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Research Article

Effect of Supplementary Liquid Colostrum on Growth Performance, Carcass Yield, Ceruloplasmin, Sialic Acid and Some Antioxidant Levels in Quails

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Abstract

This study was conducted to determine the effects of supplementary liquid-colostrum (LiqC) on growth performance, carcass yield, ceruloplasmin, sialic acid, and antioxidant levels in growing quails. In this study, a total of 90 ten-days-old mixed-sexed Japanese quail chicks were used. Quails were divided randomly into 3 groups. Chicks were fed one of three diets: basal diet or basal diet supplemented with 2% or 4% liquid colostrum. Birds were exposed to a 14L:10D illumination cycle for 32 (days of 10-42) days. When the effects of dietary liquid colostrum supplementation on performance were examined, values of final body weight, live weight gain, cumulative feed intake, feed efficiency, cold carcass weight and cold carcass yield in quails were higher in the trial groups compared to control group ($P<0.05$); but organ weights were not affected ($P>0.05$). Levels of liver malondialdehyde (MDA), ceruloplasmin, and sialic acid were lower, but levels of superoxide dismutase (SOD) were higher in trial groups ($P<0.05$), and there was no effect on total antioxidant status (TAS) levels ($P>0.05$). Serum MDA levels were lower and SOD levels were higher in liquid colostrum supplemented groups ($P<0.05$), although a numerical increase was found in TAS levels, no statistically important difference was found in trial groups. In conclusion, the oxidative, transport and slaughter stresses can be attenuated by liquid colostrum supplementation at 4% of diets in quail.

Keywords: *Colostrums, Growth performance, Ceruloplasmin, Sialic acid, Quail*

Bıldırcınlarda Sıvı Kolostrumun Büyüme Performansı, Karkas Verimi, Seruloplazmin, Sialik Asit ve Bazı Antioksidan Düzeyleri Üzerine Etkisi

Özet

Bu çalışma, bıldırcınlarda sıvı kolostrumun büyüme performansı, karkas verimi, seruloplazmin, sialik asit ve bazı antioksidan düzeyleri üzerine etkisini belirlemek amacıyla yapıldı. Çalışmada toplam 90 adet 10 günlük yaşta karışık cinsiyette Japon bıldırcını civcivleri kullanıldı. Bıldırcınlar rastgele 3 gruba ayrıldı. Bıldırcınlara bazal diyet; bazal diyete %2 ve %4 oranında sıvı kolostrum ilave edilen üç farklı yem verildi. Hayvanlar 32 gün boyunca 14 saat aydınlık:10 saat karanlık olacak şekilde bir aydınlatma programına tabi tutuldu. Bıldırcın rasyonlarına ilave edilen sıvı kolostrumun performans üzerine etkileri incelendiğinde; deneme sonu ağırlığı, canlı ağırlık artışı, yem tüketimi, yemden yararlanma oranı, soğuk karkas ağırlığı ve soğuk karkas randımanının deneme gruplarında kontrol grubuna göre daha yüksek olduğu ($P<0.05$), ancak organ ağırlıkları üzerine herhangi bir etkisinin olmadığı görüldü ($P>0.05$). Deneme gruplarında karaciğer malondialdehit (MDA), seruloplazmin ve sialik asit düzeylerinin daha düşük olmasına rağmen; süperoksit dismutaz (SOD) düzeylerinin daha yüksek olduğu görüldü ($P<0.05$). Ancak TAS düzeyine herhangi bir etkisinin olmadığı tespit edildi ($P>0.05$). Serum MDA, SOD ve TAS düzeylerine etkisi incelendiğinde MDA düzeylerinin deneme gruplarında daha düşük, SOD düzeyinin ise daha yüksek olduğu görüldü ($P<0.05$). Deneme grupları TAS düzeylerinde sayısal bir artış olmasına rağmen istatistiksel olarak önemli bir fark bulunmadı. Sonuç olarak, bıldırcın rasyonlarına %4 düzeyinde katılan sıvı kolostrum ile oksidatif, taşıma ve kesim kaynaklı stresler azaltılabilir.

Anahtar sözcükler: *Kolostrum, Büyüme performansı, Seruloplazmin, Sialik asit, Bıldırcın*

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INTRODUCTION

Colostrum is a liquid lactated by the mammary glands of female mammals for the first few days after birth. Colostrum contains not only nutrients such as protein, carbohydrate, fat, vitamins and minerals, but also various bio-active components such as growth and antimicrobial factors [1,2].

Two of the most important components contained in colostrum are immune and growth factors [3,4]. Immune factors are the substances that reduce the effects of micro-organisms causing diseases, protect from diseases and help the body [5]. Growth factors contain components that increase healing effects by building and aiding recovery of bones, muscles, fibers and cartilage, stimulating fat metabolism, sustaining blood glucose level balance and helping to regulate brain chemicals controlling state of mind [6].

Sialic acid is one of the most important structures in biological membranes and is available within the structures of glycolipids, polysaccharides, glycoprotein and muco-protein [7]. It is commonly available in animal tissues and bacteria. Serum total sialic acid increases considerably in infectious, tumoral, and metabolic diseases [8]. Cerulo-plasmin, which is an acute phase protein, functions as an antioxidant within the organism. Free copper and iron ions are powerful catalysts of free radical damage. Cerulo-plasmin by binding copper, prevents free copper ions from catalyzing oxidative damage. Ceruloplasmin levels rise following infection, trauma, or inflammation [9]. In recent years, colostrum has been used as a good protein source to support the development of the musculoskeletal system and healthy and powerful immune system, to shorten the time of regeneration after workouts, to shorten recovery period after injuries, and as a stress reducing factor [10]. Additionally, research about colostrum's effects on performance and the immune system are limited, except for studies performed on ruminants; there has not been sufficient research done on poultry. This study was conducted to determine the effects of liquid cow colostrum on growth performance, some blood parameters, and antioxidant levels in quail.

MATERIAL and METHODS

Animals, Treatments and Management

The ethical committee approval of Dicle University (DÜHADEK: 2010-44) was taken in order to conduct this study. Ten-Days-old (47±0.5 grams) mixed-sexed Japanese quails *(Coturnix coturnix japonica,* 90), obtained from the poultry unit of the Veterinary Faculty of Dicle University. The birds were distributed randomly to one of three groups, and each of the experimental groups was replicated in six cages (60x120x30), each containing five birds. Quails were housed in wire cages at 37.5°C on the first days in a temperature-controlled room. The room temperature was then gradually decreased to 22°C by the end of the third week and was then kept constant. Birds were exposed to a 14L:10D illumination cycle for 32 (days of 10-42) days. Feeds as isocaloric and isonitrogenic were prepared (LiqC was added into diets at expense of corn). Feed and fresh water were offered *ad libitum* throughout the experiment.

Sample and Data Collection

Quails were divided into 3 groups randomly. No additions were made to the basal diet of the first group. 2% LiqC was added to the second group's diet (Per kilogram of basal diet was added 100 mL LiqC), and 4% to the third group (Per kilogram of basal diet was added 200 ml LiqC). Colostrum dry matter, protein, fat and lactose was calculated as 20.4%, 12%, 6.3% and 3.2%, respectively (Funke Gerber, Laktostar, Milk Analyzer, Berlin, Germany). Nutrient and chemical components of the diets of trial groups are given in *Table 1*.

Table 1. *Ingredient and nutrient composition of the basal diet[a]*

Ingredient	Starter phase (days 10-21) (%)	Grower phase (days 22-42) (%)
Corn	53	58.9
Soybean meal	36.6	32.2
Soy oil	6	5
Limestone	1.7	1.3
Dicalcium phosphate	1.6	1.6
Sodium chloride	0.4	0.4
Vitamin-mineral premix[b]	0.5	0.5
DL-Methionine	0.2	0.1
Chemical analyses, dry matter basis		
Crude protein	22.7	20.6
Crude fat	6.73	6.15
Crude fiber	3.85	3.87
Calcium	1.0	0.9
Phosphorus	0.75	0.71
Calculated compositions[c]		
Metabolizable energy, MJ/kg	12.91	12.91
Lysine	1.18	1.05
Methionine + cystine	0.9	0.63

[a] LiqC was added into diets at expense of corn; [b] Vitamin premix provides the following per kg: all-trans-retinyl acetate, 1.8 mg; cholecalciferol, 0.025 mg; all-a-tocopherol acetate, 1.25 mg; menadione (menadione sodium bisulphate), 1.1 mg; riboflavin, 4.4 mg; thiamine, 1.1 mg; pyridoxine, 2.2 mg; niacin, 35 mg; Ca-pantothenate, 10 mg; vitamin B_{12}, 0.02 mg; folic acid, 0.55 mg; d-biotin, 0.1 mg. Mineral premix provides the following per kg: Mn (from MnO), 40 mg; Fe (from FeSO4), 12.5 mg; Zn (from ZnO), 25 mg; Cu (from $CuSO_4$), 3.5 mg; I (from KI), 0.3 mg; Se (from NaSe), 0.15 mg; choline chloride, 175 mg; [c] Calculated value according to tabular values listed for the feed ingredients [17]

Feed consumption and body weight gain of quails were recorded weekly. The weight gain and feed utilization efficiency of the birds were calculated weekly. At the end of the study, 30 quails from each group were slaughtered to determine carcass yield. Mix sexed 12 quails (one male and one female quails per replicate) were used to determine serum and liver MDA, TAS, ceruloplasmin, and sialic acid levels. The carcasses were obtained after the feathers, feet, and visceral organs were removed. The carcasses were kept at 4°C for 18 h, and cold carcass yields were calculated. Blood samples were collected into biochemical tubes to determine the level of the blood serum. The tubes containing the blood samples were centrifuged at 4°C at 3.000 rev/min for 10 min. Serum and liver samples were stored at -20ºC until analysis.

Laboratory Analyses

Tissue samples were immediately weighed and washed with 0.9% NaCl solution, homogenised (2.000 rpm/min for 1 min, 1:10 w/v) using a stirrer (Stuart SHM 1, UK) in 1.15% KCl solution in an ice bath. Then homogenate was centrifuged at 5000×g for 60 min at 4°C. The resultant supernatant was used at the analyses. Protein analysis in homogenate and supernatant was performed according to the Lowry method [11].

SOD Analysis in serum was performed to the Sun et al.[12]. MDA levels in the homogenate and serum were determined by using the single heating method of Yoshioka et al.[13] based on thiobarbituric acid (TBA) reactivity. Total antioxidant capacity (TAS) of the supernatant or serum was determined using an automated measurement method with a commercially available kit developed by Rel (Total Antioxidant Status Assay kit, Rel Assay Diagnostics, Turkey). The antioxidative effect of the sample against the potent-free radical reactions initiated by the reduced hydroxyl radical is measured using this method. The results were expressed as millimoles of Trolox equivalent per mg tissue protein in supernatant or millimoles of Trolox equivalent/L in serum. Serum and supernatant total sialic acid levels were measured spectroscopically using Warren's [14] thio-barbituric acid method (Shimadzu UV 1800, Japon). Serum and supernatant ceruloplasmin levels were determined by measurement of p-phenylenediamine oxidase activity defined by Sunderman and Nomoto [15].

The nutritional composition of the diets was determined according to the Association of Official Analytical Chemists [16]. Energy and amino acid (lysine and Methionine + cystine) contents were calculated from tabular values listed for the feedstuffs [17].

Statistical Analysis

Performance variables [feed intake, weight gain, and feed efficiency], and serum MDA, SOD, and TAS levels were analyzed by one-way ANOVA using the PROC MIXED procedure (SAS, 2002). The linear model to test the effects of dietary LiqC supplementation on response variables was as follows: $yij = \mu + b0 + Ri + ej$, where y = response variable; μ = population mean; b0 = covariate, measurements obtained at the end of the pretest period; R = LiqC supplementation; and e = residual error being N (σ, μ; 0, 1). The model also included orthogonal and polynomial contrast to determine changes in response variables as supplemental LiqC level was increased [18]. Mean differences of interaction effects were compared to Duncan test. Statistical significance was considered at P<0.05.

RESULTS

The effects of the LiqC added to the quail diet on growth performance are given in *Table 2*. When the data were examined, it was found that quail in the experimental groups increases final body weight, body weight gain, cumulative feed intake, cold carcass weight, and cold carcass yield of the quails, and decrease in feed efficiency as supplemental LiqC increased from 0% to 4% (P<0.05).

When the effect of the LiqC added to the feed mix on organ weight was investigated, it was observed that it has no effect *(Table 3)*.

The effects of the LiqC added to the quail feed mix on liver MDA, SOD, TAS, ceruloplasmin, and sialic acid levels are

Table 2. *Effects of liquid colostrum (LiqC) supplementation to quail diets on growth performance[a]*

Variable[c]	**LiqC, %**			**SEM**	**Statistical Significance, *P*>Fb**		
	0	**2**	**4**		**S**	**L**	**Q**
Final body weight, g[d]	181.52[b]	187.20[a]	191.09[a]	1.901	0.001	0.0001	0.651
Live weight gain, g	133.53[c]	139.79[b]	146.23[a]	0.913	0.0001	0.0001	0.957
Cumulative feed intake, g	635.25[c]	649.08[b]	658.33[a]	1.880	0.0001	0.0001	0.416
Feed efficiency[e]	4.76[a]	4.64[a]	4.50[b]	0.038	0.002	0.001	0.815
Cold carcass weight, g	119.71[c]	125.03[b]	129.35[a]	1.081	0.0001	0.0001	0.675
Cold carcass yield, %	65.65[b]	67.72[ab]	69.80[a]	0.984	0.030	0.009	0.995

*[a] Data are the least square means from 10-42 days animal experimentation; [b]Statistical contrast: **S** = LiqC supplementation effect (quail supplemented with LiqC vs. quail not supplemented with LiqC); **L** = Linear effect of increasing dietary LiqC; **Q** = Quadratic effect of increasing dietary LiqC; [c]Different letters within the same rows indicate differences among groups (P<0.05); [d] **n** = 30 quails per group; [e]Feed efficiency = feed consumed, **g:** weight gained, g*

Table 3. *Effects of liquid colostrum (LiqC) supplementation to quail diets on organ weights*							
Variable[b]	**LiqC, %**			**SEM**	**Statistical Significance, *P* > F[a]**		
	0	**2**	**4**		**S**	**L**	**Q**
Liver, g	2.97	3.26	3.33	0.185	0.446	0.234	0.671
Heart, g	1.73	1.72	1.70	0.038	0.950	0.758	0.941
Spleen, g	0.11	0.12	0.11	0.011	0.822	0.734	0.602

*[a] Statistical contrast: **S** = LiqC supplementation effect (quail supplemented with LiqC vs. quail not supplemented with LiqC); **L** = Linear effect of increasing dietary LiqC; **Q** = Quadratic effect of increasing dietary LiqC; [b] **n** = 12 quails per group*

Table 4. *Effects of liquid colostrum (LiqC) supplementation to quail diets on liver MDA, SOD, TAS, ceruloplasmin and sialic acid levels[a]*							
Variable[c, d]	**LiqC, %**			**SEM**	**Statistical Significance, P > F[b]**		
	0	**2**	**4**		**S**	**L**	**Q**
MDA[e]	14.53[a]	13.42[ab]	12.18[b]	0.434	0.006	0.002	0.907
SOD[f]	24.41[b]	27.82[ab]	29.63[a]	1.657	0.018	0.006	0.582
TAS[g]	1.40	1.48	1.63	0.096	0.274	0.119	0.765
Ceruloplasmin[h]	27.06[a]	23.26[b]	21.70[b]	1.017	0.012	0.004	0.431
Sialic acid[i]	184.08[a]	90.04[b]	81.00[b]	9.632	0.0001	0.0001	0.014

*[a] Data are the least square means from 10-42 days animal experimentation; [b] Statistical contrast: **S** = LiqC supplementation effect (quail supplemented with LiqC vs. quail not supplemented with LiqC); **L** = Linear effect of increasing dietary LiqC; **Q** = Quadratic effect of increasing dietary LiqC; [c,d] Different letters within the same rows indicate differences among groups (P<0.05), n = 12 quails per group (six male and six female); [e] **MDA** = µmol/ mg protein; [f] **SOD** = % inhibisyon/mg protein; [g] **TAS** = mmol trolox equiv./mg protein; [h] Ceruloplasmin = g/mg protein; [i]* Sialic acid = µg/mg protein

Table 5. *Effects of liquid colostrum (LiqC) supplementation to quail diets on serum MDA, SOD and TAS levels[a]*							
Variable[c]	**LiqC, %**			**SEM**	**Statistical Significance, P > F[b]**		
	0	**2**	**4**		**S**	**L**	**Q**
MDA[e]	12.75[a]	11.14[b]	9.96[c]	0.606	0.0001	0.0001	0.629
SOD[f]	19.80[b]	26.97[a]	31.30[a]	1.586	0.001	0.0001	0.522
TAS[g]	2.31	2.49	2.56	0.276	0.644	0.374	0.799

*[a] Data are the least square means from 10-42 days animal experimentation; [b] Statistical contrast: **S** = LiqC supplementation effect (quail supplemented with LiqC vs. quail not supplemented with LiqC); **L** = Linear effect of increasing dietary LiqC; **Q** = Quadratic effect of increasing dietary LiqC; [c,d] Different letters within the same rows indicate differences among groups (P<0.05), **n** = 12 quails per group (six male and six female); [e] **MDA** = µmol/mg protein; [f] **SOD** = % inhibisyon/mg protein; [g] **TAS** = mmol trolox equiv./mg protein*

given in *Table 4*. When the table was examined, it was seen that the MDA, ceruloplasmin, and sialic acid levels are lower and SOD level is higher in the trial groups when compared with the control group (P<0.05). On the other hand, it was detected that it has no effect on the TAS level (P>0.05).

When the effect of the LiqC on serum MDA, SOD and TAS levels was analyzed *(Table 5)*, it was seen that MDA levels are lower and SOD level is higher in the trial group (P<0.05). However, it was determined that although there is a numerical increase in TAS levels, there is not a statistically significant difference.

DISCUSSION

This study was designed to determine the effect of the LiqC on growing performance, sialic acid, ceruloplasmin, and some antioxidant levels in quails. In a previous research, we found that the addition of powdered colostrum increased final body weight, body weight gain, cumulative feed intake, cold carcass weight, cold carcass yield, and decreased feed efficiency in quails [19]. Similarly, in the present study we observed that LiqC supplementation increased body weight gain, and decreased feed efficiency in quails with increasing dietary LiqC supplementation for 42 days of the experimental period. King et al.[20] reported that dietary spray-dried colostrum improved feed conversion ratio at day 14, and in another study conducted in broiler, it was declared that colostrum added to the feed mix increased body weight gain on the 13th day of the growth [21]. Additionally, in studies made on humans, it has been reported by many researchers that cow colostrum increases muscle growth, accelerates muscle-skeleton regeneration, and enhances power and strength [10,22]. The findings of many researchers mentioned above show similarity with our findings. This can be explained by the following: colostrum is a nutritious liquid which is rich in essential and nonessential amino acids, fatty acids, minerals and vitamins, contains growth factors for cell and tissue growth [2] and helps the growth of intestinal system [23]. Lipid peroxidation occurring through free oxygen radicals is a significant cause of injury to cell membranes. It causes excessive accumulation of Ca^{2+} in cells by affecting membrane permeability [24]. Cell membrane dysfunction results in cell swelling and cell death. Malondialdehyde is an end result of lipid peroxidation and is used to show oxidative injury level. Plasma MDA and tissue MDA levels are measured as an indicator of free radicals [25]. Both tissue and serum MDA levels' being lower in the trial groups when compared with the control groups is an indicator for oxidative damage being less in this study.

Superoxide dismutase is an essential enzyme that is produced as endogen and for each cell constituting the organism. The first defense against free radicals within this organism is made with superoxide dismutase (SOD) enzyme. It protects the organism from harmful effects of oxidants by transforming superoxide radical, which causes cell injury, to less harmful hydrogen peroxide and molecular oxygen [26]. In a study made on elderly people, it was reported that addition of cow colostrum to their diets caused an increase in the level of serum SOD. In a study made on mice, Mahenderan et al.[27] reported that the level of SOD in the group fed with colostrum was higher when compared with the control group. The results of our study show similarity with the studies reporting that tissue and serum SOD level is higher in trial groups when compared with the control groups. Bovine colostrum has significant amounts of enzymatic and non-enzymatic antioxidants. Lactoperoxidase, catalase, superoxide dismutase, and glutathione peroxidase are the important enzymatic antioxidants present in bovine colostrum. The high levels of these oxidants in colostrum may cause an increase in SOD levels in trial groups [28].

Antioxidants function as a cell protection against destructive side effects of oxidative stress. Oxidative and antioxidative status evaluation can be done with the measurement of TAS and MDA levels [29]. In this study, the TAS levels in the trial groups showed no difference statistically. However, when compared with the control group, there was a numerical increase in the trial groups. This increase is caused by the fact that antioxidant substance level is high in the nutritious component of colostrum.

Acute phase proteins (AFP) synthesized by the liver as a reaction to the acute phase response may have different functions and characteristics [30]. While these proteins are present at a insignificant level in healthy animals, they increase during inflammation and have an indicator role. During the acute phase response, the synthesis and release of certain plasma proteins such as ceruloplasmin, sialic acid increase [31]. Ceruloplasmin is an α2 globulin composed of a single polypeptide chain. The transfer of copper, lipid peroxidation, oxidation of toxic ferrous iron to non-toxic ferric form and prevention of free radical generation are among the duties of ceruloplasmin [32]. In a study made on dogs, it was reported that ceruloplasmin concentration increased with infection and tissue damage [33]. With the present study, ceruloplasmin concentration was found higher in control groups when compared with the trial groups. There may be two reasons for this increase. First, it may be caused by the presence of a subclinical course of disease or a noneffective inflammatory in control groups. Second, ceruloplasmin level may have increased depending on the stress level during the transport and bird slaughter. Since no disease symptoms were detected clinically in any of the groups of birds subjected to the study, the second factor is thought to be in effect.

Sialic acid concentration increases rapidly in situations such as tissue damage, inflammation, infection, and transport [34]. During the study, sialic acid level was found higher in control groups when compared with the trial groups. As in ceruloplasmin, the increase of sialic acid in the control group may have resulted from the stress increase occurring during the transfer and slaughter of the birds.

It was observed that addition of LiqC to the feed mix increased slaughter weight, body weight gain, feed intake, carcass weight, and carcass yield but had no effect on organ weight. It was observed that it decreased MDA, ceruloplasmin and sialic acid levels, increased SOD levels, and had no effect on TAS levels. Additionally, ceruloplasmin and sialic acid levels' being low in the groups to whose feed mix was added colostrum may be a significant indicator of the animals' welfare. During transport and slaughter, the birds become stressed, and this can reduce the quality of meat. Addition of colostrum to the feed mix can minimize the oxidative, transport, and slaughter stresses that may occur.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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