The effect of dietary colostrum powder on performance, carcass yields and serum lipid peroxidation levels in Japanese quails (Coturnix coturnix japonica)

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ABSTRACT

Colostrum is a nutrient-dense fluid secreted by female mammals for the first few days following birth. Colostrum can be supplemented to poultry diets as a feed additive due to its nutritious and performance-enhancing properties. This study was conducted to determine the effect of dietary colostrum powder (CL-P, Alpha Lipid Lifeline Colostrum, New Zealand) on growing performance, carcass weight and yield, organ weights, serum vitamins and malondialdehyde (MDA) levels in quails (Coturnix coturnix japonica). A total of 90 birds, one day old, were divided into 3 groups consisting of 6 replicate cages, 5 birds per cage. Birds were randomly fed on one of three diets: basal diet and basal diet supplemented with 2.5% or 5% of CL-P. At the end of the period of 42 days, CL-P supplementation increased final body weight ($P<.001$), weight gain ($P<.001$), feed intake ($P=.03$), feed efficiency ($P<.0001$), carcass weight ($P<.0001$) and carcass yield ($P<.01$). Amounts of serum MDA ($P<.001$) levels also increased with increasing supplemental CL-P. As a result, growth performance can be improved and serum lipid peroxidation can effectively be attenuated by dietary CL-P supplementation at 5% of diets in Japanese quail.

1. Introduction

Researchers have tried to find an effective process for improving animal performance and enhancing the quality of animal origin foods. For this reason, supplementation of highly attractive phytochemicals or bioactive agents to animal diets was firstly and widely used professionally. Indeed, colostrum is known as nutrient-dense fluid secreted by female mammals after parturition (Rodríguez et al. 2009; Godhia & Patel 2013), containing lots of immune-regulating components, transferrin, essential and nonessential amino acids, insulin-like growth factor-I (IGF-I) and II (IGF-II), fatty acids, anti-microbials, immunoglobulins (Igs), enzymatic (lactoperoxidase, catalase, superoxide dismutase and glutathione peroxidase) and non-enzymatic antioxidants (vitamin A, C, E, lactoferrin and selenium), growth factors, oligosaccharides and glycoconjugates (Uruakpa et al. 2002; Przybylska et al. 2007; Moreno-Indias et al. 2012; Godhia & Patel 2013). It is also concluded that colostrum extends potent antioxidant ability against the reactive oxygen species (ROS) arising from oxidative stress in the metabolism (Zarban et al. 2009).

Colostrum intake by various newborns exhibits important morphological and functional improvements in the gastrointestinal tract, tissue and organ developments and reparations, and causes metabolic and endocrine changes (Odle et al. 1996; Xu 1996; Blum & Hammon 2000; Quigley et al. 2002b; Uruakpa et al. 2002). These marked improvements and changes in newborns fed with colostrum were the result of some distinguished factors. Growth factors and hormones, present in colostrum, effectively stimulate cellular growth and DNA synthesis in neonatal calves (Kuhne et al. 2000), enhance the rate of protein synthesis in some organs and skeletal muscles in newborn piglets (Burrin et al. 1992) and improve feed intake and growth rate in pigs (Dunshea et al. 2002). Also, Pluske et al. (1999) and King et al. (2001) reported that spray-dried colostrum added to pig starter diets have showed important performance benefits. On the other hand, in some previous studies it was declared that spray-dried or concentrate of colostrum supplementation to broiler, in a period of 14 days, improved growth performance parameters such as body weight gain, feed intake and feed conversion ratio (Qureshi et al. 2004; King et al. 2005). It seems that bovine colostrum in powdered form can practically be added to poultry diets for achieving positive effects on growth performance. However, the role of colostrum powder (CL-P) in the performance in broiler for a period of 42 days has not been investigated.

The purpose of this study was to evaluate the effects of CL-P supplementation to the Japanese quail on the performance, serum vitamins and lipid peroxidation.
2. Materials and methods

2.1. Animals, treatments and management

The birds were obtained from a commercial company (Insanay Kanatlı Hayvan Uretim Paz. Tic. Inc., Elazığ, Turkey), and were used in accordance with animal welfare regulations at the Veterinary Faculty of Dicle University, Diyarbakir, Turkey. One-day-old Japanese quails (Coturnix coturnix japonica, 90) were distributed randomly to one of three groups and each of the experimental groups was replicated in six cages (60 x 120 x 30 cm), each containing five birds. Quails were housed in wire cages at 37.5°C during the first days in temperature-controlled room. The room temperature was then gradually decreased to 22°C by the end of the third week and then kept constant. Feed and fresh water were offered ad libitum throughout the experiment.

2.2. Diet, sample and data collection

Birds were fed one of three diets: basal diet and basal diet supplemented with 2.5% or 5% CL-P for a period of 42 days. CL-P (Alpha Lipid Lifeline Colostrum, New Zealand) contained 13% protein, 0.3% fat and 59% carbohydrate. Experimental diets were stored in black plastic containers at 4°C to avoid photodestruction. Ingredients and chemical composition of the experimental diets are shown in Table 1. Feed intakes and body weights were recorded weekly, and weight gain and feed efficiency of birds were then calculated on a weekly basis. At the end of the experiment, 12 birds randomly chosen from each treatment group (two birds per replicate) were slaughtered for carcass evaluation. The carcasses were obtained by removing feather, feet and visceral organs. Carcasses were weighed after stocking carcasses at 4°C for 18 h and then carcass yields were calculated (carcass weight/body weight at slaughter). Blood samples were collected into biochemical tubes. The tubes containing blood samples were then centrifuged at 3000 rpm for 10 min at 4°C and serum was collected and stored at −20°C for later analysis.

2.3. Laboratory analyses

Serum vitamin A and E (Mori et al. 2003) and malondialdehyde (MDA; Karatepe 2004) levels were measured as described previously by the fully automatic high-performance liquid chromatography (HPLC, Shimadzu, Kyoto, Japan) system. The equipment for HPLC consisted of a pump (LC-20AD), a Diode Array Detector (DAD) (SPD-M10A), a column oven (CTO-10ASVP), an autosampler (SIL-20A), a degasser unit (DGU-20AS), insertil ODS-3 C18 column (250 x 4.6 mm, 5 μm) and a computer system with LC solution Software (Shimadzu, Kyoto, Japan).

Feed samples were analysed for crude protein (#988.05), crude fat (#932.06), crude fibre (#962.09), Ca (#968.08) and P (#965.17) in triplicate (AOAC 1990). Energy and amino acid (lysine and methionine+cystine) contents were calculated from tabular values listed for the feedstuffs (Jurgens 1996).

2.4. Statistical analyses

Performance variables (feed intake, weight gain and feed efficiency), serum vitamins and MDA levels were analysed by one-way ANOVA using the PROC MIXED procedure (SAS 2002). The linear model to test the effects of dietary CL-P supplementation on response variables was as follows: \( y_{ij} = \mu + b_0 + R_i + e_{ij} \), where \( y \) = response variable; \( \mu \) = population mean; \( b_0 \) = covariate, measurements obtained at the end of the pretest period; \( R = \) CL-P supplementation and \( e \) = residual error being N(\( \sigma \), \( \mu \), 0, 1). The model also included orthogonal and polynomial contrast to determine changes in response variables as supplemental CL-P level was increased (SAS 2002). Statistical significance was considered at \( P < .05 \).

3. Results

3.1. Effect of CL-P supplementation on growing performance and some organ weights

The effect of CL-P on performance parameters of growing quails for 42 days is shown in Table 2. There were linear increases in the final body weight \( (P < .0001) \), live weight gain \( (P < .0001) \), feed intake \( (P = .03) \), cold carcass weight \( (P < .0001) \) and yield \( (P < .01) \), and decrease in feed efficiency \( (P < .0001) \) as supplemental CL-P increased from 0% to 5% (Table 2). High doses of CL-P caused 6.8%, 11.0%, 5.6%, 11.4% and 10.1% increases in final body weight, live weight gain, feed intake, cold carcass weight and cold carcass yield, respectively, and 4.9% improvement in feed efficiency (Table 2). On the other hand, dietary CL-P supplementation did not cause an alteration in vital organ (liver, heart and spleen) weights in growing quails (Table 2).
animal species such as broilers, turkeys, dogs, rats, mice and extending important performance benefits to pigs and other (especially Igs with high molecular weight) to colostrum, protein supplement, and includes highly similar ingredients acids (Beski et al. 2015). Spray-dried plasma is a rich kind of because of deficiency in some nutrients, especially amino acids, globulins and probiotics than normal dried plasma. Additionally, it is specified above that dried CL-P bovine colostrum (Kishikawa et al. 1996; Pakkanen & Aalto 1997; Blum & Hammon 2000). It is also well known that amino acids, globulins and probiotics than normal dried plasma. Additionally, it is specified above that dried CL-P bovine colostrum (Kishikawa et al. 1996; Pakkanen & Aalto 1997; Blum & Hammon 2000). It is also well known that animal protein by-products must be added to poultry diets because of deficiency in some nutrients, especially amino acids (Beski et al. 2015). Spray-dried plasma is a rich kind of protein supplement, and includes highly similar ingredients (especially Igs with high molecular weight) to colostrum, extending important performance benefits to pigs and other animal species such as broilers, turkeys, dogs, rats, mice and calves (Thomson et al. 1994; King et al. 2001; Quigley et al. 2002a, 2004; Campbell et al. 2003, 2004; Balan et al. 2009). In the present study we observed that CL-P supplementation increased body weight gain, and decreased feed efficiency in quails with increasing dietary CL-P supplementation for 42 days of the experimental period (Table 2). Parallel to our study, enhancements of performance variables were declared by researchers in pigs and broilers fed with dietary spray-dried colostrum (Pluske et al. 1999; King et al. 2001, 2005). Also, King et al. (2005) declared that dietary spray-dried colostrum improved feed conversion ratio at day 14, and Qureshi et al. (2004) observed that protein concentrate having similar ingredients to colostrum increased body weight gain at day 13 in the growing stage of broilers. Indeed, it has been stated in literatures that CL-P supplementation extends important increase of palatability and enhancement of beneficial microflora population in the digestive system associated with better digestion and absorption of nutrients in animals (Cheeke 2005; Chiba 2014). We also achieved marked increases in feed intake, final body weight, cold carcass weight and yield in this study (Table 2). It has been presented that CL-P exerts marked growth promoter actions resulted with important increase of palatability and enhancement of beneficial microflora population in the digestive system associated with better digestion and absorption of nutrients in animals (Cheeke 2005; Chiba 2014). We also achieved marked increases in feed intake, final body weight, cold carcass weight and yield in this study (Table 2). It has been presented that CL-P exerts reported growth promoter actions which resulted in important raising in bone-free lean body mass production in active peoples (Antonio et al. 2001). Also, Fiorotto et al. (2000) proved that protein synthesis in the skeletal muscle can be enhanced by dietary colostrum in newborn piglets. On the other hand, rats fed with colostrum-supplemented (10%) diet showed no biochemical, physical or histopathological abnormalities after 90 days of application (Davis et al. 2007).

Serum MDA levels were significantly decreased, whereas serum vitamin A and E levels and organ weights were not different from control in quails fed with dietary CL-P supplementation. MDA is known as an end-product of lipid peroxidation by reactive oxygen species and it was effectively scavenged through inducing an antioxidant defence system with antioxidant agents or other biochemicals present in colostrum (Halliwell & Gutteridge 1989; McDowell 1989; Sumida et al. 1989; Przybylska et al. 2007). There are no previous studies on quail about effects of dietary CL-P supplementation on the serum MDA levels. So, we could not compare our results with any other study. However, supplementation of feed additives enriched with dietary antioxidant agents reduces the MDA levels in serum, muscle, egg yolk and liver by inhibiting ROS

| Variables, g | 0 | 2.5 | 5 | SEM | Statistical significance, P > F * |
|-------------|---|-----|---|-----|---------------------------|
| Final body weight | 177.35 | 184.70 | 189.43 | 1.770 | S: 0.0001, L: 0.0001, Q: 0.580 |
| Weight gain | 148.45 | 156.41 | 164.74 | 2.107 | S: 0.0001, L: 0.0001, Q: 0.941 |
| Cumulative feed intake | 668.97 | 689.05 | 706.29 | 9.767 | S: 0.03, L: 0.009, Q: 0.903 |
| Feed efficiencyb | 4.51 | 4.41 | 4.29 | 0.027 | S: 0.0001, L: 0.0001, Q: 0.863 |
| Carcass weighta | 116.69 | 125.70 | 129.93 | 1.345 | S: 0.0001, L: 0.0001, Q: 0.241 |
| Carcass yield, % | 64.00 | 68.16 | 70.43 | 1.589 | S: 0.01, L: 0.003, Q: 0.590 |
| Liver | 5.19 | 5.30 | 5.24 | 0.105 | S: 0.980, L: 0.925, Q: 0.862 |
| Heart | 1.83 | 1.81 | 1.85 | 0.098 | S: 0.969, L: 0.902, Q: 0.827 |
| Spleen | 0.12 | 0.11 | 0.12 | 0.008 | S: 0.888, L: 0.836, Q: 0.662 |

*Statistical contrast: S: CL-P supplementation effect (quail supplemented with CL-P vs. quail not supplemented with CL-P); L: linear effect of increasing dietary CL-P; Q: quadratic effect of increasing dietary CL-P.

Table 2. Effects of CL-P supplementation to quail diets on performance and organ weights.

| Variables | CL-P, % | 0 | 2.5 | 5 | SEM | Statistical significance, P > F * |
|-----------|---------|---|-----|---|-----|---------------------------|
| Vitamin A | 2.40 | 2.57 | 2.20 | 0.343 | S: 0.034, L: 0.0001, Q: 0.518 |
| Vitamin E | 9.56 | 8.87 | 10.02 | 0.499 | S: 0.0001, L: 0.0001, Q: 0.149 |
| MDA | 0.473 | 0.445 | 0.429 | 0.007 | S: 0.0001, L: 0.0001, Q: 0.457 |

*Statistical contrast: S: CL-P supplementation effect (quail supplemented with CL-P vs. quail not supplemented with CL-P); L: linear effect of increasing dietary CL-P; Q: quadratic effect of increasing dietary CL-P.

Table 3. Effects of CL-P supplementation to quail diets on serum vitamin and MDA levels.

3.2. Effect of CL-P supplementation on serum lipid peroxidation

Serum MDA, as an indicator of lipid peroxidation, significantly decreased (9.3%) in birds fed with CL-P-supplemented diets in increasing levels of 2.5–5% (P < .001, Table 3). Serum vitamin A and E levels were not affected by dietary CL-P supplementation to quail diets (Table 3).

4. Discussion

The present study was conducted to determine the effects of dietary bovine colostrum in powdered form on growth performance, serum vitamins and lipid peroxidation levels in Japanese quail. It is capacious that bovine colostrum is a highly nutritious fluid and essential for the development and immune status of newborns (Przybylska et al. 2007; Godhia & Patel 2013). Additionally, it is specified above that dried CL-P supplement (Alpha Lipit Lifeline) used in this study contains more quantities of nutrients such as carbohydrates, fats, amino acids, globulins and probiotics than normal dried bovine colostrum (Kishikawa et al. 1996; Pakkanen & Aalto 1997; Blum & Hammon 2000). It is also well known that animal protein by-products must be added to poultry diets because of deficiency in some nutrients, especially amino acids (Beski et al. 2015). Spray-dried plasma is a rich kind of protein supplement, and includes highly similar ingredients (especially Igs with high molecular weight) to colostrum, extending important performance benefits to pigs and other animal species such as broilers, turkeys, dogs, rats, mice and calves (Thomson et al. 1994; King et al. 2001; Quigley et al. 2002a, 2004; Campbell et al. 2003, 2004; Balan et al. 2009).
formations in animals exposed to different environmental stress conditions (Akdemir & Sahin 2009; Sahin et al. 2010, 2014; Orhan et al. 2012; Akdemir et al. 2015). On the other hand, as mentioned above, beneficial enzymatic and non-enzymatic antioxidants presented in colostrum can ameliorate gastrointestinal disorders, bacterial sepsis and oxidative stress caused by ischemia/reperfusion (I/R) injury (Playford et al. 1999; Struff & Sprotte 2008; Choi et al. 2009). Kwon et al. (2010) also indicated that antioxidant enzyme levels can be increased and MDA levels decreased by colostrum supplementation in rats manifesting intestinal I/R injury. Recently, Jahantigh et al. (2011) declared that dietary colostrum supplementation at 20–30% of body weight significantly decreased serum MDA and increased antioxidant activity in both control and diabetic rats.

5. Conclusions

In conclusion, the present study shows that dietary supplementation with CL-P, including nutrients, antioxidants and other bioactive agents, extends the performance-enhancing ability in quails fed for an experimental period of 42 days. Also, use of CL-P as feed additive in quail diets led to significant decrease in serum lipid peroxidation. However, further studies are needed to comment on the economical potency of its use in the poultry industry.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This study was supported by a grant Dicle University Scientific Research Project Unit [DUBAP, 10-VF-156].

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