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RESEARCH OPINIONS IN ANIMAL & VETERINARY SCIENCES

The effect of different levels of creatine monohydrate on the performance and carcass characteristics of broiler chickens

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Abstract

A 42-day study was conducted on 240 day-old Ross broiler chicks allocated randomly to four dietary treatments to compare the effect of different levels of creatine monohydrate (CMH) on feed intake, feed conversion ratio (FCR), body weight, carcass yield, main cuts weight, organ weights and liveability. Two types of diets were used over the period of experiment, starter diet was used from one to 21 day and then grower diet was used till the end of the experiment. Beside control group, CMH was incorporated into the diet of broilers at the rate of 4 g/kg (T1), 8 g/kg (T2) and 12 g/kg (T3). The results showed that the live body weight, FCR, feed intake, dressing percentage, and main cuts percentage of birds of all supplemented groups (T1, T2 and T3) were superior ($P<0.05$) to control diet. No significant difference was observed among all experimental groups concerning liveability and internal organ's weight (liver, kidney, heart and gizzard). In conclusion, supplementation broiler ration with CMH significantly ($P<0.05$) improved productive performance of broiler chickens. Therefore, CMH can be used as an efficient feed additive for enhancing growth performance of broiler chickens.

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Introduction

Recently creatine (Cr) supplements are popularized as a performance-enhancing supplement used as athletic aids to increase high-intensity athletic performance. Researchers have known the use of creatine as an energy source by skeletal muscles; therefore, Cr is considerably popular within the scientific community. Based on such research, creatine monohydrate (CMH) has become one of the most widely used nutritional supplements in the world with an annual estimated consumption of 2.7 million kilograms (Williams et al., 1999). In the U.S.A. alone, an annual sale of Cr totalling over $400 million has been reported since the year 2000 (Bird, 2003). Daily demand for Cr is met through two processes, either by absorption of Cr taken in through diet or by "de novo biosynthesis" (Balsom et al., 1994; Williams et al., 1999; Wyss and Kaddurah-Daouk, 2000). In the process of de novo biosynthesis, Cr is produced by the body itself. It is formed outside of the muscle itself and then transported to the muscle via the bloodstream. Human studies have shown that Cr supplementations increase lean-tissue mass (Brose et al., 2003) and muscle fibre size (Burke et al., 2003). Theoretically, Cr supplementation might enhance the metabolic adaptations from regular resistance-exercise-training sessions, leading to greater production of insulin-like growth factor-I (IGF-I) over time (Deldicqueet al., 2005). This might help explain the increase in lean-tissue mass found in Cr studies (Burke et al., 2003).

Growth performance of broiler chickens has been increased spectacularly over the last 30 years mainly due to improvements of nutrition and controlled environment. Resultantly, it takes only 33 days to reach finishing body weight of about 2 kg (Wilson, 2005). Unfortunately, this growth rate is accompanied by increased body fat deposition, high mortality and high incidence of metabolic diseases and skeletal disorders (Zubair and leeson, 1996).

These findings about Cr are of interest to the poultry industry especially for the major breast muscle of broilers

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and turkeys. The market for poultry meat has to a large extent shifted from whole birds to smaller cuts and processed meat. This has led to an increased attention on meat quality properties and the aim of the production of broilers became more focused on the increase of the performance of the birds in order to increase profit, which has a large impact on the economy within the processing industry and on consumer acceptance, respectively. Therefore, the objective of this study was to determine the effect of CMH supplementation on broiler performance and to figure out its effects on the mass of the major part of the carcass (breast and thigh) in order to achieve market weight within less time.

Materials and Methods

Layout of experiment

Day-old, straight run (unsexed) broiler chicks (Ross 308) (n =240) were purchased from a commercial hatchery, weighed, and randomly assigned to floor cages, where the new hatched chicks were raised at poultry experimental fields of Bakrajo, Faculty of Agricultural Sciences, University of Sulaimany. Sawdust was used with the thickness of 5cm as litter. Temperature and humidity of the rooms was measured by electronic thermometers. Initially, room temperature was maintained at approximately 32°C and heat lamps were placed within each pen. Heat lamps were gradually raised and then turned off by the fourth week of the study. However, a ventilation fan was used to remove excessive moisture from within the building. Broilers were provided with a continuous light source (24 h/d) throughout the study. The experiment period lasted for six weeks, from the first day to the 21st d. All chicks were raised together and then chicks were separated into the treatments till the end of the experiment. Cages were randomly assigned to four treatment groups (4 replicates for each group and 15 chicks per replicate).

Feeding programs

Birds were provided access to both feed and water via plastic hanging feeders and a bell type drinker during the whole period of experiment. Two types of diets were used over the period of experiment, starter diet was used from one to 21 days of chick's age and then grower diet was used till the end of the experiment.

The chickens were weighed individually before start of the experiment (21 d). Three graded levels of CMH (Micronized creapure, Degussa Food Ingredients, D-85354 Freising, Germany) was added to the diet at the rate of 4 g/kg (T1), 8 g/kg (T2) and 12 g/kg (T3) (Tables 1 & 2). All chicks of each replicate were weighed individually (4 to 6th week) using Sarter scale. Chick and feed were weighed weekly to determine feed efficiency. In addition, pens were visually inspected on a daily basis for morbidity and mortality, each of which was documented as it occurred. At the end of the experiment (day 42), 10 birds from each treatment were randomly chosen for slaughter and evaluation of carcass traits. Before slaughtering, they were weighed individually and the birds were starved for 12 hours. Chicks were slaughtered and allowed to bleed freely for about 5 minutes. The proportional weight of carcass, breast and thigh was determined. Two birds per replicate from each treatment were taken, starved and then slaughtered. The carcass was dipped in warm water bath at 80°C for 1 minute and the birds were scalded, defeathered and eviscerated. The relative weight of organs (liver, lungs, heart, kidney, and gizzard) was taken.

Data were analyzed using XLStat, version 7.5, 2004, and the significant differences between means of traits were determined using Duncan's multiple range test (Duncan, 1955) under the probability P<0.05.

Results

No significant difference was found in feed intake between the control and treated groups during 4th and 5th weeks of the experiment. During 6th week and accumulative feed intake was significantly high in T3 compared to control. Similarly, better FCR was found either on week or accumulative basis in T3. Compared to control group, the values of body weight during most periods of experiment gradually increased (P<0.05) due to increased level of CMH as shown in Table 3. In the 4th week, T1, T2 and T3 had a tendency to have a significant higher body weight as compared to control group in spite of there were no significant differences between T1 and T2 groups. In the 5th and 6th weeks of experiment, all Cr supplemented groups (T1, T2 and T3) recorded high values of body weight (P<0.05) compared to control group although in 6th week, T1 was not significantly different from control group. The CMH effect on carcass, internal organs characteristics and liveability are given in Table 4. It is obvious that carcass quality was significantly high in T3 compared to control. No significant difference was found in percentage weight of internal organs and liveability percentage between the control and treated groups.

Discussion

It is obvious from the data of Table 3 and 4 that CMH has important role in supporting chickens for maximum growth. Several possible mechanisms may account for the enhanced growth of chickens in response to additional CMH. The most-documented effect of Cr supplementation is an increase in body mass caused by increased water retention within the muscle (Hultman et al., 1996). Creatine is an osomatically active substance; thus extra intracellular Cr concentration may induce water

Table 1: Ingredient of the starter diet used in the experiment

Ingredients (%)	Control	T1	T2	T3
Yellow Corn	58	58	58	57.8
Soya bean meal	27	27	27	26.8
Protein concentrate*	9	9	9	9
Wheat	4	3.6	3.2	3.2
Sunflower oil	1.5	1.5	1.5	1.5
DCP**	0.3	0.3	0.3	0.3
Salt	0.2	0.2	0.2	0.2
Creatine	0	0.4	0.8	1.2
Total	100	100	100	100
		Calculated composition***		
Protein	22.01	22.00	22.00	22.00
ME (kcal/kg)	3045	3040	3040	3040
Calcium	0.74	0.74	0.74	0.74
Phosphorus	0.41	0.41	0.41	0.41
Lys.	1.3	1.3	1.3	1.3
Meth.	0.62	0.62	0.62	0.62
Meth. To Cyst. Ratio	0.96	0.96	0.96	0.96

*Protein concentrate used in the diets was produced in Holland (WAFI) which contains: 40 % crude protein, 2100 Kcal ME / Kg, 5% crude fat, 2% crude fiber, 6.5% calcium, 2.50% phosphorus, %3.85 lysine, 3.70 % methionine, and 4% cystine; **DCP: Dicalcium phosphate; ***The calculated composition of the diets was determined according to NRC (1994)

Table 2: Ingredient of the grower diet used in the experiment

Ingredients (%)	Control	T1	T2	T3
Yellow Corn	61	61	61	61
Soya bean meal	24	24	24	24
Protein concentrate*	7	7	7	7
Wheat	5	4.98	4.96	4.94
Sunflower oil	2.5	2.5	2.5	2.5
DCP**	0.3	0.3	0.3	0.3
Salt	0.2	0.2	0.2	0.2
Creatine	0	0.4	0.8	1.2
Total	100	100	100	100
		Calculated composition***		
Protein	20.15	20.13	20.13	20.13
ME (kcal/kg)	3150	3145	3145	3145
Calcium	0.6	0.6	0.6	0.6
Phosphorus	0.35	0.35	0.35	0.35
Lys.	1.16	1.16	1.16	1.16
Me.	0.54	0.54	0.54	0.54
Meth. To Cyst. ratio	0.85	0.85	0.85	0.85

*Protein concentrate used in the diets was produced in Holland (WAFI) which contains: 40 % crude protein, 2100 Kcal ME / Kg, 5% crude fat, 2% crude fiber, 6.5% calcium, 2.50% phosphorus, %3.85 lysine, 3.70 % methionine, and 4% cystine; **DCP: Dicalcium phosphate; ***The calculated composition of the diets was determined according to NRC (1994)

Table 3: Effect of dietary supplementation of creatine monohydrate on feed intake, feed conversion ratio and body weight of broiler chicken at different weeks of age

Treatments	Feed intake (g)				FCR				Body weight (g)		
	Weeks			Accumulative feed intake	Weeks			Accumulative FCR	Weeks		
	4	5	6		4	5	6		4	5	6
C	1030.8 ±12.25^{a}	1076.0 ±17.33^{a}	794.0 ±8.66^{b}	2900.83 ±33.66^{b}	1.46 ±0.02^{a}	1.95 ±0.17^{a}	2.31 ±0.1^{a}	1.81 ±0.09^{a}	1606.66 ±20.3^{c}	2156.25 ±25^{c}	2500.0 ±85.7^{c}
T1	1018.3 ±14.45^{a}	1060.0 ±18.2^{a}	695.0 ±8.33^{c}	2773.33 ±25.33^{c}	1.19 ±0.04^{b}	1.91 ±0.16^{a}	2.17 ±0.12^{a}	1.67 ±0.1^{b}	1683.33 ±22.1^{a}	2237.50 ±35.6^{b}	2556.66 ±78.4^{c}
T2	1000.3 ±16.33^{a}	1050.0 ±14.66^{a}	800.0 ±12.25^{b}	2850.33 ±30.33^{bc}	1.23 ±0.08^{b}	1.84 ±0.15^{a}	1.83 ±0.1^{b}	1.60 ±0.12^{bc}	1675.00 ±15.6^{a}	2243.75 ±32.6^{b}	2680.0 ±69.2^{b}
T3	995.0 ±16.33^{a}	1080.0 ±17.22^{a}	913.0 ±20.4^{a}	2988.0 ±38.66^{a}	1.16 ±0.04^{b}	1.65 ±0.08^{a}	1.71 ±0.09^{b}	1.52 ±0.1^{c}	1645.83 ±16.7^{b}	2297.50 ±41.2^{a}	2830.0 ±75.0^{a}

^{abc} means within the same row with different superscripts differ significantly ($P<0.05$); C: control group; T1, T2 and T3: adding creatine monohydrate to the diet of broiler chicken at levels of 0.4, 0.6 and 1.2 g/kg, respectively.

Table 4: Carcass and organ weights of broiler chickens supplemented with different levels of creatine monohydrate at 42 day of age

Parameters	C	T1	T2	T3
Live weight (g)	2500±66.7[b]	2516±94.8[b]	2680±123.8[b]	2830±97.3[a]
Carcass yield (g)	1951±55.00[c]	1970±79.4[c]	2090±98.20[b]	2180±67.8[a]
Breast (%)	28.5±1.12[b]	28.7±2.10[b]	29.3±2.21[ab]	32.00±1.65[a]
Thigh (%)l	24±1.85[c]	24.2±1.25[c]	26.6±2.1[b]	28.5±2.2[a]
Liveability (%)	88.3±1.8[a]	87.3±1.35[a]	88±1.75[a]	88.6±1.4[a]
Heart (%)	0.28±0.005[a]	0.27±0.004[a]	0.28±0.006[a]	0.30±0.004[a]
Liver (%)	0.61±0.001[a]	0.63±0.004[a]	0.62±0.006[a]	0.61±0.002[a]
Kidney (%)	0.20±0.002[a]	0.21±0.002[a]	0.24±0.002[a]	0.23±0.003[a]
Gizzard (%)	2.2±0.07[a]	2.10±0.09[a]	2.09±0.06[a]	2.21±0.08[a]

[abc]means within the same row with different superscripts differ significantly (P<0.05); C: control group; T1, T2 and T3: adding creatine monohydrate to the diet of broiler chicken at levels of 0.4, 0.6 and 1.2 g/kg, respectively

into the cell (Wyss and Kaddurah-Daouk, 2000) and this increase the mass of body. Another possible way to explain the increase of body weight is the reverse reaction of Cr that provides a rapid source of ATP to the muscle cell (Burke et al., 2003), and appears to enhance anaerobic capacity, aerobic recovery, protein synthesis and satellite-cell activity (Vierck et al., 2003). Myofibrillar protein kinetics is also increased by Cr (Willoughby and Rosene, 2003). Thus the increased cell volume is believed to be one stimulus to increase protein synthesis (Haussinger et al., 1993; Ziegenfuss et al., 1998).

Moreover, Cr supplementation has been shown to increase total body (Casey and Greenhaff, 2000) and fat free mass (Mihic et al., 2000) in humans. The results of this experiment, coupled with the information provided from previous research endeavours involving Cr ingestion (Casey and Greenhaff, 2000; Mihic et al., 2000), suggest that the significant improvement in feed efficiency observed during most periods of the experiment is most likely associated with an initial increase in muscle cellular hydration and the subsequent increase in weight gain.

Dietary treatments did not affect heart, liver, kidney and gizzard weight (Table 4). Creatine may have been converted into creatinine which in high dosages could act as a toxin (Wyss and Kaddurah-Daouk, 2000) and there is no previous study involving the supplementation of Cr effect on internal organ's weight. Additionally, no difference in mortality was noted among the three dietary treatments compared to control group in the present study. Therefore, it is possible that supplemental levels of CMH were not high enough to be lethal or toxicant for the birds. Dietary supplementation with Cr significantly (P<0.05) affected hot carcass weight and percentage of main cuts (thigh and breast) (Table 4). It is worth mentioning that T2 and T3 were significantly superior to control and T1 in both carcass weight and main cuts percentage, and this improvement may be explained by creatine's well-known osmotically active substance. Without enough available water in the body, Cr will not be properly stored within the muscle (Wyss and Kaddurah-Daouk, 2000). This is important since it increases the amount of blood flow to the muscles. The increased blood flow allows greater delivery of hormones, protein, carbohydrate and other nutrients to the muscles and therefore aids muscle growth. These results were not according to previous studies involving the supplementation of Cr to swine (Maddock et al., 2000; O'Quinn et al., 2000), each of which found that dietary treatment had little to no effect on dressing percentage and percentage of main cuts of the carcass.

Conclusion

Dietary supplementation with different levels of CMH resulted in significant improvements in productive performance of broilers. The best results were obtained at the level of 1.2 g/kg.

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