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Evaluation of the Influence of a Phytogenic Feed Additive on Carcass Traits in Broilers Compared to an Antibiotic Growth Promoter

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Abstract:
Phytogenic feed additives (PFA), comprising of herbs, spices, essential oils, plant extracts and products derived thereof have gained considerable importance in view of the worldwide ban on the inclusion of antibiotic growth promoters (AGPs) in food animals. PFA have also been reported to influence meat and carcass quality traits in animals. The present study was aimed at comparing the effects of a PFA and an AGP on carcass traits in broilers.
A 39-day trial was conducted with an as-hatched flock of 432-day-old Cobb 400 broilers. Chicks were randomly assigned to three dietary treatments with 12 replications per treatment and 12 birds per replicate. The three dietary treatments comprised of a control (basal diet), AGP (basal diet + 225 mg/kg bacitracin methylene disalicylate), and PFA (basal diet + PFA Digestarom® 150 mg/kg).
Although the carcass and breast yield being numerically higher in the PFA group than the control, the thigh yield remained unaffected by diets (P>0.05). Drumstick yield was higher in the AGP and PFA treatments as compared with the control (P=0.002). Weight of the viscera decreased (P=0.004) in the dietary treatments receiving AGP and PFA supplementation. PFA treatment had a lower meat pH compared to the other two treatments.
Results reveal that the PFA evaluated was equally effective like the AGP used as regards the carcass traits of broilers, when added to a corn-soybean meal based coccidiostat free broiler diet and hence can serve as an alternative to the AGPs in broilers.

Keywords*: broiler, phytogenic feed additive, antibiotic growth promoter, carcass*

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I. Introduction

Due to a steady growth in the human population, there has been a steady increase in the global meat production over the last decades and this trend is projected to continue steadily in the near future (FAO, 2018). An increasing demand for animal protein on one side and stricter regulations about protection of human health, animal welfare and environmental protection on the other side, make subsequent adaptations necessary for the on-going production process (Puvača et al., 2013).

The present trend worldwide to reduce the use of antibiotic growth promoters (AGP)in poultry rations following the example of Europe, has put a great pressure on the poultry industry as well as the scientific community to search for viable alternatives.

Feed additives from plant origin, also known as phytogenic feed additives (PFA), comprising of herbs, spices, essential oils, plant extracts and their products have therefore gained considerable interest as part of a strategy ofAGP replacement in animal nutrition. This is attributed to their anti-inflammatory effects elucidated in a number of studies (Kroismayr et al. 2008; Miguel 2010; Gbenou et al. 2013) as well as anti-oxidative properties reported for a large number of plant substances (Wei and Shibamoto 2007; Miguel 2010) and in turn theirability to improve performance by maintaining a healthy gut environment (Windisch et al., 2008). It is difficult to select a single alternative substance to the AGP as the mode of action of AGPs has not been clarified yet and there are still more theories accepted by scientific communities. Ideally substances with similar beneficial effects should be chosen. Essential oils have been suggested to improve gut health (Giannenas et al., 2003; McReynolds et al., 2009), nutrient digestibility (Jamroz et al., 2005) and growth performance (Giannenas et al., 2003; Isabel and Santos 2009) in poultry. Direct anti-inflammatory activity of a blend of essential oils has also been reported by Gessner et al. 2013. These various beneficial effects of PFA are attributed to their bioactive molecules like thymol, carvacrol, cineole and capsaicin etc. (Mountzouris et al., 2011). Essential oils present in PFA have also been reported to positively influence carcass and meat quality characteristics in

animals (FlorouPaneri et al., 2005; Cross et al., 2007; Isabel and Santos, 2009; Popović et al., 2016; Puvača et al., 2016). These properties project the PFA as ideal substances to be used as part of a strategy to replace AGPs.

The objective of this study was to evaluate the influence of a commercially available PFA in comparison to an AGP bacitracin methylene disalicylate (BMD) and a negative control on performance, carcass and edible organtraits in broiler chickens.

II. Material And Methods

All the animal procedures were conducted in accordance with the prevailing institutional ethical norms of the West Bengal University of Animal and Fishery Sciences, Kolkata, India**.**

Bird husbandry

An experimental trial of 39 days duration was conducted with an as-hatched flock of 432-day-old Cobb 400 broilers. The chicks were weighed and randomly assigned to 3 dietary treatments with 12 replications per treatment and 12 birds per replicate (144 birds in each treatment). Birds were raised on litter composed of paddy straw and wood shavings and received maize-soybean meal based diets from 1 to 7 days (starter), 8 to 21 days (grower) and 22 to 39 days (finisher). Feed and water were offered *ad libitum*. Lighting program was 23 h of light for the first 7 days, 20 h until day 15 and 18 h afterwards. The birds were vaccinated against Marek's disease (day 0), Newcastle disease (ND live B1 at day 7 and La Sota at day 21) and infectious bursal disease at day 14. Temperature was maintained around 32 to33^{o}C during the first 2 weeks and at 27 to 28^{o}C subsequently.

Treatments and experimental diets

The 3 dietary treatments comprised of a control (basal diet), AGP (basal diet + AGP) and PFA (basal diet + PFA)Table 1. The AGP used was bacitracin methylene disalicylate (BMD) at the inclusion rate of 225 mg/kg of diet. The phytogenic feed additive used (Digestarom Poultry, 150 mg/kg, Biomin Phytogenics GmbH, Stadtoldendorf, Germany) comprised of a selected combination of different plant materials including herbs, spices, essential oils and their extracts characterized by a blend of mint oil(*Mentha arvensis*), anise (*Pimpinella anisum*) and clove (*Syzygiumaromaticum*). The dietary inclusion level of the PFA was according to the manufacturer's recommendations. No exogenous polysaccharide degrading enzymes and anti-coccidial drugs were added to the diets because these might mask the effects of the PFA, however, a toxin binder was used to prevent mould growth in the stored feed.

Table 1. Ingredient composition of basal diet (g/kg, unless stated otherwise).

Ingredients	Starter (1 to 7 d)	Grower (8 to 21 d)	Finisher (22 to 39 d)
Ground corn	540.7	567.2	583.4
Soybean meal (460 g CP/kg)	396.0	362.5	328.0
Soybean oil	27.0	33.7	51.1
Calcite powder	12.45	12.45	12.45
Di-calcium phosphate	16.5	16.5	17.0
DL-methionine	0.55	0.95	1.35
Lysine hydrochloride	0.3	0.2	0.2
Sodium bi carbonate	2.0	2.0	2.0
Salt	2.0	2.0	2.0
Vitamin + mineral premix[1]	2.0	2.0	2.0
Toxin binder	0.5	0.5	0.5
Calculated composition			
ME (MJ/ kg)	11.85	12.14	12.65
Crude protein	223.5	210.4	196.3
Ether extract	52.7	59.8	7.33
Crude fibre	37.5	36.1	3.44
Calcium	9.57	9.47	9.38
Available P	3.18	3.16	3.13
Digestible lysine	11.02	10.19	9.39
Digestible methionine	3.51	3.76	3.99
Digestible methionine + cysteine	6.87	6.73	6.77

[1]Contained (per kg) retinyl acetate 3.75 mg, 1,25-hydroxy-cholecalciferol 4 mg, DL-α-tochopheryl acetate 30 mg, menadione 4 mg, thiamine propyl disulfide 3 mg, riboflavin tetrabutyrate 8 mg, riboflavin tetrabutyrate 8 mg, methylcobalamin 0.025 mg, sodium pantothenate 15 mg, pyridoxine 5 mg, niacin 60 mg, biotin 0.2 mg, folic acid 2 mg, manganese 40 mg, iron 30 mg, zinc 25 mg, copper 3.5 mg, iodine 0.3 mg, selenium 0.15 mg, choline chloride 200 mg.

Measurement of performance, carcass and edible organtraits

Birds were individually weighed at 7, 21 and 39 d which designated the starter, grower and finisher periods respectively. Body weight gain (BWG), total feed intake (FI) and feed conversion (FI: BWG) were calculated pen wise for each period and for the overall period. Mortality was recorded daily and the data was adjusted accordingly.

At 39 d, 12 birds having body weight closest to the mean weight of the group were selected from each dietary treatment. The birds were weighed and euthanized by cervical dislocation, followed by exsanguination. After the removal of feathers, viscera, shanks and neck, the weights of the eviscerated hot carcass, breast, drumsticks, thighs and organs (viscera, liver, gizzard and heart) were measured. Carcass yield and yields of breast, thighs and drumsticks relative to live weight (g/kg) were measured. Breast fillets (approximately 200 g) were stored at 4^{o}C for 24 h for determination of pH, drip loss andmoisture contents. Drip loss and pH were determined according to Qiao et al. (2007). Pieces of breast fillet (50 g) were stored at 4^{o}C for 48 h and the loss of weight as the percentage of the original sample weight was determined. This loss was equivalent to the drip lost from the stored meat. Meat pH was measured at 6 different locations across the sample surface with a pH meter (AB15, Thermo Fisher scientific, Waltham, MA, USA). The average represented the finale pH of the sample.

Statistical analysis and calculations

Cages were considered as experimental units and all data were pooled cagewise unless specified otherwise and expressed as mean and pooled standard error of means (SEM). The data were subjected to one-way analysis of variance (SPSS version 10.1) with the diets as the factor and when found significant the means were separated by Tukey´s test. Significant differences were accepted if $P \leq 0.05$.

III. Results And Discussion

Birds were healthy during the experimental trial with statistically insignificant mortalities of 4.22, 2.22 and 2.78% in the control, AGP and PFA groups respectively.

Carcass traits were mostly unaffected ($P>0.05$) by diets (Table 2) except the yield of drumstick which was higher in the AGP and PFA groups as compared with the control ($P=0.002$). Relative organ weights were also not affected significantly due to supplementation of AGP and PFA to the diet ($P>0.05$), however weight of the viscera decreased ($P=0.004$) in the dietary treatments receiving AGP and PFA supplementation. Weight of the heart tended to be increased in the AGP and PFA treatments as compared with the control treatment ($P=0.094$). No significant effect of the diets was observed on drip loss and pH of meat although PFA group tended to have a lower meat pH compared to the other 2 treatments ($P>0.05$).

Table 2. Carcass traits and relative organ weight (g/g live weight) of experimental birds supplemented with either an antibiotic or a phytogenic growth promoter.[1]

	Dietary treatments[2]				
Components	**Control**	**AGP**	**PFA**	**SEM**	***P*-value**
Yield of carcass cuts(g/kg live weight)					
Carcass yield	714.7	719.8	728.1	0.49	0.566
Breast	180.3	183.5	187.7	0.25	0.188
Frame	246.3	228.8	238.2	0.32	0.244
Thigh	72.6	77.3	74.7	0.13	0.35
Drumstick	136.7^{b}	149.9^{a}	153.9^{a}	0.16	0.002
Relative organ weight(g/kg live weight)					
Viscera	113.3^{a}	82.1^{b}	80.8^{b}	0.14	0.004
Liver	23.9	22.8	22.3	2.21	0.584
Gizzard	48.4	49.5	43.5	4.31	0.253
Heart	6.48	7.88	7.71	0.068	0.094
Drip loss (%) [3]	2.11	2.12	2.06	0.13	0.521
Meat pH [3]	6.01	5.89	5.81	0.044	0.298

AGP = bacitracin methylene disalicylate; PFA = Digestarom

[a,b]Means with dissimilar letters in a row varied significantly ($P< 0.05$).

[1]Means of 12 birds per treatment. Birds were selected randomly and killed at 39 d of age.

[2] The 3 dietary treatments comprised of a control (basal diet), AGP (basal diet + AGP) and PFA (basal diet + PFA).

[3] Measured after 24 h of storage at 4^{o}C.

Table 3. Performance of broilers supplemented with a PFA or an AGP from 1 to 39 d

	Dietary treatments[1]				
Components	**Control**	**AGP**	**PFA**	**SEM**	***P*-value**
Body weight gain, g	1,896.9[b]	1,969.5[a]	2,018.2[a]	14.41	0.001
Feed intake, g	3,789.5	3,800.2	3,751.5	9.81	0.101
Feed conversion ratio	2.002[a]	1.931[ab]	1.860[b]	0.015	0.0001

AGP = bacitracin methylene disalicylate; PFA = Digestarom

[a,b]Means with dissimilar letters in a row varied significantly ($P< 0.05$).

[1] The 3 dietary treatments comprised of a control (basal diet only), AGP (basal diet + AGP) and PFA (basal diet + PFA).

Phytogenic feed additives have attracted increasing interest as an alternative feeding strategy to replace the AGP particularly in the European Union, where use of AGP as feed additives is completely banned since 2006 because of a suspected risk of generating microbiota with increased resistance to the antibiotics used for therapy in humans and animals (Windisch et al., 2008; Puvača et al., 2013). PFA have also been reported to positively influence carcass and meat quality characteristics in food animals (Jamroz et al., 2003; Isabel and Santos, 2009). Results of the present investigation revealed that the yield of drumstick was higher in the AGP and PFA groups as compared with the control. Although the relative organ weights were not affected significantly due to supplementation of AGP and PFA to the diet, however, weight of the viscera decreased in the dietary treatments receiving AGP and PFA supplementation. The reduction in viscera weight by dietary supplementation of AGP and PFA implied a reduction in the nutrients required to maintain the gut, thereby leaving more nutrients available for productive processes such as body weight gain and feed conversion ratio (Table 2). These findings are further supported by the fact that supplementation with AGP and PFA improved body weight and FCR of broilers (Table 3). Plant extracts and essential oils reportedly improved broiler performance (Ciftci et al., 2005; Jamroz et al., 2005, Mountzouris et al., 2011).

IV. Conclusions

Results reveal that the used PFA when added to a maize-soybean meal based coccidiostat free broiler diet was equally effective compared to the AGP used withregard to carcass traits and performance and thus can serve as part of a strategy to replace the AGPs in broiler diets.

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