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Original Research Article

Growth Performance, Carcass Characteristics and Blood Serum Biochemistry of Broiler Chickens Fed Different Levels of Dried Whey

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Abstract

A total of 160, Cobb 500 broiler chicks at 1 week of age were randomly assigned to four treatments each of four replicates. The dietary treatments consisted of the basal diet as control, dried whey (DW) groups receiving 1.0, 1.5 and 2.0 g/kg DW added to the basal diet. Body weights of chicks were measured at 1, 3 and 6 wks of age, feed intake was measured at the same periods and feed conversion was calculated, accordingly. At 6 weeks of age, carcass characteristics and blood profile were determined. Live body weight and body weight gain were not significantly influenced by the dietary treatments. Giblets and abdominal fat percentage of broiler chicks at 6 wks were affected by dietary treatments. There were significant effect ($P<0.05$) on total protein, globulin, creatinine, urea, HDL-cholesterol, triglyceride and LDL-cholesterol due to treatments. While, the other blood parameters were not statistically affected by DW supplementation. The lowest value of creatinine and urea achieved by broilers fed diet contained 2.0 DW g/kg diet. Chicks fed DW at levels of 1.5 and 2.0 g/kg of diet produced the best results of total-cholesterol in blood versus other diets. Also HDL- cholesterol, LDL and triglyceride were significantly decreased with increasing the level of DW supplementation. It could be concluded that dietary supplementation with DW could improve growth performance of broiler chickens, in addition to lowering abdominal fat and blood content of cholesterol, creatinine and urea which means more healthy product.

Keywords

Broiler chicks
Carcass
Dried whey
Performance
Serum metabolites

Introduction

The main goals of using antibiotics in poultry industry worldwide are to improve growth performance and protect from diseases. However, repeated use of antibiotics in poultry diets resulted in severe problems like resistance of pathogen to antibiotics, accumulation of antibiotics residue in animal products and environment, imbalance of normal microflora, and reduction in beneficial intestinal microflora (Barton, 2000). These concerns resulted in severe restriction or total ban on the use of antibiotics in animal and poultry industry in many countries. As a result, the poultry industry must focus on alternative antibiotics for maintaining health and performance under commercial conditions. Probiotics refer to a group of nonpathogenic organisms that, when administered in sufficient amount, are known to have beneficial effects on health of the host (Mountzouris et al., 2007).

Several studies reported beneficial effects of probiotics and feed additives on growth performance (Kim et al., 2011; Ashour et al., 2014; Alagawany et al., 2015 a, b), nutrient retention (Shim et al., 2010), gut health (Awad et al., 2010), intestinal microflora (Mountzouris et al., 2010), reduced the susceptibility to diseases (Mulder et al., 1997), enhanced immunity function (Molnar et al., 2011), and improved carcass yield and quality in poultry (Bielecka et al., 2010). It showed that broiler chicks can be fed on *Lactobacillus bulgaricus* strain from skimmed milk as a growth promoter to improve performance, nutrient digestibility and antibody production under hot and humid conditions which prevail in the tropics (Apata, 2008).

Whey or a liquid remaining from cheese or casein production is one of the most valuable protein sources in human food chain. In spite of its balanced nutrients, liquid whey is disposed as a waste product. Liquid whey has a high biological oxygen demand so its disposal in rivers kills living organisms. Environmental pollution is also a concern in many countries (Thivend, 1977). In theory protein content of whey includes alpha and beta-lactaglubolins and can be used a valuable source of protein to animals (Brunner, 1981).

Dried whey (DW) that is produced from its liquid form can be used in chickens (Susmel et al., 1995). For years, DW is used in monogastric nutrition (Damron et al., 1971; Balloun and Khajarern, 1974). It is shown that dietary supplementation of whey powder linearly increased body weight gain and nitrogen retention in broiler chickens (Al-Ubaidi and Bird, 1964). Dietary supplementation of DW to monogastric animals significantly improved digestible protein and fat, feed to gain ratio (Balloun and Khajarern, 1974) and increased the absorption of minerals like Ca, P, Cu, Fe and Mg (Earl and Salim, 1982).

According to Schingoethe (1976) and Morishita et al. (1982), whey contains unidentified growth factors. Whey is considered an immune system enhancer, since its major protein fractions are α-lactoglobulin and β-lactalbumin. The yellow green color of whey is due to the presence of B-group vitamins, in particular vitamin B_2. Therefore, it seems that acid whey may act as a natural probiotic in birds, enhancing their immunity, improving survival rates, and stimulating the growth of beneficial intestinal bacteria.

The aim of this study was to evaluate the potential of increasing levels of dried whey as a natural antioxidant and growth promoter in broiler chicken diets, using higher inclusion levels than in previously published experiments.

Materials and methods

Birds, experimental design and feeding

The present investigation was carried out at Poultry Research Farm, Department of Poultry, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. All experimental procedures were carried out according to the Local Experimental Animal Care Committee, and approved by the ethics of the institutional committee of Department of Poultry, Faculty of Agriculture, Zagazig University, Zagazig, Egypt at November 2014.

A total number of 160 growing broiler chicks of one wk-old with average initial body weight of 117.13±1.34 g were used in a complete randomized design experiment with four treatments; 40 chick in four replicates (4×4×10). Chicks were housed in galvanized wire cages (40 cm high × 50 cm width × 100 cm length) in (ten chicks each) and fresh water was automatically available at all time. Dietary treatments were as follows: 1) Control (basal diet); 2) (basal diet+1.0 g whey /kg diet); 3) (basal diet+1.5 g whey /kg diet); 4) (basal diet+ 2.0 g whey /kg diet). Each group of broiler chicks was fed the experimental diet (in mach) from 1-5 weeks of age.

The experimental diets were fed in 2 phases: starter (1-3 wks) and finisher (3-6 wks). Feed and water were offered *ad-libitum* through the experimental period. All chicks were kept under the same managerial, hygienic and environmental conditions. Chicks were fed to cover their requirements according to NRC

(1994). Vaccinations and medical program were done according to the stages of age under supervision of a veterinarian. The formulation and composition of commercial broiler chick basal diets are shown in Table 1. Whey dried purchased from Free Trade Egypt Company, Behira, Egypt.

Table 1. Composition and chemical analysis of the basal diets.

Ingredients	Basal diets	
	Starter (1-3 weeks)	Finisher (3-6 weeks)
Ingredients (%)		
Yellow Corn	57.13	60.53
Soybean meal	31.65	27.15
Gluten meal	6.50	6.10
Di Calcium phosphate	1.70	1.50
Limestone	1.24	1.15
Vit-min Premix*	0.30	0.30
NaCl	0.30	0.30
DL-Methionine	0.05	0.02
L-Lysine	0.13	0.10
Soybean oil	1.00	2.85
Total	100	100
Calculated analysis**		
CP %	23.00	21.00
ME Kcal/kg diet	2951	3099
Ca %	1.00	0.90
P (Available) %	0.45	0.40
Lysine %	1.20	1.05
M+C %	0.83	0.74
CF %	3.56	3.31

* Growth vitamin and Mineral premix Each 2.5 kg consists of : Vit A 12000, 000 IU; Vit D3, 2000, 000 IU; Vit. E. 10g; Vit k3 2 g; Vit B1, 1000 mg ; Vit B2, 49g ; Vit B6, 105 g; Vit B12, 10 mg; Pantothenic acid, 10 g; Niacin, 20 g, Folic acid , 1000 mg ; Biotin, 50 g; Choline Chloride, 500 mg, Fe, 30 g; Mn, 40 g; Cu, 3 g; Co, 200 mg; Si, 100 mg and Zn , 45 g.
** Calculated according to NRC (1994).

Traits measured

Chickens were weighed individually at weekly intervals. Mortality was recorded daily. Average daily feed intake (ADFI), body weight gain (BWG) and feed to gain ratio (FCR) were calculated from these data by period and cumulatively. Feed wastage was recorded daily and the data were used to estimate feed consumption. At the termination of experiment, 16 broiler chicks (four each group) were sampled randomly for carcass evaluations at 6 wks of age, weighed and manually slaughtered. Carcass weight (the main body, gizzard, liver, heart and other total edible parts) were determined according to Blasco et al. (1993). The carcasses were weighed and the weights of the liver, gizzard, heart, thigh, breast and abdominal fat were recorded and expressed as g/kg of slaughter weight. Carcass and dressed weights were studied [(dressed weight = carcass weight + giblets weight)/live body weight].

Blood samples were collected from sacrificed broiler chicks in clean sterile tubes. Samples were let to coagulate and centrifuged at 3500 rpm for 15 minutes to obtain serum and serum samples were kept in Eppendorf tubes at -20°C until analyzed. The following serum biochemical parameters were determined: total protein (TP), albumin (ALB), globulin GLB (TP-ALB), total cholesterol (TCHO), high density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol and triglyceride (TRG), levels were determined spectrophotometrically using commercial diagnostic kits provided from Biodiagnostic Co. (Giza, Egypt) according to Ishihard et al. (1972).

Statistical analysis

Data were subjected to analysis of variance procedures appropriate for a completely randomized design using the GLM procedures of SPSS (2008). The differences among means were determined using the student Newman Keuls test. The mean values and standard error (SE) are reported.

Results and discussion

Growth performance

The effects of DW supplementation on growth performance of broiler chicks during the experiment are shown in Table 2. There were no differences (P<0.05) in BW and BWG due to treatments at all studied periods except BW and BWG at 3 and 1-3 wks of age, respectively. The highest value in BW and BWG in broiler chicks fed DW at level 1.5 g/kg at 6 wks and during the overall of experimental period (1-6 wks of age) compared to the control diet and other levels of DW. Kermanshahi and Rostami (2006) found that body weight gain of chickens fed 2 to 8% DW was improved at 49 days of age.

On the same context, Al-Asadi et al. (2008) reported that body weight gain of chicken received 2.5 and 5 % whey were improved at 46 days of age significantly, while 10% whey reduced body weight gain significantly (P≤0.05) compared with control group at 33-46 days of age. On the other hand, Omara (2012) clear that Broilers receiving the diets supplemented with commercial and natural probiotics showed significantly (P<0.05) improved growth performance including body weight, body weight gain, feed intake and FCR compared with those fed the basal diet (control). The improvement in growth rate of DW-fed birds occurred likely primarily due to better nutrient digestibility and/or the capacity of the intestines to absorb nutrients (Szczurek et al., 2013). Gulsen et al. (2002) reported that the improvement observed in lactose-treated broilers during the starter period, could be attributed to an increase in intestinal villi length which was assumed to improve nutrient absorption and bird performance.

Supplemental dietary DW up to 1.0 gm/kg to control diet led to numerically improvement in the final LBW (P<0.05). This observable improvement in LBW with whey groups compared to control diet may be due to provide some compounds that enhance digestion and absorption of some nutrients in the diets. Also, that may be attributed to the bioactive components causing greater efficiency in the utilization of feed, resulting in enhanced growth. Szczurek et al. (2013) attributed the improved performance of DW treated broilers to the ability of the added DW to create a more favorable intestinal environment for useful microbiota.

There was highly significant (P<0.05 or 0.01) in FI between treatments during all the different experimental periods. During the period 1-5 wks of age, FI of broiler chicks fed the diet containing 2.0 g /kg of DW were lower (P>0.05) than those of birds on diets containing 1.0, 1.5 g /kg and control diet. Contrary to these findings Kermanshahi and Rostami (2006) reported that broilers fed 1% whey diet consumed more feed and had greater body weight gain than the control group. The highest feed intake was recorded in chicks fed control diet, while the lowest feed intake recorded with the group fed DW at level of 2.0 g/kg of diet.

Effects of DW supplementation on FCR were significant (P < 0.05) in the present experiment during all the different experimental periods. Supplementing 2.0 or 1.5 g /kg of DW enhanced FCR at 3 to 6 and 1-6 wks of age (P<0.05). This improvement in FCR with DW supplementation by 2.0 or 1.5 g /kg of diet may be due to the synergetic effect of chemical constituents present in DW such as protein fractions (α-lactoglobulin and β-lactalbumin). Omara (2012) observed that feed/gain ratio improved significantly (P<0.05) with 1% whey diet compared with the control. Also, Al-Asadi et al. (2008) noted that adding whey to water lead to improved feed conversion ratio during 20-46 days of age and improved significantly (P≤0.05).

Carcass characteristics

The effect of dietary supplementation with DW on carcass traits at the end of experimental period is presented in Table 3. Results indicate that giblets yield percentage and abdominal fat were statistically (P<0.05) impacted and dressing yield percentage, thigh and breast were not significant (P<0.05) influenced by dietary treatments. Chicks fed diets supplemented with DW produced the lightest (P<0.05) value of abdominal fat compared with those in control at 6 week-old. On the other hand, the heaviest values of giblets were achieved by chickens fed 1.5 g/kg of DW or control diet compared to the diet containing DW 1.0 and 2.0 g/kg, respectively.

Table 2. Growth performance of broiler chicks as affected by dietary DW levels.

Whey level	Live body weight (g)			Body weight gain(g)			Feed intake (g/day)			Feed conversion (g feed/ g gain)		
	1 wk	3 wk	6 wk	1-3 wk	3-6 wk	1-6 wk	1-3 wk	3-6 wk	1-6 wk	1-3 wk	3-6 wk	1-6 wk
0.00 g/kg diet	117.28	535.50[a]	1453.56	29.87[a]	65.58	47.72	61.21[a]	133.31[a]	97.26[a]	2.05[a]	2.03[a]	2.04[a]
1.00 g/kg diet	117.25	511.07[ab]	1428.13	28.13[ab]	65.50	46.82	54.69[b]	125.82[ab]	90.26[b]	1.94[ab]	1.92[ab]	1.93[ab]
1.50 g/kg diet	117.75	489.91[bc]	1492.68	26.58[bc]	71.63	49.10	47.58[d]	134.98[a]	91.28[b]	1.79[b]	1.89[ab]	1.86[b]
2.00 g/kg diet	118.30	471.96[c]	1417.81	25.26[c]	67.56	46.41	50.27[c]	121.02[b]	85.64[c]	1.99[a]	1.79[b]	1.85[b]
SEM	0.22	7.92	13.20	0.57	0.99	0.47	1.57	2.06	1.38	0.04	0.03	0.03
P value	0.319	0.003	0.185	0.002	0.063	0.178	0.000	0.020	0.003	0.054	0.047	0.039

Table 3. Carcass characteristics of broiler chicks as affected by dietary DW levels.

Whey level	Carcass characteristics				
	Dressing (%)	Giblets (%)	Thigh (%)	Breast (%)	Abdominal fat (%)
0.00 g/kg diet	71.28	5.97[a]	30.30	34.83	1.80[a]
1.00 g/kg diet	72.55	5.38[b]	29.96	37.65	0.99[b]
1.50 g/kg diet	72.97	5.88[a]	30.36	36.72	1.23[b]
2.00 g/kg diet	74.19	5.30[b]	31.32	37.57	2.10[a]
SEM	0.53	0.10	0.32	0.45	0.14
P value	0.298	0.009	0.528	0.057	0.000

Table 4. Plasma metabolites of broiler chickens as affected by dietary DW levels.

Whey level	Plasma total protein and its fractions				Kidney function parameters		Plasma lipids and its fractions			
	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	A/G ratio	Creatinin (mg/dl)	Urea (mg/dl)	Triglycerides (mg/dl)	Cholesterol (mg/dl)	LDL (mg/dl)	HDL (mg/dl)
0.00 g/kg diet	6.55[a]	3.18	3.37[a]	0.95	0.63[a]	48.33	87.33[a]	103.33[a]	144.00[a]	33.00[a]
1.00 g/kg diet	6.37[b]	3.33	3.03[b]	1.10	0.53[a]	47.33	45.00[b]	100.67[a]	139.00[b]	30.00[b]
1.50 g/kg diet	6.27[b]	3.33	2.93[b]	1.14	0.18[b]	46.67	29.00[bc]	96.67[ab]	125.33[c]	25.67[c]
2.00 g/kg diet	6.27[b]	3.60	3.00[b]	1.20	0.15[b]	46.00	23.00[c]	92.33[b]	114.00[d]	17.00[d]
SEM	0.04	0.08	0.06	0.04	0.07	0.42	7.89	1.59	3.59	1.84
P value	0.001	0.361	0.006	0.092	0.000	0.244	0.000	0.042	0.000	0.000

(Same alphabets in superscript letters are not significantly different at $P<0.05$)

These results are in disagreement with those obtained by Al-Asadi et al. (2008) who reported that the carcass weight in chickens received 2.5 and 5 percent whey was maximum ($P≤0.05$) at 46 days of age compared with control group. Also, Kermanshahi and Rostami (2006) found that carcass weight in chickens received 2 and 4 % of DW was maximum ($P<0.05$) at 49 days of age.

Blood parameters

Biochemical blood parameters are usually indicators for physiological, pathological, and nutritional status of an animal and have the potential of being used to elucidate the impact of nutritional factors and additives supplied in diet (Ashour et al., 2014).

The effect of DW supplementation on serum biochemical parameters of broiler chicks are shown in Table 4. The treatment with DW significantly ($P<0.01$) reduced plasma content of both total protein and globulin, while plasma albumin and A/G ratio insignificantly increased in a linear trend along with increasing DW level in the diet. Urea is one of the microbial products that are known to have negative health effects in birds, animals and humans. Serum urea was markedly decreased with DW supplementation compared to the control diet. The lowest value of urea achieved by birds fed diet contained 2.0 DW g/kg diet. Conversely, Szczurek et al. (2013) found that the concentration of total protein in serum of blood collected on day 21 was greater ($P<0.05$) for DW-fed birds compared with the control group of chickens.

Measuring serum creatinine is the most commonly used indicator of renal function as reported by Taylor (1989). Our results showed that feeding broilers on a diet supplemented with DW resulted in more healthy kidneys. Plasma content of creatinine was linearly ($P<0.01$) depressed as the level of DW increased.

Results of lipid profile were, by any standards, unique. Linear ($P<0.01$) decreases in plasma content of triglycerides, cholesterol, LDL and HDL were observed in response to DW treatment. In harmony with our findings, Ghasemi et al. (2014) found that serum triglycerides and cholesterol levels were significantly lower in the birds fed diets supplemented with probiotics and prebiotics than in birds fed the control diet. Previous studies indicated that dietary supplementation of probiotics and prebiotics may have the potential to lower serum cholesterol levels (Salma et al., 2007; Velasco et al., 2010). The most important mechanism by which probiotics reduce serum cholesterol possibly is through interfering with cholesterol absorption in the gut by deconjugating bile salts or by directly assimilating cholesterol (Ooi and Liong, 2010). The lowering effect of prebiotics on the serum cholesterol level would likely be through reducing lipid absorption in the intestine by binding bile acids, which results in increased cholesterol elimination and hepatic synthesis of new bile acid (Ooi and Liong, 2010).

In this present study, it was obvious that DW 1.5 and 2.0 g /kg of diet produced the best results of total-cholesterol in blood versus other diets. Additionally, HDL- cholesterol and triglycerides were gradually decreased with increasing DW supplementation compared to the control diet. The disturbance in lipid profile may be attributed to increased biosynthesis and accumulation of cholesterol in liver and/or impaired biliary function.

Conclusion

In view of the above findings and discussion, a conclusion could be drawn that dietary supplementation with DW could improve the final productive performance of broiler chickens, in addition to lowering abdominal fat and blood content of cholesterol, creatinine and urea which means more healthy product.

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