Indian J. Anim. Nutr. 2019. 36 (4): 414-418
doi: 10.5958/2231-6744.2019.00067.7

Indian Journal of Animal Nutrition

Effect of Dietary Incorporation of Short Chain and Medium Chain Fatty Acid on Feed Intake and Serum metabolites in Broiler Chickens

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ABSTRACT

An experiment was conducted to study the effect of incorporation of short chain and medium chain fatty acid (SCMCFA) on feed intake and serum parameters in broiler chickens. Three hundred one-day-old AP-95 strain broiler chicks were reared under uniform managemental conditions. The broiler chicks were individually weighed and distributed randomly into five treatments having four replicates with 15 birds per replicate. Birds were fed either a control diets (C), control plus probiotics (500 mg/kg; P), control plus SCMCFA (1000 mg/kg; F), control plus butyric acid supplement (500 mg/kg; B) or control plus SCMCFA + butyric acid (1000 mg/kg + 500 mg/kg; FB) during pre-starter, starter and finisher phases. The intake followed similar trend in all the groups during the six-week study period, except a significant decline in feed intake in the probiotic fed group during the fifth week. Blood glucose, cholesterol and serum triglycerides were similar among the groups. These results indicated that dietary supplementation of SCMCFA showed no adverse effect on intake, performance and serum metabolites of broiler chicken.

Keywords: Broilers, Feed intake, Serum chemistry, Short chain and medium chain fatty acid

INTRODUCTION

Emerging concerns on animal ethics, evolving customer demands and government regulations in India has resulted in changing the way of animal rearing, especially the use of antibiotics (Manyi-Loh *et al.,* 2018). An endless number of alternatives are being considered in order to achieve the same feed efficiency and growth rate that are accomplished with antibiotics (Phillips *et al.,* 2004; Den Hartog *et al.,* 2005). Among potential alternatives for antibiotic growth promoters (AGPs), short chain fatty acids (SCFAs) and medium chain fatty acids (MCFAs) act similarly like AGPs (Khatibjoo *et al.,* 2018). Short-chain fatty acids are saturated aliphatic organic acids that consist of one to six carbons, of which acetate (C_2), propionate (C_3), and butyrate (C_4) are found to be absorbed from both the small intestine and the ceca by passive transport (den Besten *et al.,* 2013). MCFAs are effective alternatives for antibiotics, due to their high antibacterial activity, and they enter the cell un-dissociated (Khatibjoo *et al.,* 2018). SCFA and MCFA have shown to have synergistic effect and may act by disrupting the cell wall membrane of the microorganisms helping the SCFCA to enter the cytoplasm where they act (Del Alamo *et al.,* 2007). Therefore, this experiment was carried out to determine the effect of SCFA and MCFA, in comparison with probiotic, butyric acid alone or SC&MCFA with butyric acid, on feed intake and serum parameters in broilers.

MATERIALS AND METHODS

The experiment was carried out at the experimental shed of College of Veterinary and Animal Sciences, Udgir, Maharashtra. Three hundred day-old straight run broiler chicks (AP-95) were purchased from a commercial broiler hatchery from Udgir, Maharashtra. The broilers were housed in identical sized pens, environmental temperature was set at 31°C for the first week and 28°C for the second week, which was further decreased to 22°C until the end of the experiment. The relative humidity was above 55% throughout the study. The basal diet was formulated to meet the nutrient requirements of broilers (BIS, 2007). Following a completely randomized design, broilers were allotted to five dietary treatments with four replicates of 15 birds each. The experimental diets consisted of control (C), control plus probiotics (500 mg/kg; P),

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control plus SCMCFA (1000 mg/kg; F), control plus butyric acid t (500 mg/kg; B) and control plus SCMCFA + butyric acid (1000 mg/kg + 500 mg/kg; FB). The supplements were fed during pre-starter, starter and finisher phase as mentioned in Table 1 and 2.

The birds were reared under uniform managemental condition following standard protocols for vaccination, and maintenance of temperature, ventilation and lighting. They were fed experimental diets from 1 to 42 day of age. Feed intake was recorded for each period and during the whole experiment (1–42 d of age). On 42nd day, eight birds from each dietary treatment were sacrificed and blood samples were collected, alalyzed for total glucose, serum cholesterol and serum triglycerides content using diagnostic kits. The data obtained were statistically analysed as per one-way ANOVA following method of Snedecor and Cochran (1994) and significant differences between them were tested by Duncan's New Multiple comparison Test according to methods described by SAS (1985). Significance was considered at P<0.05 levels.

RESULTS AND DISCUSSION

Data pertaining to the feed intake of the birds are presented in Table 3. Overall, feed intake was not significantly influenced by dietary treatments, except the probiotic supplemented group whose intake was significantly reduced in the 5th week. However, Duncan Multiple Range Test (multiple comparison test) revealed that the effect of supplementation did not differ significantly from each other except for the said week. The weekly feed intake of birds fed probiotic diet was comparable with that of 0.05% butyrate supplemented group. In all the treatments, the feed intake followed similar trend and supplementation of SCMCFA had similar intake as that of control. In the fatty acid supplemented groups, the feed intake was marginally improved as compared to other groups. Feed intake was unaltered in broilers fed diets supplemented with medium-chain fatty acids at 0, 1, 2 and 4 g/kg (Saeidi *et al.,* 2016). Khatibjoo *et al.* (2018) have also reported similar effect of treatments on feed intake during growing period of experiment. The inclusion of dietary

Table 1. Ingredient composition of experimental diets (%)

Ingredients (on DM basis)	Pre-starter (0-7 days)	Starter (8-21 days)	Finisher (21-42 days)
Maize	51.12	53.0	57.85
De-oiled soybean cake	42.00	39.5	33.44
Soybean oil, crude	3.00	4.0	5.00
Di-calcium phosphate	1.70	1.8	1.90
Limestone powder	1.00	0.8	0.80
Vitamin premix*	0.025	0.025	0.025
Salt	0.30	0.30	0.30
Methionine	0.17	0.20	0.21
Lysine	0.16	0.14	0.15
Trace mineral mixture** (TMM)	0.10	0.10	0.10
Coccidiostat	0.05	0.05	0.05
Choline	0.06	0.06	0.06
Toxin binder	0.10	0.10	0.10
Total	99.79	100.07	99.99

*Each kg of vitamin premix contains Vitamin A-22.5 million IU, Vitamin D_3-4.5 m IU, Vitamin E-60 g, Vitamin K_3-4 g, Vitamin B_1-4 g, Vitamin B_2-20 g, Niacin-60 g, calcium D-panthonate-30 g, Vitamin B_{12}-35 g, Folic acid-4 g, Biotin-0.2 g; **Each kg of TMM contains Mn-50 g, Zn-50 g, Fe-55 g, Copper-10 g, Iodine-1.25 g, Selenium-250 mg

Table 2. Nutrient composition of pre-starter, starter and finisher diets

Nutrients	Treatments*				
	C	P	B	F	FB
Pre-starter diet					
CP (%)	23.0	23.2	23.0	23.0	22.8
EE (%)	5.18	6.58	7.0	5.2	4.41
CF (%)	3.88	4.15	4.2	3.88	4.04
TA (%)	7.45	6.18	6.53	6.78	6.53
AIA (%)	1.6	1.63	1.67	1.62	1.87
ME (kcal)	3002	3006	3007	3005	3003
Starter diet					
CP (%)	22.0	21.8	21.9	21.9	21.9
EE (%)	7.04	6.98	7.5	7.4	7.67
CF (%)	3.97	3.92	3.9	3.94	3.95
TA (%)	7.08	6.8	6.9	6.5	6.4
AIA (%)	1.61	1.61	1.61	1.61	1.61
ME (kcal)	3107	3105	3108	3098	3097
Finisher diet					
CP (%)	20.0	20.1	19.0	19.9	20.0
EE (%)	8.41	8.6	8.7	8.6	8.7
CF (%)	3.2	3.4	3.5	3.4	3.3
TA (%)	6.1	6.0	6.2	6.1	6.3
AIA (%)	1.46	1.5	1.43	1.45	1.46
ME (kcal)	3230	3219	3220	3215	3219

*Treatments: T, control diet; P, probiotic-500 mg/kg; B, butyric acid-500 mg/kg; F, SCMFCA-1000 mg/kg; FB, SCMFCA 1000 mg + butyric acid- 500 mg

coconut oil as a source of medium-chain fatty acid by replacing 25, 50, 75 or 100 % of the soybean oil had no adverse effect on feed intake in broilers (Wang *et al.,* 2015). Supplementation of basal diet with 0.1, 0.15 or 0.2 % medium chain fatty acids for period 1-21 day of age, 0.15% for period 21-36 day of age and 0.1% for period 36-42 day of age did not affect feed intake (Mohammadzade *et al.,* 2013). Pinchasov and Jensen

Table 3. Effect of dietary supplementation of probiotics and SCMCFA on weekly feed intake (g)

Age in weeks	Treatments*					P-value
	C	P	B	F	FB	
1	129.7±7.45	129.1±2.83	134.6±6.60	119.9±2.33	111.6±7.43	0.080
2	409.0±38.89	359.4±19.70	410.0±18.78	432.1±35.70	337.4±6.95	0.120
3	569.3±54.91	563.0±46.25	585.8±7.11	574.8±14.2	579.6±26.53	0.980
4	900.6±25.73	892.4±9.69	948.5±18.44	957.8±18.77	872.0±43.97	0.140
5	1102±23.63^{ab}	1025±12.42^{a}	1076±13.01^{ab}	1145±20.52^{b}	1124±17.8^{ab}	0.002
6	874.4±35.11	876.5±19.75	909.6±54.19	900.3±13.3	877.1±4.56	0.88

^{a,b} Means bearing different superscripts within the same row are significantly different (P<0.05); *Treatments: T, control diet; P, probiotic-500 mg/kg; B, butyric acid-500 mg/kg; F, SCMFCA-1000 mg/kg; FB, SCMFCA 1000 mg + butyric acid- 500 mg

Table 4. Effect of dietary supplementation of probiotics and SCMCFA on serum profile

Parameters	Treatments*					P-value
	C	P	B	F	FB	
Blood glucose (mg/dl)	128±23.5	125±29.5	156±7.0	222±14.0	139±24.0	0.64
Serum cholesterol (mg/d)	163±12.0	139±15.0	149±11.0	178±8.0	176±34.0	0.55
Triglycerides (mg/dl)	97.5±1.5	80±18.0	70.5±1.5	130±13.5	133±27.5	0.12

*Treatments: T, control diet; P, probiotic-500 mg/kg; B, butyric acid-500 mg/kg; F, SCMFCA-1000 mg/kg; FB, SCMFCA 1000 mg + butyric acid- 500 mgg/kg; B, butyric acid-500 mg/kg; F, SCMFCA-1000 mg/kg; FB, SCMFCA 1000 mg + butyric acid- 500 mg

(1989) summarized that in case of well-nourished healthy chicks housed at a moderate stocking density and hygienic condition, dietary inclusion of MCFAs or SCFAs had no significant influence on the birds' performance. In an another study on MCFA, Miller *et al.* (2009) reported no differences with regard to feed intake, feed efficiency and weight gain in grower and finisher pigs when fed diets with 1, 3, or 6% of MCFA oil compared with diets containing the same amount of tallow, pig fat or corn oil. However, in our study birds were fed 1000 mg/kg of SCMCFA in feed and we did not observe any effect of supplementation on feed intake.

Serum concentration of glucose, cholesterol and triglycerides were similar among the groups (Table 4). In another study it was observed that the serum triglyceride concentrations was significantly increased in broilers with MCFA diet as compared to control (Baltic *et al.,* 2018). The present findings corroborate well with that Khatibjoo *et al.* (2018) who bserved no effects of supplemental dietary short-and medium-chain fatty acids on serum cholesterol and glucose of broiler chickens.

CONCLUSION

Our results suggest that combination of short chain and medium chain fatty acid supplementation in broiler diet to be beneficial and exert no adverse effect on feed intake and blood biochemistry.

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Received on 04-11-2019 and accepted on 15-12-2019