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Impact of Phytogenic Feed Additives on Growth Performance, Carcass Traits and Immune Response in Broilers under Summer Stress

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ABSTRACT

This study was conducted to evaluate the effect of some phytogenic feed additives (PFA) on growth performance, carcass parameters and immune response in broiler chicken during summer stress. A total of 240-day-old commercial male broiler chicks were randomly allotted to either of four dietary treatments with twelve replications of five birds each and reared in battery brooder up to 42 days of age. The treatments consist of a control diet (CD), CD supplemented with PFA-I containing clove and eucalyptus essential oil @ 25g/100kg (0.025%), PFA-II containing blend of oregano, cinnamon, citrus peel and fructo-oligosaccharides @10g/100kg (0.01%) and PFA-III containing amla and linseed powder @10g/100kg (0.01%). At the end of 42 days, the results indicated that body weight gain, feed intake, feed conversion ratio and carcass parameters were significantly ($P<0.05$) improved in the phytogenic supplemented groups. However, humoral immunity (NDV titer) and cell-mediated immune response to PHA-P were not affected by different phytogenic supplementation. Finally, it can be concluded that supplementation of phytobiotics improved the growth performance and dressing percentage, but did not show any significant effect on immune parameters.

KEYWORDS: Body Weight, Broilers, Feed Conversion Ratio, Immunity, Summer

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INTRODUCTION

India has a tropical climate where the weather remains hot in the summer and cold in the winter. The performance of broilers is impacted by high ambient temperatures i.e. when the temperature goes beyond the thermo-neutral zone (16-25^{0}C) it negatively influences the growth and production and also weakens the immune system resulting in disease outbreaks, which will affect the economics of broiler farming.

One of the most popular and effective strategies to reduce the impact of high temperature on chickens is through dietary changes (Sahin et al., 2004). Phytogenic feed additives (PFA) are natural bioactive compounds derived from plants and incorporated into feed due to their various beneficial properties. They may be present in solid, dried and ground form or as extracts or essential oils. Essential oils (EO's) are a complex blend of a variety of volatile molecules such as terpenoids, phenol-derived aromatic components, terpenes, terpenoids and aliphatic components. The supplementation of poultry diets with EO's such as clove and eucalyptus have favorable effects on digestive enzymes (Jang et al., 2004) and intestinal microflora since they inhibit harmful microbial growth in the gut and increase digestibility (Al-Snafi, 2017). They also have other properties like antimicrobial, antioxidant, anti- inflammatory and immunomodulatory activities (Hanieh et al., 2010). Phytobiotics such as amla and linseed have improved growth performance (Duarte et al., 2014) and immune status (Reddy et al., 2012). The supplementation EO's such as clove and eucalyptus have favourable effects on digestive enzymes (Jang et al., 2004) and intestinal microflora since they inhibit harmful microbial growth in the gut and increase digestibility (Al-Snafi, 2017). However, these

phytogenic feed additives vary widely in their functional properties and their combination may complement each other. Hence the present experiment was aimed to study the effect of combination of different phytogenic feed additives on growth performance, carcass parameters and immune response in broiler chicken.

MATERIALS AND METHODS

Experimental design, diets and housing

In this study, a total of 240-day-old commercial male broiler chicks were procured, wing banded and individually weighed. The birds were later randomly distributed into four groups with twelve replicates and five birds in each replicate. The chicks were reared in battery brooders with optimum brooding conditions from day-old to 42 days of age. The temperature during experimental period (0-6 weeks) i.e., between April and May range between 33.8 to 37.5°C and humidity was maintained between 46-75% by water spray. Birds were immunized against New castle disease (ND) with Lasota vaccine on 7th (primary) and 28th (booster) days of age and Infectious bursal disease (intermediate – Georgia strain) vaccine on 14th (primary) and 21st (booster) days of age. All the dietary treatment groups received iso-nitrogenous and iso-caloric diets as per BIS (2007). During the experiment, the broiler chickens had *ad libitum* access to feed and water. The treatments consist of a control diet (CD), CD supplemented with PFA-I containing clove and eucalyptus essential oil @25g/100kg, PFA-II containing blend of oregano, cinnamon, citrus peel and fructo-oligosaccharides @10g/100kg and PFA-III containing amla and linseed powder @10g/100kg.

Growth performance

The data of body weight was recorded on broiler birds on weekly basis, while the feed consumption of each replicate was recorded at weekly intervals up to 42 days of age. The feed conversion ratio (FCR) was calculated (feed intake/body weight gain) considering mortality.

Carcass parameters

Slaughter variables were studied at the end of the experiment (42 days of age). One bird from each replicate was randomly selected, fasted overnight with free access to water, weighed and sacrificed by cervical dislocation on the next day. Dressing percentage (%), breast yield (%), thigh yield (%), drumstick yield (%) and giblet % were recorded.

Immune response

Cell mediated immunity

On the 40th day of experiment, 6 birds from each treatment were selected randomly for testing. The web between the third and fourth inter-digital space of right foot was injected with 100ìg of PHA-P suspended in 0.1 ml of phosphate buffer saline (PBS), while the left web (control) was administered with 0.1 ml of PBS. The web thickness of both feet was measured by micrometer after 24 hours of injection and CBH was calculated using the formula (Edelman et al., 1986).

Humoral immunity

Six birds from each treatment were randomly selected for blood collection at 42 days of age. The blood samples were collected via wing vein from each bird. The serum was separated by centrifugation at 3000 RPM for 20 minutes and decanted into clean, sterile plastic vials and stored under deep freeze at –18 to –20ºC. Haemagglutination inhibition (HI) activity of serum was estimated against Newcastle disease (ND) vaccine (antibody production against ND virus) and the antibody titers (log2) were measured following the standard procedure (Wegmann and Smithies, 1966).

Statistical analysis

The data was analyzed using the General Linear Model procedure of Statistical Package for Social Sciences (SPSS) 20th version and comparison of means was done using Duncan's multiple range test (Duncan, 1955) and significance was considered at $P<0.05$.

Table 1. Ingredient and chemical composition of the basal diets for chickens

Ingredients (%)	Pre starter (0-14 days)	Starter (15-28 days)	Finisher (29-42 days)
Maize	53.1	53.8	58.4
Vegetable oil	2.74	4.30	5.00
Soyabean meal	40.2	38.0	32.5
Stone grit	1.20	1.20	1.20
Dicalcium Phosphate	1.80	1.90	2.00
Salt	0.35	0.30	0.30
DL-Methionine	0.15	0.15	0.13
L-Lysine HCl	0.06	0.00	0.03
Trace Mineral Mixture***	0.15	0.15	0.15
Vitamin AB_2D_3K*	0.02	0.02	0.02
Vitamin B-Complex**	0.02	0.02	0.02
Choline chloride 60%	0.06	0.06	0.06
Toxin binder	0.05	0.05	0.10
Coccidiostat	0.05	0.05	0.05
Total	100	100	100
Nutrient composition (calculated values)			
ME (kcal/kg)	2992.91	3097.12	3183.80
Crude protein (%)	23.01	22.0	20.0
Lysine (%)	1.31	1.20	1.10
Methionine (%)	0.50	0.49	0.45
Calcium (%)	1.00	1.09	1.02
Available phosphorous (%)	0.46	0.45	0.46

*AB_2D_3K provided per kg diet: Vitamin A 20000 IU, Vitamin B_2 25 mg, Vitamin D_3 3000IU, Vitamin K 2mg.
** Vitamin B-Complex provided per kg diet: Riboflavin 25mg, Vitamin B_1 1mg, Vitamin B_6 2mg, Vitamin B_{12} 40mg, and Niacin 15mg.
***Trace mineral provided per kg diet: Manganese 120mg, Zinc 80mg, Iron 25mg, Copper 10mg, Iodine 1mg.

RESULTS AND DISCUSSION

Growth performance

Dietary supplementation of PFA-I resulted in higher body weight gain compared to PFA-II, PFA-III and control, whereas PFA-II and PFA-III were similar (Table 2). The overall feed consumption (0-42 days) of broilers supplemented with PFA-I diet is significantly high compared to PFA-III and control. During the experimental period broilers supplemented diet with PFA have shown significantly ($P<0.05$) better FCR compared to control. The results of the present study are in agreement with the previous conclusions of Mahrous et al. (2017) and Forogh (2021). However, Tiago et al. (2019) didn't find any significant variation in body weight gain when herbal products are supplemented along with broiler's diet. The active ingredient present in eucalyptus (1.8-cineol) is associated with modulation of gut microbiota, thus improved the body weight gain of broiler's supplemented with PFA- I diet. Clove essential oil decreases the harmful gut bacterial populations, protects the amino acids against oxidation and improves the activity of the digestive enzymes, thus it enhances the performance of broilers (Forogh, 2021). PFA-II and PFA-III supplemented

groups showed significant weight gain compared with control and these results were similar to that of Srinivas et al. (2017), Sahar (2018) and Aljumaily et al. (2019) respectively. The anabolic and antioxidant properties of the amla, oregano, cinnamon and citrus peel are responsible for increased body weight gain (BWG).

Eugenol present in clove essential oil stimulates the bile salt secretion and the activity of digestive enzymes (Azadegan et al., 2014). Thus, it significantly ($p<0.05$) improved the feed consumption and FCR in broilers supplemented diet with PFA-I. These results were in accordance with Mukhtar (2011) who reported better FCR with supplementation of clove essential oil. Edwards-Jones et al. (2004) and Tiwari et al. (2016) supplemented oregano and amla powder respectively in the diet of broilers and obtained results which are similar as that of current study. Amla is known to act as a stomachic (Bhandari and Kamdod, 2012) and good appetizer (Patel et al., 2016) and helps in improving feed efficiency.

The present results in PFA- III group are in accordance with that of Al-Zuhairy and Alasadi (2013) who obtained better FCR with inclusion of linseed oil in the diet of broilers. Essential oils can activate enzymes (Mohamed et al., 2021), increases nutrient absorption and improves microbial population thus improves FCR. On contrary, supplementation of mentofin (herbal product) in broilers didn't show any significant effect (Rehman et al., 2013).

Table 2. Effect of phytogenic feed additives on body weight gain, feed intake and feed conversion ratio in broiler chicken from 0 to 42 days

Treatment	Overall period (0-42 days)		
	BWG	FI	FCR
CD	2025.95^{c}	3228.20^{b}	1.59^{b}
PFA-I	2273.11^{a}	3457.15^{a}	1.52^{a}
PFA-II	2179.00^{b}	3344.02 ^{ab}	1.54^{a}
PFA-III	2135.19^{b}	3273.73^{b}	1.53^{a}
SEM	18.01	25.31	0.01
N	12	12	12
P value	0.01	0.01	0.01

Means with different superscripts in a column differ significantly ($P<0.05$).

Carcass parameters

Statistically significant ($P<0.05$) differences exists between the means of various treatments regarding the dressing percentage as shown in Table 3. Significantly ($P<0.05$) high dressing percentage was observed in PFA-II and PFA -III fed groups. This is attributed to increased nutrient absorption (e.g., amino acids), which in turn lead to better carcass yield (Shabaan, 2017). Similar results were observed in the studies conducted by Chandra et al. (2019) and Eler et al. (2019) who fed amla and oregano oil, respectively. However, no significant difference was observed in giblet, breast, thigh and drumstick percentage in broilers fed with PFA.

Table 3. Effect of phytogenic feed additives on carcass parameters in broiler chicken at 42 days of age.

Treatments	Dressing percentage (%)	Breast %	Thigh %	Drumstick %	Giblet %
CD	65.13[b]	20.0	9.85	10.0	4.02
PFA-I	66.83[ab]	20.1	10.3	10.2	3.88
PFA-II	68.77[a]	20.8	9.95	9.64	4.05
PFA-III	68.56[a]	20.6	10.8	9.86	3.78
SEM	0.37	0.28	0.18	0.15	0.05
N	12	12	12	12	12
P value	0.02	0.92	0.20	0.54	0.17

Means with different superscripts in a column differ significantly (P<0.05).

Immune response

Cell-mediated immunity (CMI) was assessed by delayed type hypersensitivity reaction against PHA-P and measured in the skin fold thickness of broilers. No significant difference was observed in broilers which are supplemented with phytogenic feed additives. At 42 days of age humoral immune response was evaluated in terms of antibody response to ND vaccine and is presented at Table 4. The supplementation of phytogenic feed additives doesn't significantly influenced the mean log_2 antibody response to ND vaccine. The insignificant values of immune parameters in the present study might result from high environmental temperatures (33.8°C to 37.5°) and low dosage when compared to Gole et al. (2020).

Table 4. Effect of phytogenic feed additives on immune response in broiler chicken at 42 days of age

Treatments	*PHA-P response (mm) (thickness index)	HI ND titer (log_2)
CD	129.18	7.50
PFA-I	141.88	7.67
PFA-II	129.87	7.50
PFA-III	129.82	7.62
SEM	2.96	0.15
N	6	6
P value	0.38	0.87

*PHA-P: Phytohaemagglutinin-phosphate.

CONCLUSION

Based on the overall results, it can be concluded that supplementation of PFA in the diets of broilers significantly improved the body weight gain, feed consumption, feed efficiency and dressing percentage during summer season with an average temperature range of 33.8 to 37.5°C and relative humidity of 46-75%.

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