Effect of diet dilution at early age on performance, carcass characteristics and blood parameters of broiler chicks

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Abstract

The effect of energy and protein dilution during 16 to 20 d of age, on performance, carcass characteristics and blood parameters of broiler chickens was studied in a completely randomized design with 3 treatments and 3 replicates in each treatment. A total of 144 mixed-sex chickens (Cobb 500) were randomly allocated to 9 pens. In order to dilute the diets three levels (0, 20 and 40%) of rice hull was used. During the experiment feed intake, body weight gain, feed conversion ratio were measured weekly. The results indicated that dilution of diet from 16 to 20 d of age increased feed intake in this period, but adjusted feed intake (excluded rice hull) was decreased (P<0.05). Restricted bird consumed more feed in the whole period of the experiment (16 to 44 d). With increasing dilution rate during restriction period, body weight gain of chickens decreased in comparison to control group (P<0.05). Due to compensatory growth after restriction period, restricted chickens had higher body weight gain than control groups at 44 d of age. Feed dilution up to 20 percent had not significant effect on feed conversion ratio in the whole period of the experiment. Diet dilution had not significant effect on carcass, breast meat, legs, proventriculus, heart and feet weight proportion. Diet dilution significantly increased gizzard weight proportion, and decreased abdominal fat pad weight, carcass crude fat, and increased carcass crude protein proportion (P<0.05). Feed dilution up to 20% increased HDL and decreased LDL concentration in plasma at 21 d of age. Diet dilution up to 40% decreased the concentrations of cholesterol, triglyceride, plasma T₃, and increased the concentrations of uric acid and plasma T₄ at 21 d of age (P<0.05). Diet dilution up to 20 percent increased plasma glucose concentration at 42 d of age (P<0.05). The results of the present study indicated that feed dilution with 20% rice hull during 16 to 20 d of age had not adverse effect on broiler performance and it also reduced abdominal fat pad weight and carcass crude fat proportion.

Introduction

Modern broiler strains are characterized by a very high growth rate and a low conversion ratio. On the other hand, high incidences of metabolic diseases, leg problems and an increased fat deposition are typical for these extreme selected lines (Leeson, 2007). These negative aspects are of major concern for the farmer and processor, because they can bring about important economic losses (Lippens et al., 2002). Feeding strategies in growing broiler chickens should be aimed at optimizing lean carcass tissue, feed conversion ratio (FCR) and body weight gain (Gous and Cherry, 2004). Nutrient restriction is usually employed to tackle problems that accompany early-life fast growth rate in broilers, such as increased body fat deposition, high incidence of metabolic disorders, increased mortality, and high incidences of skeletal diseases (Crouch 2000; Saleh et al., 2005; Ozkan et al., 2006; Rezaei et al., 2006). Feed dilutions have also been used to change the carcass composition of broiler chickens (Nielson et al., 2003). Success of feed dilution programs is measured based on complete compensatory growth and the amount of body fat content (Hassanabadi and Nassiri Moghaddam, 2006). Compensatory growth is defined as the rapid weight gain that usually follows a period of reduced nutrient intake of an animal, when it is placed back. Osbourn and Wilson (1960) demonstrated compensatory growth in poultry, following a period of growth retardation by early feed dilution. This means that there is potential to underfeed broiler chickens for some time, without affecting weight at normal market age. Male broilers have a greater ability to exhibit compensatory growth, after a period of undernutrition, than females (McMurtry et al., 1988; Plavnik and Hurwitz, 1991). As nowadays the consumer puts high demand upon animal welfare, production systems and feed additives, two qualitative feed dilutions have been chosen taking in account these aspects. Dilution of the diet with oat hulls, rice bran, cellulose, can be a rather easy way to induce growth retardation. Leeson et al. (1991) found a complete recovery of body weight at the age of 42 d, after diet dilution with rice hulls up to 53% from 4 to 11 d of age. The overall efficiency of feed utilization was not affected, although during the diluted period bird increased their feed consumption in an attempt to maintain their energy intake. However, there was an indication of reduced abdominal fat content for males at 56 d. Zubair and Leeson (1994a) reported no difference in body weight at either 42 or 49 d when birds were fed with a 50% oat-hull diluted diet for six d. In another trial, Leeson et al. (1992) offered bird a conventional finisher diet diluted up to 50% with a 50:50 mixture of sand, and oat hulls from 35 to 49 d of age, and showed no significant difference in body weight at 49 d or breast weight at 42 or 49 d of age. Restriction of feed intake of broilers by chemical means was suggested in literature as an alternative to diet dilution. Therefore, the aim of the present trial was to examine the effect of diet dilution on performance, carcass characteristics and blood parameters of broiler chickens.

Materials and methods

A total of 144, one-d old mixed-sex broiler chickens (Cobb 500) were obtained from a commercial hatchery on the hatching day. The experimental design was completely randomized design (CRD) with 3 treatments, 3 replicates and 16 chicks in each replicate. In this experiment, diet dilution was achieved by substitution of rice hull for the major ingredients in the control diet. The experimental diets, containing 0, 20, 40% rice hull were formulated by using corn, soybean meal and wheat as main ingredients (Table 1). Chickens were fed with starter diet (1 to 10 d) and grower diet (11...
At d 16, chickens were subjected to diet diluted until 20 d of age. After this period, chickens were fed with grower diet up to 28 d of age and finisher diet up to 44 d of age. All diets were formulated to meet the nutrient requirements according to Cobb 500 rearing guideline. The composition of experimental diets are shown in Table 1. Rice hull contained 91% DM, 18.71% Ash, 41.4% CF, 2.4% CP, and 0.5% EE, and 27.9% NFE. The room was lighted up continuously during the whole experimental period and room temperature was controlled at 32°C from 1 to 3 d and then gradually reduced by 2-3°C per week to a final temperature of 18°C. During the experiment weight gain, feed intake and feed conversion ratio were measured weekly. Blood samples were collected from wing veins of 12 birds in each treatment at 21 and 42 d of age. To prevent coagulation, blood samples were mixed with EDTA and centrifuged at 3000xg for 10 minutes. Plasma stored at -20ºC until hormone and metabolite analyses were carried out. Plasma glucose concentration was determined as mg/dL using commercial laboratory kits (zist-shimi and parsazmoon) with god-pap method at 546 nm wavelengths. Triglyceride, cholesterol, LDL-cholesterol and HDL-cholesterol were measured using commercial laboratory kits (Friedewald et al., 1972; Gordon and Amer, 1977). The concentrations of plasma thyroxine (T4) and triiodothyronine (T3) were measured by radioimmunoassay (RIA) using standard commercial kits (Pishtazteb) according to the procedure of Kloss et al. 1994 (Gama manic1, Contron, Italy, with Automatic Gama Counter). At the end of the experiment (44 d) 4 birds from each pen with body weight close to the mean of each pen were selected for carcass analyses. After feed withdrawal for 9 h, the selected birds were transported to the university pilot for processing. The chickens were slaughtered by cervical dislocation to determine the carcass characteristics. In order to determine carcass composition 12 chickens per treatment were scarrificd and after freeze drying, samples were finely ground, and carcass protein (Kjeldahl N), ash and fat (ether extract) were analyzed according to AOAC (1990). Dry matter was determined as a percentage of total wet carcass weight. The percentage of carcass protein, ash and fat were reported on a DM basis.

### Table 1. Composition of basal diets in different period of the experiment (%).

| Ingredients          | Starter 1-10 d | Grower 11-28 d | Experimental treatment* 16-20 d | Finisher 29-44 d |
|----------------------|---------------|----------------|---------------------------------|-----------------|
| Corn                 | 43.69         | 37.42          | 37.42                           | 30.70           |
| Soybean meal         | 35.67         | 31.46          | 31.46                           | 22.54           |
| Wheat                | 15.00         | 25.00          | 25.00                           | 21.00           |
| Soybean oil          | 1.83          | 2.35           | 2.35                            | 2.30            |
| Rice hull            | 0.00          | 0.00           | 0.00                            | 20.00           |
| Dicalcium phosphate  | 1.30          | 1.19           | 1.19                            | 1.22            |
| Oyster shell         | 1.23          | 1.31           | 1.31                            | 1.35            |
| Salt                 | 0.3           | 0.3            | 0.3                             | 0.3             |
| Vitamin premix°      | 0.25          | 0.25           | 0.25                            | 0.25            |
| Mineral premix⁴       | 0.25          | 0.25           | 0.25                            | 0.25            |
| DL-Methionine        | 0.32          | 0.30           | 0.30                            | 0.28            |
| L-Lysine HCl         | 0.17          | 0.18           | 0.18                            | 0.16            |
| Total                | 100           | 100            | 100                             | 100             |

Calculated analysis

|                  | Starter 1-10 d | Grower 11-28 d | Experimental treatment* 16-20 d | Finisher 29-44 d |
|------------------|---------------|----------------|---------------------------------|-----------------|
| ME (Kcal kg⁻¹)   | 2950          | 3000           | 3000                            | 1800            |
| Crude protein     | 22.00         | 21.00          | 21.00                           | 16.80           |
| Calcium           | 0.86          | 0.86           | 0.86                            | 0.86            |
| Available phosphorus | 0.43       | 0.43           | 0.43                            | 0.43            |
| Sodium            | 0.14          | 0.14           | 0.14                            | 0.14            |
| Arginine          | 1.47          | 1.36           | 1.36                            | 1.03            |
| Lysine            | 1.33          | 1.23           | 1.23                            | 0.98            |
| Methionine        | 0.35          | 0.33           | 0.33                            | 0.35            |
| Methionine + cystine | 1.00      | 0.94           | 0.94                            | 0.80            |
| Threonine         | 0.86          | 0.80           | 0.80                            | 0.58            |
| Tryptophan        | 0.28          | 0.26           | 0.26                            | 0.21            |

*Supplied per kilogram of diet: 6059 µg vitamin A (retinyl acetate + retinyl palmitate), 55 µg vitamin D₃, 22.05 µg vitamin E (α-tocopheryl acetate), 2 mg vitamin K₃, 5 mg vitamin B₁₂, 6 mg vitamin B₆, 60 mg vitamin B₂, 4 mg vitamin B₁, 0.02 mg vitamin B₁₂₁₀, 10 mg pantothenic acid, 5 mg folic acid, 0.15 mg biotin, 0.625 mg ethoxyquin. °Supplied per kilogram of diet: 500 mg CaCO₃, 80 mg Fe, 80 mg Zn, 80 mg Mn, 10 mg Cu, 0.3 mg I, 0.3 mg Se. *Treatment 1, 2, 3 contain 0, 20, and 40 percent of rice hull, respectively.

Statistical analysis

The experimental design was completely randomized design (CRD) with 3 treatments and 3 replicates in each treatment. Data of this experiment were subjected to analysis of variance using GLM procedures (SAS institute, 2001). When significant differences were detected, means were compared by the Duncan’s multiple range tests at 5% probability (Duncan, 1955).
Results and discussion

Feed intake
During the period of diet dilution, birds fed with 40% restricted diet significantly consumed more feed (Table 2). This is in contrast with the findings of Leeson et al., 1991, Yussefi Kelaricolaie et al., 2001 and Zhan et al., 2007. If rice hull is excluded from the calculation of feed intake (assumed indigestible) the feed intake of birds under restriction is reduced (P<0.05). During the 21 to 44 d (re-alimentation period), diet dilution increased feed intake in broiler chickens. Similarly feed intake between 16 to 44 d of age increased by the diet dilution during 16 to 20 d of age. Results of the present study are in agreement with the finding of Osburn and Wilson (1960). The great variability of data shown in the literature regarding early feed restriction in broilers seems to be related to several factors, i.e., severity and duration of feed restriction, broiler age, refeeding period (Lippens et al., 2000) and energy level (Downs et al., 2006). Zubair and Leeson (1994b) reported hypertrophy of the digestive tract associated with higher feed intake relative to body weight in restricted chickens, which is in agreement with the findings of the present study. Kamran et al. (2008) examined effect of low protein diets having constant energy/protein ratio. Weight gain was linearly decreased (P<0.001), whereas feed intake and feed conversion ratio were increased (P<0.001) linearly as dietary protein and energy decreased during grower, finisher, and overall experimental periods. It seems that, being necessary to obtain nutrient requirements and to show compensational effects.
tory growth, restricted broiler chickens consumed more feed; we conclude that diet dilution increased chickens’ appetite in the whole period of the experiment.

**Body weight gain**

With increasing level of dilution there was a corresponding reduction in body weight gain during restriction period (Table 2). When bird resumed eating the regular undiluted grower diet after 21 d of age, chickens’ body weight gain was increased. Treatment 2 caused the highest body weight gain in the whole period of the experiment. Obviously, that was due to high level of feed intake. Broiler chickens under feed dilution could show compensatory growth at 44 d of age. This is in agreements with the findings of Rezaei *et al*., 2006; Tumova *et al*., 2002; Lee and Leeson, 2001. An enhanced rate of growth exceeding the rate of normal gain occurs when growth has been retarded by nutritional deprivation and followed by ad libitum feeding (Khetani *et al*., 2008). There is a transient decrease in basal metabolic rate of feed restricted bird, leading to less energy required for maintenance (Rincon and Leeson, 2002; Tolkamp *et al*., 2005).

Birds with retarded growth due to undernutrition can achieve a growth rate higher than normal for chronological age after removal of the feed restriction (Plavnik and Hurwitz, 1985). This compensatory growth or catch up growth exhibited by restricted birds allows the recovery of body weight at slaughter age and sometimes a higher body weight than that of birds fed ad libitum (Plavnik and Hurwitz, 1990).

However, the mechanisms responsible for this capacity have not yet been fully clarified. McMurtry *et al*., 1988 stated that changes in the weight gain composition, higher efficiency of energy utilization and reduction in maintenance requirements, or a combination of these factors, contribute to the phenomenon of compensatory growth. However, other factors are related to total or partial compensatory gain as sex, qualitative or quantitative feed restriction, feed restriction severity, strain and broiler age (Yu and Robinson, 1992).

Although compensatory gain after feed restriction has been investigated, the hormonal profile involved in this process has not been often studied. In chickens, as well as in other species, the animal metabolism is controlled by a variety of hormones that form a complex system directly affecting growth. Among hormones, growth hormone (GH), insulin-like growth factor-1 (IGF-1), insulin, triiodothyronine (T3) and thyroxine (T4) have been reported to be involved in broiler growth control (Scanes *et al*., 1984). However, it should be emphasized that the final growth expression is the result of interactions among nutritional, environmental, and genetic factors interacting with endocrine secretion.

**Feed conversion ratio**

During the period of diet dilution (16 to 20 d of ages), feed dilution increased feed conversion ratio (Table 2). If rice hull is again assumed to be indigestible, then adjusted feed conversion ratio decreases (P < 0.05). Yu *et al*., (1990) reported that feed efficiency was inferior for the restricted chickens during the first week after resuming *ad libitum* feeding, but it later improved slightly beyond the feed efficiency for the unrestricted chickens. Diet diluting had no significant effect on feed conversion ratio of broiler chickens in comparison to control group in the whole period of the experiment (16 to 44 d). Excluding rice hull in diets, birds fed with diet diluted at the level of 20% had lower feed conversion ratio (16 to 44). Similarly, during re-alimentation period (21-44 d), birds fed with treatment 2 had the lowest feed conversion ratio. This is in agreement with the findings of Govaerts *et al*., 2000; Rincon, 2000; Tumova *et al*., 2002 and Tolkamp *et al*., 2005. They reported a period of slow growth, followed by compensation to regular market weight, reduced maintenance costs as well as improved feed efficiency. Osbourn and Wilson (1960) reported that increased appetite following re-feeding is largely responsible for any improved growth and feed efficiency associated with compensatory growth. These results are in contrast with the findings of Khetani *et al*., 2008. They designed 3 treatments (T1 control, T2 one week of feed dilution and T3 two weeks of feed dilution) in their experiment and reported there was no significant difference among broiler chickens’ feed conversion ratio.

**Carcass characteristics**

Carcass weight and feet weight expressed as the percent of live weight were not affected by feed dilution (Table 3). Legs, breast meat, proventriculus and heart weight proportion were not affected by dilution. Leeson *et al*., 1991; Zubair and Leeson, 1994a; Palo *et al*., 1995; Lippens *et al*., 2000; and Rezaei *et al*., 2006 could not demonstrated any effect of feed dilution on dressing proportion and other carcass characteristics. In contrast with these results, Saleh *et al*., (1996) found an improvement in dressing proportion while final body weight was significantly reduced. Inducing a significant improvement of the breast meat proportion with feed dilutions is rarely seen in literature (Saleh *et al*., 1996). In contrast, when restrictions are rather severe, lower breast meat proportions should be expected (McGovern *et al*., 1999). A reduction in abdominal fat content with concomitant reduction in body weight were found by Plavnik and Hurwitz (1985, 1991); Jones and Farrell, 1992; Santoso *et al*.,

| Treatment | 1 | 2 | 3 | SEM |
|-----------|---|---|---|-----|
| **21 d of age** | | | | |
| Glucose, mg/dL | 235.9 | 230.1 | 233.0 | 1.99 |
| Cholesterol, mg/dL | 137.0a | 127.2a | 121.3c | 1.58 |
| HDL, % | 55.6b | 62.9a | 55.5b | 1.54 |
| LDL, % | 39.6b | 32.5b | 40.3a | 1.46 |
| Triglycerides, mg/dL | 34.1a | 28.2a | 24.4a | 1.24 |
| Uric acid, mg/dL | 147.3ab | 150.4ab | 155.0a | 1.80 |
| T3, µg/dL | 3.2a | 3.1ab | 2.5b | 0.15 |
| T4, nmol/L | 46.3a | 58.5b | 65.6a | 1.72 |
| **42 d of age** | | | | |
| Glucose, mg/dL | 232.9b | 239.4a | 238.3ab | 1.68 |
| Cholesterol, mg/dL | 140.0 | 139.3 | 138.9 | 1.17 |
| HDL, % | 56.8 | 59.2 | 57.3 | 1.38 |
| LDL, % | 37.7 | 35.7 | 37.3 | 1.62 |
| Triglycerides, mg/dL | 37.2 | 34.6 | 36.5 | 1.44 |
| Uric acid, mg/dL | 168.1 | 173.5 | 169.5 | 1.84 |
| T3, µg/dL | 0.8 | 1.0 | 1.2 | 0.14 |
| T4, nmol/L | 32.8 | 35.3 | 33.0 | 1.52 |

*Percentages of total lipoprotein.*
including feathers) were not changed by significantly. This is in contrast with the findings of Harris and Martin, 1984; De Boer carcass crude protein proportion, and it decreased abdominal fat pad at 63 d of age. Other researchers were not able to show a clear effect (Urrutia-Rincon and Leeson, 2002; Saleh et al., 2005; Novele et al., 2008). This inconsistency may be due to the different strategies of feed dilution applied, conditions of re-alimentation, age of imposition, strain of bird and sex, all of which may affect the birds’ response. In this study abdominal fat pad weight proportion in restricted birds on 44 d of age was significantly lower than in control birds (Table 3). Zubair and Leeson, (1996) showed that feed restricted bird usually had a numerically smaller abdominal fat pad. Cherry et al., 1984 concluded that although hyperplasia proceeds during period of nutrient restriction, the adipocytes remain smaller. Similarly Rosebrough et al., (1986) observed reductions in both liver size and lipogenesis in 12 d-old bird subjected to feed dilution from 6 to 12 d. The rate of lipogenesis in feed restricted broiler chickens was lower compared to the rate of lipogenesis found in ad libitum fed chickens up to 54 d of age (Rosebrough and McMurtry, 1993; Zhong et al., 1995). Data of the present study showed that diet dilution up to 40 percent, increased gizzard proportion in restricted birds (Table 3). This is in agreement with the findings of Zubair and Leeson (1994b).

These investigators observed hypertrophy of the digestive tract associated with higher feed intake relative to BW in chickens subjected to early feed restriction. They did not observe reduction of maintenance requirements during refeeding, which, according to a number of investigators, could explain a higher efficiency in energy retention after the restriction period (Harris and Martin, 1984; De Boer et al., 1986).

**Carass composition**

There were not any significant difference among chickens carcass dry matter and ash proportion (Table 3). Feed dilution increased carcass crude protein proportion, and it decreased carcass crude fat proportion significantly. This is in contrast with the findings of Lippens et al., 2002. They reported that total protein and total fat content (% entire animal including feathers) were not changed by restrictions. The result of this study is in agreement with Yu et al. (1990), who reported that bird under restriction had lower carcass fat and abdominal fat pad.

**Blood parameters**

Evaluation of plasma biochemistry in bird allows the identification of metabolic alterations due to a realm of factors, including genetic type, husbandry conditions, age, physiological state and pathology (Harr, 2002; Gayatri et al., 2004; Juráni et al., 2004; Alonso-Alvarez, 2005). The stress induced by feed dilution may reflect in dramatic changes to the plasma biochemistry. Previous researches in poultry showed that feed dilution modified the plasma levels of hormones that modulate energy metabolism and growth, such as T3, T4, growth hormone (GH), insulin-like growth factor-I (IGF-I), plasminogen activator inhibitor, vitamin D (D3), thyroid hormones, including T3, and lipogenesis (Dewil et al., 1999). The findings of Rosebrough et al. (1992, 1999) are in agreement with this assumption; they reported that neither the increase of dietary energy to protein ratio nor the addition of T3 altered the plasma glucose levels of male broiler chicks. Lipid accumulation in cells depends on the balance between lipogenesis and lipolysis of TAG and it is subjected to both nutritional and hormonal control (Kersten, 2001). Results showed that diet dilution up to 20 percent increased HDL%, and decreased LDL% in plasma in comparison to control group at 21 d of age. With diet dilution up to 40 percent, plasma cholesterol and triglyceride concentration decreased at 21 d of age. Yaman et al. (2000) reported similar TAG pattern in growing feed-deprived chickens, while plasma cholesterol was not influenced. Zhan et al. (2007) reported that feed dilution (feed deprived for 4 h per d from 1 to 21 d) decreased serum triglyceride concentration and increased serum free fatty acid concentration of broiler chickens at 21 d of age. Table 4 shows that feed dilution decreased plasma T3 and increased plasma T4 concentration in at 21 d of age. This is in agreement with the findings of Darras et al., 1995; Bruggeman et al., 1997; Kubiková et al., 2001; and Rajman et al., 2006. Thyroid hormones, including T3 and T4, are recognized as the key metabolic hormones of the body, with T3 being the most functionally active form. The majority of circulating T3 is derived from the deiodination of T4 in nonthyroidal tissues such as liver and kidney. The serum level of thyroid hormones is associated with protein synthesis and energy production. Bruggeman et al. (1997) showed that T3 concentrations decreased and T4 concentration increased in both restricted and ad libitum fed chicks during ontogeny (2-4 weeks). However, the nutrition effect was more marked than the age effect. The changes in plasma TH levels in feed restricted bird likely result from a shift in the balance between deiodination of T3 by hepatic D1, and T3 degradation by hepatic D3 deiodinases (Darras et al., 1995; Reym et al., 2002). Long-term feed dilution did not diminish hepatic D1 activity but considerably elevated the hepatic D2 activity, thereby possibly contributing to the decreased plasma T3 concentrations (Darras et al., 1995; Reym et al., 2002). In this study, feed dilution increased T3 concentration in blood, which is in contrast with the findings of Hassanabadi and Nassiri Moghadam, (2006), and Zhan et al., 2007. Any changes in protein catabolism would be mainly reflected by uric acid concentrations. In the present study, feed dilution increased plasma uric acid concentration at 21 d of age, which is in agreement with the findings of Mbugua et al., 1995, Lin et al., 2004 and Alonso-Alvarez and Ferrer, 2001.

Rosebrough et al., 1992, 1999) found that decreasing the dietary energy to protein ratio increased plasma uric acid in broiler chickens. Addition of T3 decreased uric acid concentration. There was a trend toward increase of uric acid from d 58 till the end of experiment in severe feed restricted bird observed in this study and a significant increase at 100 d of age. Mbugua et al. (1985) found a consistent increase in plasma uric acid levels in laying chickens after feed dilution from nine to 19 weeks of age. High levels of plasma uric acid have been associated with the use of structural proteins as an energy source when animals reach the limit of their fasting capability (Alonso-Alvarez and Ferrer, 2001). Long-term dietary supplementation of corticosterone to broiler chickens resulted in elevation of plasma corticosterone and caused significant increase of plasma uric acid and enhanced protein catabolism (Lin et al., 2004), that was further reflected in suppressed body mass. This result is in contrast with the findings of Rajman et al. (2006).

The results of the present experiment showed that diet dilution up to 20% increased plasma glucose concentration at 42 d of age. This is in agreement with the findings of Zhan et al. (2007). The higher level of glucose might
be due to the enhanced insulin resistance and reduced glucose tolerance caused by the metabolic programming for early malnutrition (Zhan et al., 2007). This result is in contrast with the findings of Rajman et al. (2006), who reported that concentration of glucose was not altered by feeding treatment. Table 4 shows that there was not any other significant difference among chickens’ blood parameters at 42 d of age.

Conclusions

In conclusion, the use of rice hull up to 20% for diet dilution from 16 to 20 d of age had not adverse effect on broiler chickens performance, since broilers could reach higher body weight at 44 d of age and they had lower feed conversion ratio compared to control diet (containing 0% rice hull). Abdominal fat pad and crude fat in carcasses obtained from chickens fed with diluted diets were significantly decreased compared with the carcasses from control chickens, while their carcass crude protein was increased. Using rice hull in broiler chickens (Cobb 500), diets had not any adverse effect on carcass characteristics. Feed dilution up to 20% increased HLDL%, and decreased LDL% in plasma at 21 d of age. Diet dilution up to 40% decreased the concentrations of cholesterol, triglyceride and Tg and increased the concentrations of uric acid and Tt in plasma at 21 d of age. Diet dilution up to 20% increased plasma glucose concentration at 42 d of age, but there was no significant difference among other blood parameters.

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