OPEN ACCESS
DOI: 10.5455/javar.2015.b94

J. Adv. Vet. Anim. Res., 2(3): 304-309.
Available at- *http://bdvets.org/JAVAR*

JAVAR Journal of Advanced Veterinary and Animal Research

ORIGINAL ARTICLE

Volume 2 Issue 3 (September 2015)

Prebiotic competence of spirulina on the production performance of broiler chickens

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ABSTRACT

The study was conducted to evaluate the prebiotic effects of Spirulina as a growth and immunity promoter for broiler chickens. Birds (n=100) were randomly and equally distributed into four groups (T_0, T_1, T_2 and T_3) and fed on a diet containing 0, 2, 4 and 8 g Spirulina/kg feed respectively for 4 weeks. The body weight was significantly (P<0.05) increased in the treatment groups fed with Spirulina diet from 7th days to 28th days old. FCR was also significantly (P<0.05) decreased among the treatment groups. Hematological parameters were significantly (P<0.05) increased except ESR which was decreased significantly (P<0.05) in the treatment group. Aspartate aminotransferase (ALT) and alanine aminotransferase (AST) level were significantly (P<0.05) decreased in all the treatment groups. The study suggests that, Spirulina is a good natural feed additive which has a tremendous effect to improve the broiler production and thereby may reduce the production cost.

Keywords

Body weight, Broiler, FCR, Hemato-biochemical parameter, Spirulina

ARTICLE HISTORY

Received : 16 May 2015, **Revised**: 30 June 2015,
Accepted : 2 July 2015, **Published online**: 2 July 2015.

INTRODUCTION

Over 80% people of the Bangladesh live in the rural areas, and are highly dependent on agricultural system that is finely attuned to a tropical monsoon climate (BBS, 2013). About 49.8% people live below the poverty line and they receive less than 2100 calorie /person/day per capita availability of animal protein presently stands at around 21 g meat/day, 43 mL milk/day and 41 eggs/year vis-a-vis the recommended intakes of 2300 calories, 120 g meat/day, 250 mL milk/day and 104 eggs/year. Total meat production in Bangladesh was 11300 metric tons of which chicken and duck meat contributed 154,000 tons, which ranked second after beef. Per capita meat consumption was only 5.12 kg/ year and per capita protein intake 67 gm/day (BBS, 2011) which is markedly below recommended requirements. Meat production could be increased through poultry rearing and poultry meat is the most popular meat throughout the country. A variety of synthetic feed additives including drugs and antibiotics are used in poultry feeds to maximize the efficiency of production, product quality and to control diseases (Whitehead, 2002). But now-a-days poultry industries are currently moving towards a reduction in use of synthetic antibiotics due to public concerns regarding development of antibiotic–resistant bacteria in humans (Barton, 1998). There is a widespread discouragement on the use of antibiotics in poultry industry as antimicrobial compounds to control infections and as growth promoters because of bacterial resistance in poultry and occurrence of residues of antibiotics in meat. This is necessitating the use of prebiotics and probiotics as alternative substances to antibiotics. So, the recent trend in the feed business is currently directed toward the use of natural ingredients as alternatives to antibiotics, synthetic colors, and other chemicals.

Spirulina is rich in thiamin, riboflavin, pyridoxine, vitamin B12, vitamin C and antioxidant carotenoids, and have been used throughout the world as a feed

component in broiler and layer diets to enhance yolk, flesh and color (Ross and Dominy, 1990). Spirulina has beneficial effects in arthritis (Parikh et al., 2001; Rasool et al., 2006) and immuno-stimulatory effects and antiviral activity (Khan et al., 2005a).

Moreover, Spirulina has been shown to enhance immune function, reproduction and increase growth. Less than 1% Spirulina added to chicken diets has been found to enhance the defense systems by increasing microbial killing, antigen processing and greater T-cell activity (Qureshi et al., 1996). In addition, Ross and Dominy (1990) and Nikodémusz et al. (2010) reported that broilers fed Spirulina-containing diets achieved superior productive performance to their control birds. Spirulina improve absorption of minerals, protect from diarrhea and optimize nutrient digestion processes (Gružauskas et al., 2004). Inborr (1998) found that carotenoid concentrations increased in the liver, adipose tissue and breast muscle with increasing algae meal in the diets, and birds had increased yellow pigment in skin compared to the control group. The broilers on the algae meal diet gained weight faster and significantly (P<0.05) utilized their feed. In an early study, Ross et al. (1994) found no adverse effect of dietary Spirulina on body weight or mortality rate. Recently, Islam et al. (2009) found that Spirulina may be helpful for reducing the tissue burden of arsenic in ducks. Also, Kaoud (2012) and Kharde et al. (2012) found that body weights, average daily weight gain, carcass yield percentage and feed conversion ratio improved by the dietary inclusion of the *Spirulina platensis* as compared the control. *Spirulina platensis* supplementation improved feed conversion and mortality rate. Considering the cost-effectiveness and prompt growth of broiler, Spirulina would be a natural feed additive to improve the broiler production. So, this study was conducted to evaluate the effects of Spirulina as an alternative feed additive to improve the effectiveness in promoting growth in broiler chickens.

MATERIALS AND METHODS

Study area and time period: The present study was carried out in the National Youth Training Centre, Khulna, Bangladesh from January to June 2014.

Birds and Husbandry: A total of 100 day old (0 day) Cobb-500 broiler chickens of Kazi Farms Limited were obtained from a local commercial dealer. Chickens were randomly allocated to 3 experimental (T1, T2 and T3) groups with a control group (T0) for 28 days. Each group had 25 birds and was assigned to a clean floor pen (10x10 feet), and birds were raised on a rice husk litter. The chickens in all the experimental groups were reared under similar management conditions with *ad libitum* supply of feed and water. The response of the chickens were assessed in terms of daily body weights, feed intake, and feed conversion efficiency.

Feeds and Spirulina: The birds were fed with commercially available broiler feed (Chamak Feed, Paragon feed limited, Bangladesh). The feed was supplied to the birds according to the manufacturer schedule: Broiler starter: 01-14 days, broiler grower: 15-24 days, broiler finisher: 25-28 days. The supplied prebiotic Spirulina was Eskalina® (Organic Spirulina 100%), Manufactured by- Eskayeef Bangladesh). Limited, Agro vet Division, Gazipur Bangladesh. The Composition of the supplied Eskalina® was: Protein-60%, Carbohydrate- 15.1%, Fat- 8.2%, Amino Acids: Met, Lys, Thr, Trp,ILeu, Leu, Phe, Val, Ala, Arg, Asp, Cys, Glu, Gyl, His, Pro, Ser, Tyr. Vitamins: B1, B2, B3, B5, B6, B7, B9, B12, C, D, E, K, β-Carotene, Inositol. Minerals: Ca, P, Na, K, Mg, Fe, I, Cu, Mn, Zn, Cr, Se, Al.

Dietary treatment: Prebiotic Eskalina® was added to combined feed of the T_1, T_2 and T_3 group of chickens at a rate of 2 g, 4g and 8g of Eskalina/Kg of starter, grower and finisher feeds respectively.

Data collection: Feed consumption, weight gain and FCR were recorded daily. Blood was collected twice for hematological & biochemical tests during the period at 14th day and 28th day. 3ml blood was collected from wing vein with Ethylene Diamine Tetra-Acetic Acid (EDTA) for hematological studies from randomly selected 5 birds of each group. These blood samples were analyzed for TEC, Hb, PCV, TLC, ESR and WBC. Blood (3ml) was collected again without anticoagulant for biochemical tests of serum from randomly selected 5 birds of each group. All hematological study was performed as per methods indicated by Coffin (1955). These samples were analyzed for ALT and AST. Tests were performed at lab tech diagnostics, Khulna, Bangladesh. Sera were thawed on the laboratory bench (≈+25^{o}C) and the ALT, AST activity and serum creatinine were determined through the use of Reflotron® Plus (Boehringer Mannheim, Germany) according to the method described by Deneke et al. (1985).

Statistical analysis: All data were analyzed by analysis of variance (ANOVA) procedures (Steel and Torrie,

1980) appropriate for a completely randomized design by the GLM procedure of SAS (1995). The effect of *Spirulina platensis* on growth performance, feed gain ratio and villus height were the main effect. The level of statistical significance was preset at $p \leq 0.05$.

RESULTS AND DISCUSSION

The body weight was significantly ($P<0.05$) increased on 7th, 14th and 28th days in all treated groups (**Figure 1**). These results are in agreement with other study (Ross et al., 1994). However, Ross and Dominy (1990) and Nikodémusz et al. (2010) reported that birds fed dietary Spirulina had beneficial effects on productive performance. Also, Kaoud (2012) found that body weight and weight gain were significantly ($P<0.05$) increased by the dietary supplementation of *Spirulina*. The significant ($p=0.5$) effect of dietary treatments on body weight and weight gain of broiler fed Spirulina diet may be brought through improving the efficiency of feed utilization.

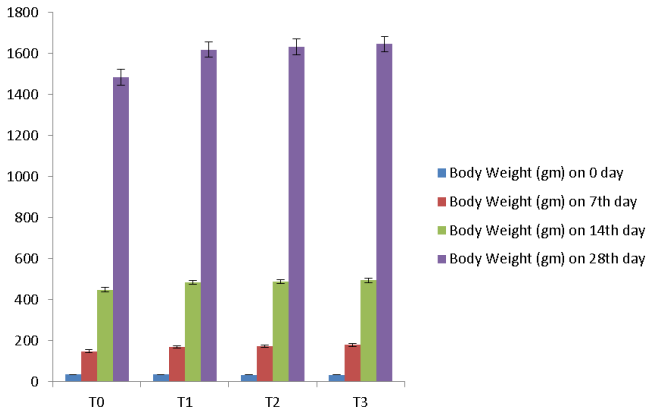

Figure 1. Effects of Spirulina on the body weight (g) gain of broiler.

Statistical differences were found in the case of Spirulina treated groups- T_1, T_2 and T_3 with control on 7th, 14th and 28th days that were significantly ($P<0.05$) decreased (**Table 1**). These results agreed with the findings by Kaoud (2012) and Kharde et al. (2012), who reported that feed conversion ratio significantly ($P<0.05$) improved by dietary inclusion of *Spirulina* as compared the control broilers. Though the body weight gain was matched with the previous report, however the current study found significant changes in the hematological parameters as well. In this regard Gružauskas et al. (2004) reported that Spirulina improve absorption of minerals, protect from diarrhea, and optimize nutrient digestion processes. Feeding Spirulina containing diets may increase the lactobacillus population and enhance the absorbability of dietary vitamins (Tsuchihashi et al., 1987; Mariey et al., 2012). Also, the present resulted supported by Baojiang (1994) who reported that Spirulina is good for the beneficial intestinal flora.

TEC (million/mm^3) was increased significantly ($P<0.05$) in group T_1 on 14th days, in group T_3 on 14th and 28th days (**Table 2**). It is not so important because it is not below the normal level is (3 million/mm3 in Cobb-500) (Talebi et al., 2005). All values of TEC observed in this figure are within the normal ranges reported by several authors (Clarence, 1986). The increment in the blood indices may be related to the rich mineral content in Spirulina of Fe, Cu, and zinc (Tokuşoğlu et al., 2003; Babadzhanov et al., 2004). It is well known that iron plays an important role in hemoglobin and red blood cells biosynthesis to prevent anemia and is essential for metabolic enzymes biosynthesis such as cytochromes, superoxide dismutase and glutathione reductase (Bartove and Kanner, 1996; Mohamed, 1998; Badway, 1998).

Hb (g/dL) level were increased significantly ($P<0.05$) in group T_3 on 14th and 28th days (**Table 2**). These results are in agreement with other studies also (Bartove and Kanner, 1996; Mohamed, 1998; Badway, 1998). 1% of *Spirulina platensis* supplementation significantly improves the Blood Parameters **(**Shanmugapriya et al., 2014).

ESR (mm in 1st hour) was represented in **Table 2**. The results were shown the statistically significant value ($P<0.05$) in group T_1 on 14th and 28th days and in group T_3 on 14th days. 1 % of *Spirulina platensis* supplementation significantly improves the Blood Parameters **(**Shanmugapriya et al., 2014).

PCV was increased significantly ($P<0.05$) on 28th days in all three treatment groups and 14th days in T_3 group (**Table 2**). This result is supported by Mariey et al. (2012) who showed insignificant increase in PCV % of birds fed 0.2 and 0.3 g Spirulina/kg diet by 2.3 and 3.0% compared with the control group, respectively. 1% of *Spirulina platensis* supplementation significantly improves the Blood Parameters **(**Shanmugapriya et al., 2014).

WBC (million/mm^3) were increased significantly ($P<0.05$) in all the treatment groups on 14th and 28th days (**Table 2**). This result has similarity to Mariey et al. (2012) who found, All dietary supplements of Spirulina significantly ($P<0.05$) increased red blood cells count of chickens by 2.3, 5.6 and 12.2% in groups fed 0.1, 0.2 and 0.3 g Spirulina/kg diet compared with

Table 1. Effects of Spirulina on the FCR of broiler.

Treatment	Pre-treatment	Post-treatment		
	0-day (Mean ± SD)	7th day (Mean ± SD)	14th day (Mean ± SD)	28th day (Mean ± SD)
T_0	0.091±0.0028	0.815±0.0064	1.092±0.0038	1.650±0.0022
T_1	0.092±0.0023	0.716±0.0078[a]	1.014±0.0081[a]	1.513±0.0053[a]
T_2	0.092±0.0018	0.704±0.0086[a]	1.005±0.0080[a]	1.501±0.0054[a]
T_3	0.092±0.0034	0.680±0.0066[a]	0.992±0.0052[a]	1.488±0.0025[a]

[a]- Indicates the level of significance at 5 percent (P<0.05)

Table 2: Effects of Spirulina on TEC (million/mm^3), hemoglobin (g/dL), ESR (mm. in 1st hour), PCV/hematocrit (%) and WBC (million/mm^3) in broiler.

Hematological parameters	14th day (Mean ± SD)				28th day (Mean ± SD)			
	Control group	Treatment group			Control group	Treatment group		
	T_0	T_1	T_2	T_3	T_0	T_1	T_2	T_3
TEC	3.30± 0.136	3.61± 0.106[a]	3.13± 0.091	3.79± 0.158[a]	3.24± 0.238	3.50± 0.185	3.39± 0.075	3.63± 0.133[a]
Hb	10.26± 0.397	10.38± 0.303	9.96± 0.364	11.06± 0.665[a]	10.22± 0.550	10.74± 0.638	10.90± 0.489	11.38± 0.389[a]
ESR	10.38± 0.167	10.99± 0.092[a]	10.29± 0.280	11.81± 0.662[a]	10.512± 0.150	11.5120± 0.089[a]	10.39± 0.180	10.41± 0.252
PCV	30.38± 0.557	30.93± 0.277	30.89± 0.332	33.26± 0.609[a]	28.22± 0.589	31.85± 0.948[a]	31.79± 0.738[a]	33.400± 0.620[a]
WBC	0.002± 0.0001581	0.003± 0.000158[a]	0.003± 0.000164[a]	0.003± 0.000151[a]	0.002± 0.00011	0.003± 0.000151[a]	0.003± 0.000164[a]	0.003± 0.000181[a]

[a] - Indicates the level of significance at 5 percent (P<0.05)

Table 3. Effects of Spirulina on ALT (U/L) in broiler.

Treatment	Post-treatment	
	14th day (Mean±SD)	28th day (Mean±SD)
T_0	19.60±2.074	20.80±1.924
T_1	13.40±1.140[a]	11.80±0.837[a]
T_2	14.00±1.581[a]	11.60±1.140[a]
T_3	10.60±1.140[a]	9.40±1.140[a]

[a] - Indicates the level of significance at 5 percent (P<0.05)

Table 4. Effects of Spirulina on AST (U/L) in broiler.

Treatment	Post-treatment	
	14th day (Mean±SD)	28th day (Mean±SD)
T_0	376.20±6.907	360.60±14.553
T_1	264.80±0.16.544[a]	239.00±18.841[a]
T_2	231.00±14.748[a]	227.20±13.828[a]
T_3	212.80±6.340[a]	211.00±4.950[a]

[a] - Indicates the level of significance at 5 percent (P<0.05)

control group, respectively. Small amount of Spirulina builds up both the humoral and cellular mechanisms of the immune system in chickens to enhance immune function, reproduction and growth (Qureshi et al., 1996; Khan et al., 2005b). Increased Zn concentration of Spirulina is also play a vital role to increase the cellular immunity in birds (Mohamed, 1998). *Spirulina platensis* supplementation (1%) significantly improves the blood parameters **(**Shanmugapriya et al., 2014).

The ALT (U/L) and AST (U/L) level significantly (P<0.05) decreased in all the treatment groups on 14th and 28th days (**Table 3, 4**). The present study revealed the hepatoprotective activity of the *Spirulina* in broiler. The liver is the main metabolic organ of the body. It indicates the hepatoprotective activities of spirulina due it antioxidatives and anti-inflammatory quality (Dartsch, 2008; Deng at al., 2010). More severe liver damage releases the higher amount of liver enzymes (El-Khayat et al., 2009). The increased levels of serum enzyme such as AST and ALT indicated the increased permeability and damage or necrosis of hepatocytes (Pari and Suresh, 2008).

CONCLUSION

Our study suggests that Spirulina might be used as an alternative and safe nutritional and dietary supplement in broiler production.

ACKNOWLEDGEMENT

The authors are highly grateful to the authorities of National Youth Training Centre, Khulna, Bangladesh for their cordial support during experiment.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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