Research Article

Study of Immune Response and Economics of Production with the Organic Acids and Peppermint Essential Oil in Broiler Diet

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Abstract

The present biological experiment was carried out to find out the effect of dietary supplementation of peppermint essential oil and organic acids alone or in combinations on immunity and economics of broiler production. A total of 420 'Vencobb-400' day old chicks were randomly distributed into 8 treatment groups having 3 replicates of 20 chicks each. The control group (A) received basal diet and the dietary different treatment group B received basal diet supplemented with peppermint essential oil at 200 mg/kg, whereas, groups C, D and E received basal diet supplemented with sorbic acid, fumaric acid and propionic acid at a dose of 1%, and groups F, G and H received basal diet with combination of peppermint essential oil at 200 mg/kg along with sorbic acid, fumaric acid and propionic acid at a dose of 1%, respectively. At 6th week of age, the antibody titers for ND was significantly ($P<0.05$) higher in different treatment groups. Overall, the supplementation of combination of peppermint essential oil with different organic acids resulted in better immune response in broilers. Results showed that the dietary supplementation of peppermint essential oils with different organic acids resulted in improved performance with higher profit in broiler production and enhanced immune response of broilers.

Keywords: Immunity, Economics of production, Organic acids, Peppermint essential oil

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Introduction

Modern poultry production has achieved extraordinary gains with the efficient and economical production of chicken meat and eggs. At a similar time as use of feed additives for creating gains in production and to maximize the health and well-being of the birds is commonly followed in poultry production. In poultry diets feed additives are used for growth of birds, improve feed conversion ratio with better absorption of nutrients and enhance immune response to prevent disease. Antibiotics used as growth promoters in poultry feeds have been banned recently due to development of antibiotic resistant to human pathogenic bacteria. Nowadays, the possibility of using new natural alternative additives instead of antibiotics in poultry diets is being researched [1]. The focus of alternative strategies has been to prevent propagation of pathogenic bacteria and modulation of indigenous bacteria so that the health, immune status and performance are improved

The essential oils are volatile oils present in different herbs. Natural medicinal products originating from herbs and spices have also been used as feed additives for farm animals in ancient cultures for the same length of time [2]. The modes of action by which organic acids and plant derived bioactive substances exert their positive effects (antimicrobial, growth-promoting, immunomodulatory effects) have been well documented [3, 4]. Therefore, the combinations of suitable organic acids and essential oils may improve performance and immune response in broiler chickens.

Hence, the present study was planned to find out effects of combination of organic acids and peppermint essential oil to improve immune status and economics performance in broiler chickens.

Materials and Methods

The experiment was conducted on four hundred eighty Vencobb-400 strain *straight run* broilers for the period of six weeks to study the effect of peppermint essential oil and organic acids on performance of broilers. The day-old broiler chicks, immediately after arrival, were randomly divided into eight equal groups of 60 birds each viz., A to H having three replicates of 20 birds each. The birds in control group (A) offered basal diet adequate in all nutrients as per BIS [5]. The birds in dietary treatment groups B were offered diets containing peppermint essential oil at dose rate of 200mg/kg. The birds in dietary treatment groups C, D and E were offered different organic acids viz. 1% sorbic acid,

1% fumaric acid and 1% propionic acid, respectively in diet of broilers. Birds in groups F, G and H were offered diet containing peppermint essential oil at dose rate of 200mg/kg in combination with different organic acids viz. sorbic acid, fumaric acid and propionic acid at 1% level, respectively. All the diets were isocaloric and isonitrogenous.

The birds from the experimental trials were assessed for the antibody titer against the Newcastle Disease (ND) at 21st and 42nd days of age. Two birds from each replicate were randomly selected and the blood samples were collected via wing vein. The serum was separated by centrifugation at 3000 RPM for 20 minutes and stored at -20^{0}C. The Haemagglutination Inhibition (HI) test was performed as per O.I.E. [6]. Two fold serial dilutions of antigen and serum was used as antigen for HI test. The HI titer was expressed as $\log_2$ value of the highest dilution of serum causing complete inhibition of 8 HA unit of antigen. The initial ND titers were also assed at 0 day of age.

During this study, attempts were made to calculate the economics of broiler production under different treatment groups. The economics of broiler production was worked out by considering the prevailing prices of inputs and sale price of broilers in local market. All other cost components of production i.e. cost of chick, medicines, vaccine and other overhead were taken as constant for all the treatment groups. Gross profit per bird was calculated by subtracting the cost of production per bird from the price fetched per bird after selling it in the local market on live weight basis.

Figure 1 Experimental birds during starter and finisher phases

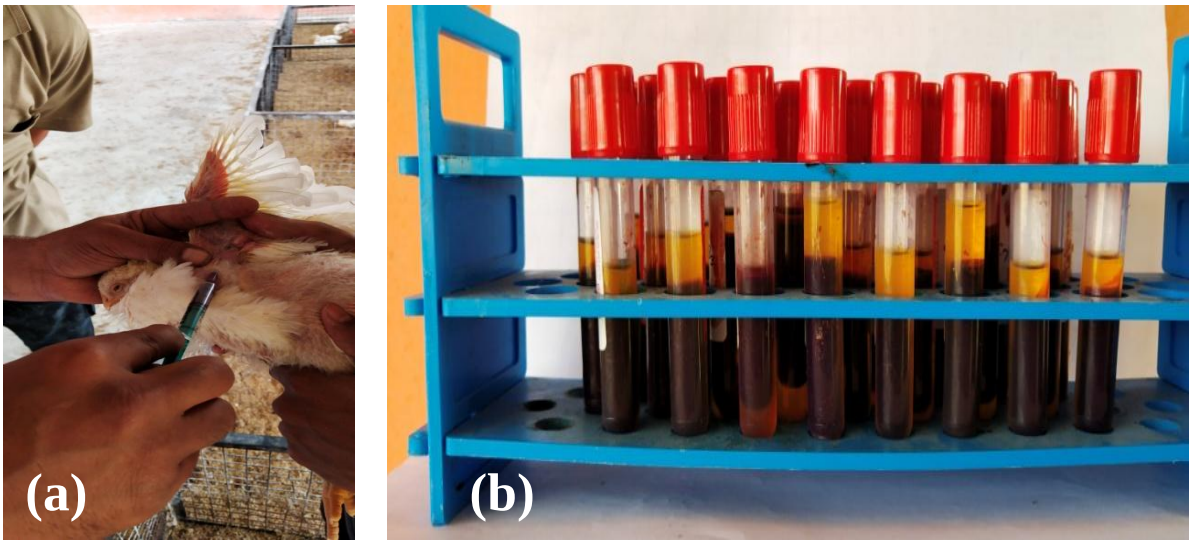

Figure 2 (a) Blood Sample Collection. (b)Separation of serum for ND titer

Results and Discussions

Immune Response

The immune response was judged by employing HI test to detect the antibody titer against ND at 3rd and 6th weeks. The results for antibody titer against ND are presented in **Table 1**. The analysis of variance for antibody titer against ND and IBD is presented in **Table 2**.

The antibody titers against ND (log_2 values) showed non-significant difference in all treatment groups at 3rd week of age. The antibody titer against ND at 3rd week was numerically higher in treatment groups as compared to control. The analysis of variance for the antibody titers for ND (log_2 values) at 6th week of age in broilers showed significant ($P<0.05$) differences among treatment groups. At 6th week of age significantly ($P<0.05$) increased ND titers were recorded in all treatment groups compared to control.

Table 1 Antibody titers against ND (log_2 values) at 3rd and 6th weeks in broilers fed peppermint essential oil and organic acids

Treatment Groups	3rd week	6th week
A control	2.83±0.31	3.00^{c}±0.37
B (peppermint EO@200mg/kg)	4.17±0.60	6.00^{ab}±0.37
C (sorbic acid 1%)	3.83±0.48	4.33^{bc}±0.67
D (fumaric acid1%)	3.50±0.22	4.67^{abc}±0.84
E (propionic acid 1%)	4.33±0.56	5.00^{ab}±0.77
F (peppermint EO + sorbic acid 1%)	4.00±0.37	6.33^{a}±0.67
G (peppermint EO + fumaric acid)	4.33±0.33	5.83^{ab}±0.79
H (peppermint EO + propionic acid)	4.67±0.42	6.17^{ab}±0.54
CD	NS	1.86 *
CV %	26.49	30.86

Means bearing different superscripts within a column differ significantly.
*P<0.05, NS-Non-significant.

Table 2 Analysis of variance for Antibody titers against ND (log_2 values) at 3rd and 6th weeks in broilers fed peppermint essential oil and organic acids

Source	df	ND titers			
		3rd week		6th week	
		MSS	'F' value	MSS	'F' value
Treatments	7	1.988	1.807^{NS}	7.857	3.091*
Error	40	1.100	-	2.542	-

*P<0.05. NS-Non-significant

The results are in agreement with the researchers who reported that some essential oils have positively influenced the avian immune system, since they promote production of immunoglobulins, enhance lymphocytic activity, and boost interferon-γ release [7, 8]. Awaad reported that adding eucalyptus and peppermint essential oils to water at 0.25 ml/l for broilers results in an enhanced cell-mediated and humoral immune response [9]. Several studies have been observed that the addition of herbs or extracts to diets improved immune response [10, 11]. Placha found that supplementation of thyme essential oil enhanced immune response in chickens [12]. Arab-Ameri [13] demonstrated that the addition of peppermint improved immunity and minimized oxidative stress in heat-stressed broilers. It was revealed that peppermint and thyme essential oil mist could positively influence the immune systems of birds with higher values of gamma-globulin concentration as well as the weights and growth indices of lymphoid organs [14].

Many researchers observed that organic acids could stimulate the natural immune response in poultry. Lohakare revealed that supplementation of ascorbic acid at 200 ppm in diet of commercial broilers is beneficial for improving the immunity and for exploiting the full genetic potential [15]. Researcher reported that addition of 0.5% citric acid in broiler diet reduced the pH of the diets, and improved immune status [16]. It was found that supplementation of phytase and organic acids improved intestinal integrity and immune response of broilers [17]. Citric acid supplementation enhanced the density of lymphocytes in the lymphoid organs and increased the non-specific immunity [16, [18]. Birds having the greater density of lymphocytes have stronger immune status to combat antigens [19].

However, Flamand noted that immune response in broilers was not affected by administration of organic acid blends of ascorbic, citric, malic, sorbic, and tartaric acids through the drinking water [20]. It was indicated that dietary supplementation with oregano had no effect on SRBC titer and ND titer [21]. Parvar reported that supplementation of Satureja essential oils in drinking water of broiler chicken had no desired impact on immune response of heat stressed broiler chicken [22].

Economics of Broiler Production

The economics of broiler production of all the treatment groups was worked out by considering the prices of inputs prevalent in the market at the time of experiment. The feed cost was calculated for broiler pre-starter, starter and finisher diets. The broilers were sold at the rate of Rs. 76/kg on live body weight basis. The details of the cost of broiler production under different treatment groups are presented in Table 3.

Table 3 Economics of broilers fed peppermint essential oil and different organic acids

Sr. No.	Parameter	Dietary Treatment Groups							
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
1	Chick cost (Rs.)	35	35	35	35	35	35	35	35
2	Feed intake (g)								
	Pre-starter	128.08	120.87	122.68	123.48	121.02	123.48	119.20	124.47
	Starter	850.65	847.43	852.40	835.38	817.83	864.73	819.78	827.39
	Finisher	3116.99	3036.52	3022.64	2941.40	3062.04	3043.60	3023.80	2997.66
	Total Feed Intake (g)	4095.73	4004.82	3997.72	3900.27	4000.89	4031.81	3962.78	3949.52
3	Feed price per kg (Rs.)								
	Pre-starter	28.83	29.43	32.83	30.08	30.35	33.43	30.68	30.95
	Starter	29.00	29.60	33.00	30.25	30.52	33.60	30.85	31.12
	Finisher	28.40	29.00	32.40	29.65	29.92	33.00	30.25	30.52
4	Feed cost per bird (Rs.)								
	Pre-starter	3.69	3.56	4.03	3.71	3.67	4.13	3.66	3.85
	Starter	24.67	25.08	28.13	25.27	24.96	29.05	25.29	25.75
	Finisher	88.52	88.06	97.93	87.21	91.61	100.44	91.47	91.48
5	Total feed cost per bird (Rs.)	116.88	116.70	130.09	116.19	120.24	133.62	120.41	121.08
6	Miscellaneous cost per bird (Rs.)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
7	Net cost of production per bird (Rs.)	161.88	161.70	175.09	161.19	165.24	178.62	165.41	166.08
8	Cost of production per kg live weight (Rs.)	69.09	66.51	70.66	66.34	66.37	68.59	65.06	66.70
9	Live body weight at the end of 6^{th} week (g)	2343.04	2431.07	2477.87	2429.82	2489.83	2604.10	2542.29	2490.00
10	Returns on sale @ Rs. 76 per kg live body weight	178.07	184.76	188.32	184.67	189.23	197.91	193.21	189.24
11	Net profit per bird (Rs.)	16.19	23.07	13.23	23.47	23.98	19.29	27.80	23.16
12	Net profit per kg(Rs.)	6.91	9.49	5.34	9.66	9.63	7.41	10.94	9.30

From the Table 3, it is observed that cost of production (Rs./bird) was 161.88, 161.70, 175.09, 161.19, 165.24, 178.62, 165.41 and 166.08 for treatment groups A, B, C, D, E, F, G and H, respectively. The net profit (Rs. /kg live weight) was 6.91, 9.49, 5.34, 9.66, 9.63, 7.41, 10.94 and 9.30 for the treatment groups A, B, C, D, E, F, G and H, respectively. The higher net profit rupees per kg of live weight were observed in treatment groups G. Among different dietary treatments, the lowest cost per kg live weight gain for total period was observed in treatment G which might be due to better FCR in this group.

Furthermore, all the treatment groups supplemented with combination of peppermint essential oil with organic acids resulted in to higher net profit when compared to treatment group where they are supplemented individually.

European Production Efficiency Factor (EPEF)

At the end of the experimental period (42 days), based on live weight (LW), livability (LA), slaughter age (SA) and feed conversion ratio (FCR) European production efficiency factor (EPEF) was calculated. The production efficiency factor of all treatment groups were worked out and presented in **Table 4**.

The analysis of variance for European production efficiency factor (EPEF) showed non-significant differences in all treatment groups. The highest EPEF was observed in treatment groups F offered blend of peppermint essential oil with sorbic acid in diet of birds compared to all treatment groups but the statistical difference was non-significant among all treatment groups.

Table 4 European Production Efficiency Factor (EPEF) of broilers fed peppermint essential oil and organic acids

Treatment groups	European production efficiency factor (EPEF)
A control	286.71±7.80
B (peppermint EO@200mg/kg)	321.95±6.41
C (sorbic acid 1%)	329.72±15.87
D (fumaric acid1%)	331.00±19.53
E (propionic acid 1%)	338.35±10.73
F (peppermint EO + sorbic acid 1%)	362.49±26.79
G (peppermint EO + fumaric acid)	349.33±7.16
H (peppermint EO + propionic acid)	342.46±7.36
CD	NS
CV %	7.53

NS-Non-significant

Conclusion

The dietary supplementation of peppermint essential oils @ 200 mg/kg feed with different organic acids resulted in higher profit in broiler production with improved performance and enhanced immune response. The results showed that peppermint essential oil with fumaric acid showed significant effect on net profit in broiler production. The highest EPEF was observed in treatment groups offered with blend of peppermint essential oil with sorbic acid in diet of birds compared to all other treatment groups. Thus, all the treatment groups supplemented with combination of peppermint essential oil with organic acids resulted in to higher profit.

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