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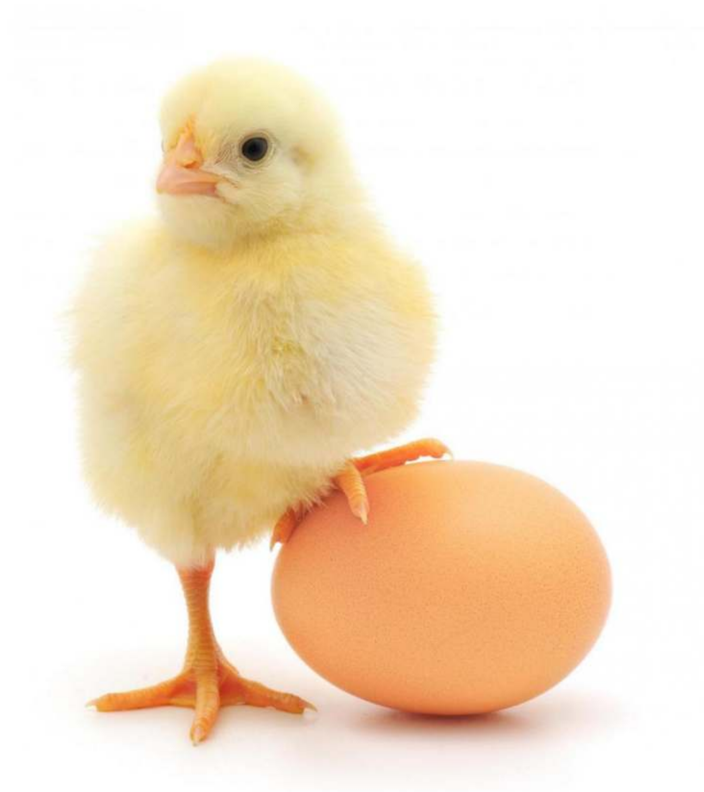

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Effect of Time of Initiation of Feeding after Hatching and Influence of Dietary Ascorbic Acid Supplementation on Productivity, Mortality and Carcass Characteristics of Ross 308 Broiler Chickens in South Africa

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Abstract: An experiment was conducted to evaluate the effect of time of initiation of feeding after hatching and influence of dietary ascorbic supplementation during realimentation on productivity, carcass characteristics and mortality of Ross 308 broiler chickens. The study was a factorial arrangement in a complete randomized design. Six hundred and seventy five unsexed Ross 308 broiler chickens with an initial weight of 32±2 g per bird were assigned to 15 treatments in a 3 (times of initiation of feeding) x 5 (ascorbic acid supplemental levels) factorial arrangement with three replications, each having 15 birds each. The experimental diets were isocaloric and isonitrogenous but with different ascorbic acid supplementation levels. Ascorbic acid supplementation started three days after hatching. More than 50% of the birds died between one and three days of age when initiation of feeding after hatching was above 36 hours. Time of initiation of feeding above 36 hours of hatching resulted in lower ($p<0.05$) live weight between one and three days of old. However, the birds 'caught-up' within ten days of realimentation. This compensatory growth could be explained in terms of increased efficiency of growth. Thereafter, ascorbic acid supplementation during realimentation lowered ($p<0.05$) mortality rate and improved ($p<0.05$) growth rates and live weight irrespective of time of initiation of feeding after hatching. Growth rate and live weight increased incrementally with increasing levels of ascorbic acid supplementation within each time of initiation of feeding after hatching in comparison with those without ascorbic acid supplementation at 21 day of age and continued until 42 days of age. Similarly, increasing ascorbic acid supplementation within each time of initiation of feeding after hatching increased dressing percentage and breast meat yield at 42 days old. However, ascorbic acid supplementation had no effect ($p>0.05$) on feed intake of the bird's irrespective of time of initiation of feeding after hatching. It is concluded that time of initiation of feeding above 36 hours after hatching is not desirable, mainly because of its effect on mortality. However, the beneficial effect of ascorbic acid supplementation could be exploited in reducing mortality rate and improving growth rates in broiler chickens subjected to delayed initiation of feeding after hatching.

Key words: Ascorbic acid supplementation, growth rate, Mortality, Ross 308 broiler chickens, time of initiation of feeding

Introduction

Food restriction consists of limiting the level of consumption of a food in time, quantity, quality or reducing the hours of illumination of feeding (Religious *et al.*, 2001). This practice is used for a reduction in carcass fat content and improvement in food utilization (Plavnik and Hurwitz, 1985), as well as for a reduction in pathological disorders associated with early rapid growth due to selection and genetic breeding such as ascites and ostoprosis (Acar *et al.*, 1995; Jones, 1995; Sanchez *et al.*, 2000). However, the period between final stage of embryonic development and first days of life in the broiler chickens is made up of a complex and sensitive stage of digestive, physiological and immune system maturation. Feed restriction during this period may significantly affect the bird's growth and livability (Dibner *et al.*, 1998). Incidentally, in Limpopo province, farmers receive chicks late, sometimes two days or more after hatching thus subjecting the chicks to delayed initiation of feeding after hatching. Often, the reason for long delivery times is as a result of distance from the hatcheries to the rearing facilities. This leaves the residual yolk sac as the only source of nutrients for the chicks during this period (Dibner *et al.*, 1998). In order not to jeopardize the development of the chick, the best preliminary practice would be to stimulate the initial growth so that the bird can express all its muscular growth potential, digestive and immunizing capacities (Fanguy *et al.*, 1980). This first stage of initial stimulation relates to, in particular, the time of initiation of feeding after hatching. Thus, the effect of time of initiation of feeding after hatching in Limpopo province and elsewhere requires further evaluation.

After hatching, the broiler chicks are exposed to environmental, pathological and nutritional stresses. Supplementation with exogenous nutrients such as ascorbic acid provides benefits to growing chicks (Pardue and Thaxton, 1986). It has been observed that

Table 1: Treatments indicating initiation of feeding (hours after hatching) and ascorbic acid supplementation (ppm/kg feed) during the starter phase

Treatment	Feed	Feed initiation	Ascorbic acid suppl.
ST_0C_0	Starter	1-24	0
ST_0C_1	Starter	1-24	100
ST_0C_2	Starter	1-24	200
ST_0C_3	Starter	1-24	300
ST_0C_4	Starter	1-24	1000
ST_1C_0	Starter	36-48	0
ST_1C_1	Starter	36-48	100
ST_1C_2	Starter	36-48	200
ST_1C_3	Starter	36-48	300
ST_1C_4	Starter	36-48	1000
ST_2C_0	Starter	48-60	0
ST_2C_1	Starter	48-60	100
ST_2C_2	Starter	48-60	200
ST_2C_3	Starter	48-60	300
ST_2C_4	Starter	48-60	1000

Table 2: Treatments indicating initiation of feeding (hours after hatching) and ascorbic acid supplementation (ppm/kg feed) during the grower phase

Treatment	Feed	Feed initiation (hours after hatching)	Ascorbic acid suppl. (ppm / kg feed)
GT_0C_0	grower	1-24	0
GT_0C_1	grower	1-24	100
GT_0C_2	grower	1-24	200
GT_0C_3	grower	1-24	300
GT_0C_4	grower	1-24	1000
GT_1C_0	grower	36-48	0
GT_1C_1	grower	36-48	100
GT_1C_2	grower	36-48	200
GT_1C_3	grower	36-48	300
GT_1C_4	grower	36-48	1000
GT_2C_0	grower	48-60	0
GT_2C_1	grower	48-60	100
GT_2C_2	grower	48-60	200
GT_2C_3	grower	48-60	300
GT_2C_4	grower	48-60	1000

ascorbic acid supplementation enhanced productivity, immune responses and survivability under nutritional stress (Zulkifli *et al.*, 1996). However, there are other studies indicating no significant beneficial effects of ascorbic acid supplementation in nutritionally stressed chickens (Puron *et al.*, 1994). It is, therefore, important to ascertain such responses in broiler chickens under different times of initiation of feeding after hatching. Such information would be very beneficial to poultry farmers in rural areas of Limpopo province and elsewhere.

The main objective of this study was to determine the effect of time of initiation of feeding after hatching and influence of dietary ascorbic acid supplementation during realimentation on productivity, mortality and carcass characteristics of Ross 308 broiler chickens.

Materials and Methods

Study site: This study was conducted in 2006 in an open-sided house with curtains at the Experimental farm of the University of Limpopo, Limpopo Province, South Africa. The farm is located at about 10 km northwest of the University campus. The ambient temperatures around the study area are above 32°C during summer and around 25°C or lower during the winter season. The mean annual rainfall is between 446.8 and 468.4 mm.

Birds, treatments, design and data collection: Day old Ross 308 broiler chicks were used in the study. They were purchased from South Africa Chicks Hatchery in Pretoria. On arrival, 675 unsexed day old Ross 308 broiler chicks were allocated to 15 treatments (Table 1 and 2) with three replications in a 3 (initiation of feeding after hatching) x 5 (supplemental ascorbic acid levels) factorial arrangement in a complete randomized design (SAS, 2000). Fifteen chicks were used in each replication. Ascorbic acid supplementation started 72 hours post-hatching. At each stage of the experiment, diets were isocaloric and isonitrogenous except for ascorbic acid and time of initiation of feeding after hatching. Otherwise, the birds were offered feed and fresh water ad-libitum. The daily lighting program was 24 hours. The experiment was terminated when the birds were 42 days of age.

The initial live weights of the chickens were taken at 24 hours old and every 12 hours thereafter until they were 72 hours old. Thereafter, daily mean live weights and feed intake were measured until the end of the experiment. Daily growth rates and feed conversion ratio were calculated. However, 24 to 36 hours feeding period was not chosen in order to allow for a longer variation in time of initiation of feeding after hatching hence the choice of 36 to 48 hours feeding period (Table 1 and 2). Mortality was measured throughout the experiment. At Days 36 to 42, four birds were randomly selected from each replication and transferred to metabolic cages for measurement of apparent digestibility. At 42 days old, all remaining birds were slaughtered by cervical dislocation to determine the carcass characteristics.

Nutrient analysis: Dry matter, crude protein, lysine, calcium, phosphorus and fat contents were determined as described by AOAC (2000). The Gross Energy (GE) of the diets and excreta samples were determined using an adiabatic bomb calorimeter (University of Kwazulu-Natal Laboratory, South Africa). The Apparent Metabolizable Energy (AME) content of the diets was calculated (AOAC, 2000).

Data analysis: Effect of time of initiation of feeding after hatching and influence of dietary ascorbic acid supplementation on live weight, feed intake, feed conversion ratio, digestibility, carcass characteristics and mortality were analyzed using the General Linear Models (GLM) procedures of statistical analysis of variance (SAS, 2000). Tukey test for multiple comparisons was used to test the significance of

Table 3: Nutrient composition of the starter diet (Units are in g/kg DM except energy as MJ/kg DM and DM as g / kg feed)

			Nutrient composition				
Treatment	DM	Energy	Protein	Fat (min)	Phosphorus	Calcium	Lysine
ST_0C_0	880	16.6	220	25	6	12	11
ST_0C_1	880	16.6	220	25	6	12	11
ST_0C_2	880	16.6	220	25	6	12	11
ST_0C_3	880	16.6	220	25	6	12	11
ST_0C_4	880	16.6	220	25	6	12	11
ST_1C_0	880	16.6	220	25	6	12	11
ST_1C_1	880	16.6	220	25	6	12	11
ST_1C_2	880	16.6	220	25	6	12	11
ST_1C_3	880	16.6	220	25	6	12	11
ST_1C_4	880	16.6	220	25	6	12	11
ST_2C_0	880	16.6	220	25	6	12	11
ST_2C_1	880	16.6	220	25	6	12	11
ST_2C_2	880	16.6	220	25	6	12	11
ST_2C_3	880	16.6	220	25	6	12	11
ST_2C_4	880	16.6	220	25	6	12	11

[1]*Composition of vitamin premix supplied per kilogram of diet: vitamin A 7714 IU; cholecalciferol 2204 IU; vitamin E 16.53 IU; vitamin B12 0.013 mg; riboflavin 6.6 mg; niacin 39 mg; pantothenic acid 10mg; menadione 1.5 mg; folic acid 0.9 mg; choline 1040mg; thiamin 1.54 mg pyridoxine 2.76 mg; d-biotin 0.066 mg; ethoxyquin 125 mg; selenium 0.1 mg; [2]*Composition of Trace mineral premix supplied per kilogram of diet: Mn 100mg; Zn 100 mg; Fe 50 mg; Cu 10 mg; iodine 0.50 mg

Table 4: Nutrient composition of the grower diet (Units are in g/kg DM except energy as MJ/kg DM and DM as g / kg feed)

			Nutrient composition				
Treatment	DM	Energy	Protein	Fat (min)	Phosphorus	Calcium	Lysine
ST_0C_0	880	16.6	200	25	6	12	11.5
ST_0C_1	880	16.6	200	25	6	12	11.5
ST_0C_2	880	16.6	200	25	6	12	11.5
ST_0C_3	880	16.6	200	25	6	12	11.5
ST_0C_4	880	16.6	200	25	6	12	11.5
ST_1C_0	880	16.6	200	25	6	12	11.5
ST_1C_1	880	16.6	200	25	6	12	11.5
ST_1C_2	880	16.6	200	25	6	12	11.5
ST_1C_3	880	16.6	200	25	6	12	11.5
ST_1C_4	880	16.6	200	25	6	12	11.5
ST_2C_0	880	16.6	200	25	6	12	11.5
ST_2C_1	880	16.6	200	25	6	12	11.5
ST_2C_2	880	16.6	200	25	6	12	11.5
ST_2C_3	880	16.6	200	25	6	12	11.5
ST_2C_4	880	16.6	200	25	6	12	11.5

[1]*Composition of vitamin premix supplied per kilogram of diet: vitamin A 7714 IU; cholecalciferol 2204 IU; vitamin E 16.53 IU; vitamin B12 0.013 mg; riboflavin 6.6 mg; niacin 39 mg; pantothenic acid 10mg; menadione 1.5 mg; folic acid 0.9 mg; choline 1040mg; thiamin 1.54 mg pyridoxine 2.76 mg; d-biotin 0.066 mg; ethoxyquin 125 mg; selenium 0.1 mg; [2]*Composition of Trace mineral premix supplied per kilogram of diet: Mn 100mg; Zn 100 mg; Fe 50 mg; Cu 10 mg; iodine 0.50 mg

differences between treatment means ($p<0.05$) (SAS, 2000). Regression analysis was used to determine the relationships between times of initiation of feeding after hatching, live weight and mortality of the broiler chickens (SAS, 2000).

Results

The nutrient compositions of the starter and grower diets are presented in Table 3 and 4. The diets at each phase (i.e. starter and grower phases) were isocaloric and isonitrogenous but with different levels of ascorbic acid supplementation. Levels of other nutrients of the diets were similar. Results of the effect of time of initiation of feeding after hatching on live weight and feed intake at three days old and mortality of Ross 308 broiler chickens between one and three days of age are presented in Table 5. Broiler chickens on initiation of feeding within 1 to 24 hours after hatching weighed and ate more ($p<0.05$) than those on initiation of feeding within 36 to 48 hours and those within 48 to 60 hours after hatching. Mortality was also lower ($p<0.05$) in broiler chickens on initiation of feeding within 36 hours after hatching than those on initiation of feeding above 36 hours after hatching. However, broiler chickens on initiation of feeding within 36 to 48 hours and those within 48 to 60 hours after hatching had similar ($p>0.05$)

Table 5: Effect of time of initiation of feeding after hatching on live weight at 3 days old (g/bird), feed intake (g/bird/day) at 3 days old and mortality (%) between 1 and 3 days of age of Ross 308 broiler chickens

Treatment	Live weight	Intake	Mortality
ST_0C_0	71^a	39^a	10^b
ST_0C_1	74^a	38^a	14^b
ST_0C_2	70^a	37^a	10^b
ST_0C_3	75^a	39^a	10^b
ST_0C_4	71^a	36^a	14^b
ST_1C_0	53^b	16^b	45^a
ST_1C_1	52^b	15^b	48^a
ST_1C_2	51^b	14^b	52^a
ST_1C_3	50^b	15^b	57^a
ST_1C_4	52^b	15^b	57^a
ST_2C_0	40^b	10^b	57^a
ST_2C_1	39^b	9^b	52^a
ST_2C_2	40^b	9^b	48^a
ST_2C_3	37^b	11^b	55^a
ST_2C_4	38^b	10^b	49^a
SE	3.25	3.58	5.69

^{ab}:Means in the same column not sharing a common superscript are significantly different ($p<0.05$), SE: Standard error

Table 6: Prediction of mortality and live weight at three days old from time of initiation of feeding after hatching (T) in Ross 308 broiler chickens

Factor	Y = variable	Formula	r	Probability
T	Mortality	$Y = 3.10T+17$	0.963	0.173
T	Live weight	$Y = 16.70T+87.6$	-0.991	0.085

Table 7: Effect of time of initiation of feeding after hatching and ascorbic acid supplementation during "catch up" period on intake (g/bird/day), intake as % of live weight and feed conversion ratio (FCR) of Ross 308 broiler chickens following realimentation

Treatment	Days of 'catch-up' following suppl*	Intake	Intake as a% of live weight	FCR
ST_0C_0	-	27	25	2.1
ST_1C_0	7	28	25	2.0
ST_2C_0	7	28	25	2.3
ST_0C_1	-	26	23	2.1
ST_1C_1	7	26	23	2.0
ST_2C_1	7	27	25	2.2
ST_0C_2	-	28	25	2.3
ST_1C_2	7	24	22	2.1
ST_2C_2	7	28	25	2.3
ST_0C_3	-	26	23	2.2
ST_1C_3	7	24	22	2.2
ST_2C_3	7	29	26	2.2
ST_0C_4	-	28	24	2.2
ST_1C_4	7	24	22	2.0
ST_2C_4	7	28	26	2.1
SE		1.31	0.86	0.10

SE: Standard error, *ST_0C_0, ST_0C_1, ST_0C_2, ST_0C_3 and ST_0C_4 had similar body weights at 3 days old

live weight and feed intake at three days of age and similar ($p>0.05$) mortality between one and three days of age.

Table 6 presents a series of linear regressions that predict mortality and live weight of Ross 308 broiler chickens at 3 days of age after hatching. Mortality was positively and strongly correlated ($r = 0.963$) with time of initiation of feeding after hatching. Live weight was negatively and strongly correlated ($r = -0.991$) with time of initiation of feeding after hatching. Time of initiation of feeding after hatching and ascorbic acid supplementation during 'catch-up' period had no effect ($p>0.05$) on intake per bird, intake as% of live weight and feed conversion ratio of Ross 308 broiler chickens (Table 7). The 'catch-up' period for all the treatments was 7 days irrespective of time of initiation of feeding after hatching and ascorbic acid supplementation. Time of initiation of feeding after hatching had no effect ($p>0.05$) on growth rate, feed conversion ratio and mortality of Ross 308 broiler chickens between 3 and 21 days of age (Table 8). Similarly, time of initiation of feeding after hatching and ascorbic acid supplementation had no effect ($p>0.05$) on feed intake within each period of feeding of Ross 308 broiler chickens. Within each period of initiation of feeding after hatching, increasing ascorbic acid supplementation increased growth rates, improved feed conversion ratio and reduced mortality rates of Ross 308 broiler chickens. Time of initiation of feeding after hatching had no effect ($p>0.05$) on live weight of Ross 308 broiler chickens at 21 days of age (Table 8). Similarly, time of initiation of feeding after hatching and ascorbic acid supplementation had no effect ($p>0.05$) on feed intake of Ross 308 broiler chickens. However, ascorbic acid supplementation increased ($p<0.05$) live weight of Ross 308 broiler chickens at 21 days of age. Time of initiation of feeding after hatching had no effect ($p>0.05$) on live weight, growth rate, feed intake, feed conversion ratio

Table 8: Effect of time of initiation of feeding after hatching and ascorbic acid supplementation on live weight (g/bird/day) at 21 days old, growth rate (g/bird/day), feed intake (g/bird/day), feed conversion ratio (FCR) and mortality (%) of Ross 308 broiler chickens between 3 and 21 days of age

Treatment	Live weight	Growth rate	Intake	FCR	Mortality
ST_0C_0	338^e	16^e	54	3.3^a	33^a
ST_0C_1	415^d	20^d	48	2.4^b	0^b
ST_0C_2	580^c	29^c	52	1.7^c	0^b
ST_0C_3	752^b	37^b	49	1.2^d	0^b
ST_0C_4	1093^a	57^a	48	0.8^e	0^b
ST_1C_0	333^e	16^e	54	3.4^a	31^a
ST_1C_1	421^d	21^d	49	2.3^b	0^b
ST_1C_2	578^c	29^c	52	1.7^c	0^b
ST_1C_3	755^b	39^b	49	1.2^d	0^b
ST_1C_4	1110^a	59^a	49	0.8^e	0^b
ST_2C_0	336^e	15^e	54	3.4^a	40^a
ST_2C_1	422^d	20^d	49	2.3^b	0^b
ST_2C_2	580^c	29^c	52	1.7^c	0^b
ST_2C_3	757^b	39^b	49	1.2^d	0^b
ST_2C_4	1113^a	59^a	49	0.8^e	0^b
SE	11.97	0.77	1.89	0.65	4.32

^{abcde}: Means in the same column not sharing a common superscript are significantly different ($p<0.05$), SE: Standard error

Table 9: Effect of time of initiation of feeding after hatching and ascorbic acid supplementation on live weight and feed intake (g/bird/day) at 42 days old, growth rate (g/bird/day), feed conversion ratio (FCR) and mortality (%) of Ross 308 broiler chickens between 22 and 42 days of age

Treatment	Live weight	Growth rate	Intake	FCR	Mortality
GT_0C_0	1042^e	33^e	171	5.1^a	0
GT_0C_1	1217^d	38^d	158	4.1^b	0
GT_0C_2	1548^c	48^c	164	3.5^c	0
GT_0C_3	1892^b	54^b	152	2.7^d	0
GT_0C_4	2642^a	75^a	148	1.9^e	0
GT_1C_0	1055^e	34^e	172	5.1^a	0
GT_1C_1	1229^d	38^d	158	4.1^b	0
GT_1C_2	1547^c	46^c	164	3.5^c	0
GT_1C_3	1899^b	54^b	152	2.7^d	0
GT_1C_4	2642^a	74^a	147	1.9^e	0
GT_2C_0	1054^e	34^e	172	5.1^a	0
GT_2C_1	1229^d	38^d	158	4.1^b	0
GT_2C_2	1547^c	46^c	164	3.5^c	0
GT_2C_3	1897^b	54^b	152	2.7^d	0
GT_2C_4	2641^a	74^a	147	1.9^e	0
SE	18.03	0.67	6.45	0.09	0

^{abcde}: Means in the same column not sharing a common superscript are significantly different ($p<0.05$), SE: Standard error

Table 10: Effect of time of initiation of feeding after hatching and ascorbic acid supplementation on dry matter and nitrogen digestibilities (decimal), nitrogen retention (g/bird/day) and metabolisable energy (ME) (MJ/kgDM) of Ross 308 broiler chickens between 40 and 42 days of age

Treatment	DMD	ND	NR	ME
GT_0C_0	0.83	0.82	2.9	14
GT_0C_1	0.83	0.83	2.7	14
GT_0C_2	0.86	0.84	2.6	14
GT_0C_3	0.77	0.76	2.4	13
GT_0C_4	0.70	0.69	1.7	13
GT_1C_0	0.78	0.74	1.6	14
GT_1C_1	0.75	0.73	2.0	13
GT_1C_2	0.80	0.78	2.0	14
GT_1C_3	0.82	0.79	3.0	14
GT_1C_4	0.71	0.66	2.0	13
GT_2C_0	0.69	0.64	1.5	13
GT_2C_1	0.82	0.78	2.2	14
GT_2C_2	0.82	0.83	2.6	14
GT_2C_3	0.85	0.82	2.5	14
GT_2C_4	0.77	0.69	2.7	14
SE	0.05	0.04	0.59	0.69

SE: Standard error, *DMD: Dry matter digestibility, ND: Nitrogen digestibility, NR: Nitrogen retention, ME: Metaboliziable energy

and mortality of Ross 308 broiler chickens at 42 days old (Table 9). However, ascorbic acid supplementation improved ($p<0.05$) live weight, growth rate and feed conversion ratio of Ross 308 broiler chickens at 42 days old. Time of initiation of feeding after hatching and ascorbic acid supplementation had no effect ($p>0.05$) on dry matter and nitrogen digestibilities, nitrogen retention and metabolisable energy of the chickens (Table 10).

Time of initiation of feeding after hatching had no effect ($p>0.05$) on live weight, carcass characteristics and dressing percentage of the chickens (Table 11). Within each period of initiation of feeding after hatching, increasing ascorbic acid supplementation improved ($p<0.05$) live weight, dressing percentage, breast meat yield, wing meat, thigh meat and drum stick of the chickens.

Discussion

It was observed that initiation of feeding within 1 to 36 hours after hatching promoted good growth and feed intake in broiler chickens. Increasing time of initiation of feeding above 36 hours after hatching decreased live weight and reduced feed intake by the age of three days. These results are similar to the findings of Noy and Sklan (1998). However, these results are different from the findings of Dibner *et al*. (1998) and Maiorka and Malheiros (2000) which indicated that initiation of feeding within 24 hours after hatching enhanced growth and feed intake, while increasing initiation of feeding above 24 hours after hatching decreased growth and reduced feed intake in broiler chickens. Immediately after hatching, most nutrients are used for maintenance activities and growth, specifically for intestinal growth (Noy and Sklan, 1999). This preferential growth occurs regardless of initiation of feeding after hatching. When the nutrients are not supplied by exogenous feed, newly hatched chicks use the nutrients from the yolk sac for intestinal growth (Maiorka and Malheiros, 2000). However, as observed by Dibner *et al*. (1998), the maximum amount of nutrients produced by the york sac is less than the optimal maintenance requirements of the chick during the first day of life. Therefore, in order to achieve its optimal nutrient requirements for growth during this period, intake of nutrients from exogenous feed is necessary. Nitsan *et al*. (1991) and Shehata and Skalan (1984) observed that intestinal growth immediate post-hatch is accompanied by increase in the production and activity of digestive enzymes such as amylase, trypsin and pancreatic lipase from intestinal membranes. However, Sell *et al*. (1991) and Traber and Turro (1991) reported that these digestive enzymes are already in gastrointestinal tract during embryo phase but the presence of nutrients from oral intake of exogenous feed improves their activity. Therefore, birds fed immediately after hatching have a constant secretion of these enzymes resulting in higher trypsin, amylase and lipase activities in intestinal mucosa, which results in higher intestinal weight and body weight growth (Sklan and Noy, 2000). Feeding immediately after hatching, therefore, seems to improve the activities of the digestive enzymes in the intestinal mucosa, increases digestion and consequently enhances feed intake and growth of broiler chickens. Feed restriction above 36 hours immediate post-hatch might have led to low enzymatic activity in the intestinal mucosa and hence a decrease in digestion. This might have led to lower growth rates. These results support the finding that residual york sac

Table 11: Effect of time of initiation of feeding after hatching and ascorbic acid supplementation on live weight (g), carcass characteristics (g) and dressing percentage of Ross 308 broiler chickens at 42 days old

Treatment	Live weight	Dressing %	Breast muscle	Gizzard	Fat
$ST_0C_0 + GT_0C_0$	1042^e	51^e	142^e	36	19
$ST_0C_1 + GT_0C_1$	1217^d	62^d	198^d	30	17
$ST_0C_2 + GT_0C_2$	1548^c	71^c	235^c	38	13
$ST_0C_3 + GT_0C_3$	1892^b	81^b	300^b	37	16
$ST_0C + GT_0C_4$	2642^a	91^a	450^a	37	16
$ST_1C_0 + GT_1C_0$	1055^e	50^e	141^e	38	19
$ST_1C_1 + GT_1C_1$	1229^d	61^d	198^d	32	15
$ST_1C_2 + GT_1C_2$	1547^c	72^c	235^c	37	17
$ST_1C + GT_1C_3$	1899^b	80^b	300^b	34	14
$ST_1C4 + GT_1C_4$	2642^a	91^a	450^a	33	12
$ST_2C_0 + GT_2C_0$	1054^e	51^e	142^e	35	12
$ST_2C_1 + GT_2C_1$	1229^d	61^d	197^d	36	15
$ST_2C_2 + GT_2C_2$	1547^c	72^c	235^c	38	17
$ST_2C_3 + GT_2C_3$	1897^b	81^b	300^b	39	21
$ST_2C_4 + GT_2C_4$	2641^a	91^a	450^a	35	16
SE	18.03	1.01	6.66	1.64	03.05

^{abcde}: Means in the same column not sharing a common superscript are significantly different (p<0.05), SE: Standard error

nutrients are optimally utilized for enhancing growth and intake where initiation of feeding after hatching is within 36 hours (Noy and Sklan, 1998).

More than 50% of the chicks died by the age of 60 hours when initiation of feeding was delayed to above 36 hours after hatching. This observation is similar to that of Dibner *et al.* (1998). These authors explained that when initiation of feeding after hatching is longer than 24 hours, the chick degrades maternal immunoglobulins present in the vitelline residue to produce its own proteins necessary for survival. During this time of fasting, exogenous food and non-food particles, which constitute an important antigen battery, are not introduced to the chick. Thus, the diversity of the immunoglobulin pool produced is negatively affected and this tends to weaken the immune system of the bird. Furthermore, Lowenthal and Trout (1994) observed that lymphocytes of one day-old chicks, although apparently mature, are functionally immature at hatch and gradually acquire immune activity with the intake of exogenous nutrients. Similarly, Rose and Rogaush (1974) and Klasing (1998) indicated that lack of oral intake of exogenous nutrients during the first days of life may lead to the absence of a specific and well developed humoral response in the chick and this condition leads the chick to be very dependent on maternal antibodies, which might not satisfy the required immune needs of the bird within this period. Thus, intake of nutrients from exogenous feed are essential for the adequate development of the bird's immune system after hatching. As a result, delayed initiation of feeding after hatching leads to high mortality rates. Time of initiation of feeding after hatching above 36 hours is not encouraged.

The current study indicated that mortality was positively and strongly correlated with time of initiation of feeding after hatching while live weight was negatively and strongly correlated with time of initiation of feeding after hatching at 3 days of age. This is in agreement with the findings of Fanguy *et al.* (1980) and Wyatt *et al.* (1985) which indicated that delayed initiation of feeding post-hatch induces high mortality rate and lowers live weight in broiler chickens due to its negative effect on maturation of the supply and immune organs which play a key role in supplying nutrients for growth and enhanced immune competence. Perhaps, this could explain some of the impact of delayed time of initiation of feeding after hatching on growth and mortality.

The present study indicates that ascorbic acid supplementation but not time of initiation of feeding after hatching affected mortality rates of the broiler chickens between 3 and 21 days of age. Lower mortalities were observed in birds supplemented with ascorbic acid irrespective of time of initiation of feeding after hatching. This is similar to the results of Giang and Doan (1998), Doan (2000), Pardue and Thaxton (1986) and Null (2001). These authors have indicated that ascorbic acid takes part in the synthesis of leukocytes, especially phagocytes and neutrophiles, which enhance immunity in the broiler chickens and by so doing lower mortality.

In the current study, time of initiation of feeding after hatching and ascorbic acid supplementation had no effect on feed intake, intake as percentage of live weight and feed conversion ratio of Ross 308 broiler chickens during the 'catch-up' period. Thus, compensatory growth in this study cannot be explained in terms of increased feed intake and feed efficiency. However, it is possible that the bird's delayed for a longer period of initiation of feeding of 36 to 60 hours after hatching had a reduced maintenance requirement due to their small body size which allowed for comparatively more energy for growth upon realimentation hence contributing to the compensatory response (Ryan, 1990). It is, also possible, that the compensatory growth response was as a result of increased efficiency of growth (Carstens *et* *al.*, 1991; Ryan *et al.*, 1993). These authors observed that increased efficiency of protein deposition results in more gain per gram protein deposited than lipid deposited. Thus, higher rates of protein deposition during realimentation would have a significant impact on the overall growth rate hence contributing to compensatory growth response.

Following the 'catch-up' period, it was observed that time of initiation of feeding after hatching and ascorbic acid supplementation had no effect on feed intake of the broiler chickens. These results are in agreement with Blaha and Kroesna (1997) and Jaffar and Blaha (1996) who reported that feed intakes of broiler chickens were not affected by the supplementation of ascorbic acid. However, ascorbic acid supplementation but not time of initiation of feeding after hatching affected growth rates and feed conversion ratio of the birds. Growth rate increased incrementally with increasing levels of ascorbic acid supplementation within each time of initiation of feeding after hatching. Improved growth rate in the ascorbic acid supplemented birds resulted in improved live weight in comparison with those without ascorbic acid supplementation. Live weight increased incrementally with increasing levels of ascorbic acid supplementation within each time of initiation of feeding after hatching. However, the optimum level of ascorbic acid supplementation was not calculated because of the short range of values used. These results are similar to those of Jaffar and Blaha (1996) who observed a 10.9% increase in body weight of chickens supplemented with ascorbic acid at 20 mg/bird/day in drinking water during acute heat stress (29-43°C). Blaha and Kroesna (1997) observed an even higher increase of 18% among chickens placed on ascorbic acid supplementation. Njoku (1984) and Njoku (1986) also observed that ascorbic acid supplementation improved growth rates of broiler chickens. However, during the winter period with temperatures ranging between 10.1 and 26°C, Puron *et al.* (1994) found that 200 ppm dietary ascorbic acid supplementation had no effect on performance and survivability of broiler chickens. Sykes (1977) pointed out that only a slight effect of ascorbic acid supplementation on the performance of broiler chickens would be expected under winter conditions. Apparently, beneficial effects of ascorbic acid supplementation are most expressed under high ambient temperatures (Njoku, 1984).

Increasing the level of ascorbic acid supplementation improved feed conversion ratio. This is similar to the results of Blaha and Kroesna (1997), Mckee and Harrison (1995). These authors detected an improvement in feed conversion ratio of broiler chickens as a result of ascorbic acid supplementation during heat stress. Ascorbic acid is associated with the conversion of body proteins and fat into energy for production and survival through increased corticosterone secretion (Marshall and Hughes, 1980; Bains, 1996). Similarly, ascorbic acid supplementation has been shown to enhance productivity, immune resistance and survivability under stressful conditions (Zulkifli *et al.*, 1996).

Time of initiation of feeding after hatching and dietary ascorbic acid supplementation had no effect on nutrient digestibility at 42 days of age. However, dietary ascorbic acid supplementation had a significant effect on dressing percentage and breast meat yield at 42 days old. Increasing ascorbic acid supplementation within each time of initiation of feeding after hatching increased dressing percentage and breast meat yield. Quarks and Adrian (1988) observed similar results when they supplemented broiler chickens with ascorbic acid before slaughter.

Conclusion: The time from hatching to initiation of feeding is a critical period in the development of the broiler chickens. Time of initiation of feeding above 36 hours after hatching resulted in growth reduction. However, the birds 'caught-up' within 7 days of realimentation. It is concluded that time of initiation of feeding above 36 hours after hatching is not desirable, mainly because of its effect on mortality.

On the other hand, ascorbic acid supplementation during realimentation reduced mortality rate and improved growth rates irrespective of time of initiation of feeding after hatching. Growth rate increased incrementally with increasing levels of ascorbic acid supplementation within each time of initiation of feeding after hatching. Dietary ascorbic acid supplementation also had a significant effect on dressing percentage and breast meat yield at 42 days old. Increasing ascorbic acid supplementation within each time of initiation of feeding after hatching increased dressing percentage and breast meat yield. It is concluded that ascorbic acid supplementation to broiler chicken diet could be exploited in reducing mortality rate and improving growth rates in broiler chickens subjected to delayed initiation of feeding after hatching.

Time of initiation of feeding after hatching and dietary ascorbic acid supplementation had no significant effect on feed intake, dry matter and nitrogen digestibilities, nitrogen retention, metabolisable energy, intestinal length and nitrogen content of breast meat of Ross 308 broiler chickens during the grower phase. This, possibly, may indicate that the levels of dietary ascorbic acid used in the present study were equal or above the optimum requirements for these parameters.

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