.758	17.2^{b}	20.0^{ab}	21.7^{a}	23.4^{a}	1 – 21 d
1.248	70.1	73.8	74.5	77.1	22 - 35 d
1.025	41.3^{b}	43.5^{ab}	47.2^{a}	47.9^{a}	1 – 42 d

a-c: Mean values within a row with no common superscripts differ significantly ($P < 0.05$).

The results of the present study are summarized in Tables 2 to 6. The results showed that the average body weight of the birds at 11, 16, 21, 28, 35 and 42 days of age was significantly (P <0.05) influenced by time of access to feed and water (Table 2). The chicks that had access to feed and water immediately after arrival at the experimental facility had higher body weights compared with the birds fasted for 48 h. The adverse effects of long-term feed and water deprivation (48 h) at post-hatch on the live weight of the birds were still evident at marketing age (42 d). However, the birds with shorter periods of feed and water deprivation (up to 32 h), were capable of gaining enough weight during the rest of rearing period to compensate for the early growth retardation. The results also indicated that the effects of feed and water deprivations on average daily gain of the birds were significant (P <0.05) during 1 - 11, 1 - 21 and 1 - 42 days of age. Feed and water deprivation also influenced average daily feed intake (P <0.05) during 1 - 11, 1 - 21 and 1 - 42 days of age, where chicks with immediate access to feed and water had higher feed consumption rates during these growth periods. Feed conversion ratio was only significantly (P <0.05) influenced by delayed access to feed and water on placement during the first week of age.

Table 3 The effect of post-hatch delayed access to feed and water on average daily feed intake, feed conversion ratio and mortality rate in broiler chicks

SEM	Delayed access (h) to feed and water				
	48	32	16	0	
			Average daily feed intake (g)		
0.850	14.8[c]	18.9[b]	21.1[a]	23.0[a]	1 - 11 d
1.616	34.5	37.1	39.3	41.6	12 – 16 d
2.084	55.7	59.5	63.0	64.2	17 - 21 d
2.186	121.2	129.2	128.6	135.2	22 – 28 d
2.568	126.2	119.4	134.1	136.3	29 - 35 d
2.263	152.1	157.0	163.1	160.1	36 – 42 d
1.137	28.6[b]	32.3[ab]	35.2[a]	37.0[a]	1 - 21 d
2.085	123.7	124.3	131.4	135.8	22 – 35 d
1.750	78.0[b]	80.1[ab]	88.4[a]	88.8[a]	1 - 42 d
			Feed conversion ratio (g/g)		
0.019	1.16[b]	1.24[ab]	1.30[a]	1.28[a]	1 – 11 d
0.046	1.57	1.55	1.58	1.58	12 - 16 d
0.033	1.69	1.64	1.67	1.62	17 – 21 d
0.019	1.73	1.67	1.74	1.72	22 - 28 d
0.025	1.80	1.72	1.80	1.82	29 – 35 d
0.026	2.27	2.24	2.25	2.27	36 - 42 d
0.026	1.43	1.41	1.51	1.47	1 – 21 d
0.018	1.77	1.69	1.77	1.76	22 - 35 d
0.012	1.89	1.84	1.88	1.86	1 – 42 d
				Mortality (%)	
1.00	1.25	1.25	0.00	0.00	0 – 7 d
2.224	5.00	5.00	1.25	1.25	0 - 42 d

[a-b] Mean values within rows with no common superscripts differ significantly (P <0.05).

The results of the present experiment showed that absolute and relative weight of residual yolk sac to body weight at three days of ages were not influenced (P >0.05) by duration of feed and water deprivation (Table 4). However, as shown in Table 5, relative weight (%) of the jejunum, ileum and liver at three days of ages significantly (P <0.05) decreased by extending the duration of feed and water deprivation. The negative

Table 4 The effect of delayed access to feed and water on absolute and relative weight of residual yolk to body weight in broiler chicks at day 3

SEM	Delayed access (h) to feed and water				
	48	32	16	0	
1.99	42.5	45.6	45.9	50.5	Body weight (g)
					Residual yolk
0.133	1.52	1.04	1.44	1.66	Absolute weight (g/bird)
0.007	0.037	0.023	0.031	0.033	Relative weight (g/100 g)

Table 5 The effect of delayed access to feed and water on relative weight (g/100 g) of small intestinal segments to body weight in broiler chicks

SEM	Delayed access (h) to feed and water				
	48	32	16	0	
					Duodenum
0.076	1.51	1.69	1.65	1.70	3 d
0.058	1.66	1.55	1.71	1.53	21 d
0.056	0.60	0.62	0.62	0.56	42 d
					Jejunum
0.162	1.48^{b}	2.09^{a}	2.47^{a}	2.26^{a}	3 d
0.204	2.54	2.54	2.38	2.74	21 d
0.070	1.23	1.13	1.26	1.17	42 d
					Ileum
0.095	1.11^{b}	1.60^{a}	1.61^{a}	1.69^{a}	3 d
0.185	1.77	1.78	1.86	1.86	21 d
0.072	1.06	0.89	1.00	0.90	42 d
					Liver
0.258	3.43^{c}	4.94^{a}	3.82^{b}	4.16^{ab}	3 d
0.204	3.46	2.82	2.72	2.97	21 d
0.120	2.36	2.21	2.42	2.22	42 d
					Pancreas
0.014	0.51	0.45	0.46	0.47	3 d
0.025	0.53	0.49	0.51	0.45	21 d
0.023	0.23	0.25	0.25	0.20	42 d
					Proventriculus
0.069	0.92	1.12	1.09	1.06	3 d
0.004	0.76	0.72	0.74	0.70	21 d
0.038	0.43	0.42	0.43	0.37	42 d
					Gizzard
0.422	8.92	8.67	9.24	9.23	3 d
0.239	4.67	4.60	4.94	4.58	21 d
0.132	2.23	2.31	2.30	2.27	42 d

a-b - Mean values within a row and under each main effects with no common superscripts differ significantly (P <0.05).

effects of lag of access to feed and water on relative weight (%) of aforementioned organs disappeared at 21 and 42 days of age. The results also indicate that relative weight of the duodenum, pancreas, proventriculus and gizzard at 3, 21, and 42 d of age were not affected by feed and water deprivation. The broiler carcass relative weights (breast, thighs and drums) and abdominal fat percentage were not significantly affected by time of access to feed and water (P >0.05) at 42 days of age (Table 6).

Table 6 The effect of post-hatch delayed access to feed and water on carcass characteristics (%) in broiler chicks at 42 days

SEM	Delayed access (h) to feed and water				
	48	32	16	0	
1.58	87.4	85.2	86.1	85.0	Unprocessed carcass[1]
1.65	73.2	71.1	72.3	70.9	Processed carcass
1.17	22.6	21.1	21.8	22.7	Breast
0.60	13.3	12.0	13.5	13.3	Thighs
0.279	9.67	9.53	9.68	9.42	Drums
0.110	1.62	1.82	1.83	1.69	Abdominal fat

[1] Processed carcass equals the sum of all parts excluding abdominal cavity contents.

The results of this experiment are in agreements with previous findings (Noy & Sklan, 1998; Corless & Sell, 1999; Noy & Sklan, 1999; Batal & Parsons, 2002), that the extended deprivations from feed and water during the first hours of arrival at the farm have long-term adverse effects on the performance of birds even up to market weight. Batal & Parsons (2002) have indicated that an early access to nutrients triggers the growth process and results in considerable performance benefits. The results of the present experiment also demonstrated that feed and water deprivation have adverse effects on bird performance, which is mainly mediated via retardation of feed intake rather than disturbances in feed utilization ability. Noy & Pinchasov (1993) indicated that broiler chicks with delayed access to feed and water for 24 h post-hatch had a lower feed consumption up to 40 d of age. Corless & Sell (1999) also reported that 30 and 54 h delayed placement in poults decreased cumulative 28 d feed consumption compared with 6 h delay placement. These findings are also in agreement with reports claiming that appropriate nutrition and access to feed close to hatch can accelerate growth performance of broiler chicks via different mechanisms such as gastrointestinal development, increase absorptive surface area and thus enhance nutrient assimilation, contribute to muscle growth and finally result in increased marketing performance (Uni *et al*., 1998; Noy & Sklan, 1999; Moore *et al*., 2005).

Conclusions

The results of this experiment indicate that providing neonatal chicks with an appropriate mix of essential macro and micro nutrients as soon as possible, is essential for development of supplying organs such as the gastrointestinal tract. Without proper development of supplying organs during earlier days of life, the growth of broiler chicks would suffer significantly from insufficient absorption of essential nutrients to meet growing requirements of demanding organs such as muscles in the most important period of lifespan with the highest potential for growth. However, the broiler chicks posed an amazing ability to recover in gastrointestinal development at 21 and 42 days of ages from the negative impact of early moderated feed and water deprivation. However, they needed more time to fully compensate from the reduced growth rate in the earlier part of the growth period due to feed and water deprivation, to a comparable level in birds subjected to a moderate deprivation period or earlier access to feed and water. Since broiler chicks need longer periods of time to fully recover from such a long-term deprivation from feed and water, it is recommended to avoid severe shortage in supplying feed and water during the neonatal period. More research is needed to

determine the separate effects of water or feed deprivation on the gastrointestinal development, performance and also carcass chemical composition of broiler chicks.

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References

Batal, A.B. & Parsons, C.M., 2002. Effect of fasting versus feeding Oasis after hatching on nutrient utilization in chicks. Poult. Sci. 81, 853-859.

Corless, A.B. & Sell, J.L., 1999. The effects of delayed access to feed and water on the physical and functional development of the digestive system of young turkeys. Poult. Sci. 78, 1158-1169.

Dibner, J., Knight, C.D. & Ivey, F.J., 1998. The feeding of neonatal poultry. Wrld's Poult. Sci. J. 14, 36-40.

Moore, D.T., Ferket, P.R. & Mozdziak, P.E., 2005. Early post-hatch fasting induces satellite cell self-renewal. Comparative Biochemistry and Physiology-Part A: Molecular & Integrative Physiology 142, 331-339.

NRC, 1994. Nutrient Requirements of Poultry. 9th rev. ed. National Academy Press, Washington D.C., USA.

Noy, Y. & Pinchasov, Y., 1993. Effect of a single posthatch intubation of nutrients on subsequent early performance of broiler chicks and turkey poults. Poult. Sci. 72, 1861-1866.

Noy, Y. & Sklan, D., 1998. Metabolic responses to early nutrition. J. Appl. Poult. Res. 7, 437-451.

Noy, Y. & Sklan, D., 1999. Energy utilization in newly hatched chicks. Poult. Sci. 78, 1750-1756.

Noy, Y. & Sklan, D., 2002. Nutrient use in chicks during the first week posthatch. Poult. Sci. 81, 391-399.

SAS, 2001. Statistical Analysis Systems user's guide: Version 8.02 Edition. SAS Institute, Inc., Cary, N.C., USA

Sklan, D., 2003. Fat and carbohydrate use in posthatch chicks. Poult. Sci. 82, 117-122.

Uni, Z., Ganot, S. & Sklan, D., 1998. Posthatch development of mucosal function in the broiler small intestine. Poult. Sci. 77, 75-82.

Uni, Z., Smirnov, A. & Sklan, D., 2003. Pre- and posthatch development of goblet cells in the broiler small intestine: effect of delayed access to feed. Poult. Sci. 82, 320-327.

Vieira, S.L. & Moran Jr, E.T., 1999. Effects of egg of origin and chick post-hatch nutrition on broiler live performance and meat yields. Wrld's Poult. Sci. J. 55, 125-142.