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Effect of sun dried whole bulb garlic powder on growth, carcass characteristics and meat quality of commercial broilers

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ABSTRACT

A study was conducted to evaluate the effect of sun dried whole bulb garlic powder as phytogenic alternative to antibiotic growth promoters in broilers. Day-old broiler chicks (225; IBL 80) were randomly distributed to 5 treatments with 3 replicates. The dietary treatments comprises of basal diet as control, antibiotic group receiving 0.1g/kg of oxytetracycline, 1.0,1.5 and 2.0% of sun-dried whole bulb garlic powder (WBGP) added to basal diet. Daily feed intake, weekly body weight and residue left any were recorded to calculate the feed conversion and protein efficiency ratios. At the end of fifth week 2 birds / replicate were sacrificed to determine the carcass characteristics and meat sensory evaluation. Results revealed that supplementation of WBGP at 1.5% improved the body weight, which is statistically comparable with the antibiotic fed group but the feed conversion ratio was significantly lower in 1.5% WBGP supplemented group than the control and antibiotic groups. Dietary treatment does not significantly influence the carcass characteristics except the relative heart weight. Supplementation of WBGP significantly improved the meat quality parameters as compare to control group. From the results of present study, it is concluded that dietary inclusion of 1.5% sun dried WBGP can be used as phytogenic alternative to antibiotic growth promoters in broilers.

Key words: Broiler, Garlic powder, Growth performance, Meat sensory qualities

Use of feed antibiotic below therapeutic level as antimicrobial growth promoters (AGPs) is widely prevalent in the poultry industry due to several benefits. However, their consistent use at sub-therapeutic level can result in the development of drug resistant bacteria (Alexander *et al*. 2008), which poses a serious threat to life of human beings. European Union had banned the use of antibiotic as AGPs in animal production. Plants and plant derived products being natural, non toxic, residue free and their easy availability make them first choice as alternate to AGPs. They have multiple effects on animal including appetite stimulator, enhance digestive secretion, immuno-stimulant, bactericidal, antiviral, antioxidants and are termed as phytogenics (Hashemi and Davoodi 2011).

Garlic (*Allium sativum*), the wonder drug of the herbal world due to its multi functional benefits (Sikka and Singh 2009), possess at least 33 sulphur containing compounds, several enzymes, amino acid and minerals (Newall *et al*. 1996). The major active ingredients in garlic are allicin, ajoene, diakyl polysulphides, s-allylcysteine etc. which may be responsible for the various properties of garlic (Canogullari *et al*. 2010). *In vitro* studies showed that garlic possesses antibacterial, antifungal, antiparasitic, antiviral (Ankari and Mirelman 1999) and antioxidant (Prasad *et al*. 2009) properties. Suriya *et al*. (2012) suggested that inclusion of 0.5% garlic may have the potential to be an alternative to antibiotic growth promoter for broiler chicken. The present study was designed to evaluate the potential of incorporating 3 levels of sun dried WBGP as a phytogenic alternative to antibiotic growth promoters in commercial broilers.

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MATERIALS AND METHODS

Birds and experimental diets: Day-old broiler chicks (225; IBL–80) were randomly assigned to 5 different dietary treatments using completely randomized design. Each dietary treatment had 3 replicates each having 7 male and 7 female broiler birds. The feeding was done in 2 phases i.e. starter (0–21 days) and finisher (22–35 days) phase. For each phase, 5 iso-caloric and iso-nitrogenous (T1–T5) diets were formulated (Table 1) as per BIS (1992). Diet T1 served as control while diet T2 was supplemented with antibiotic (oxytetracycline) @ 0.1g/kg as growth promoter. Garlic bulbs fragmented into pieces and paste was prepared, which was sun-dried and ground to obtain whole bulb garlic powder (WBGP). Nutritional composition of this WBGP includes 91.22% dry matter, 13.69% crude protein, 1.63%

Table 1. Composition of starter and finisher feed

	Starter (S)					Finisher (F)				
	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
Ingredients										
Maize	55.64	55.63	54.64	54.14	53.64	60.79	60.78	59.79	59.29	58.79
Soyabean meal	38.10	38.10	38.10	38.10	38.10	32.14	32.14	32.14	32.14	32.14
Oil	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0
DCP	1.7	1.7	1.7	1.7	1.7	1.5	1.5	1.5	1.5	1.5
LSP	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6
WBGP	-	-	1.0	1.5	2.0	-	-	1.0	1.5	2.0
Oxytetracyclin (g)	-	10	-	-	-	-	10	-	-	-
Additives*	+	+	+	+	+	+	+	+	+	+
Analysed values (DM basis)										
CP	21.42	21.24	21.42	21.06	21.24	19.14	19.14	19.76	20.12	19.28
Fat	3.03	3.17	2.85	2.79	3.45	5.7	5.4	4.06	4.97	4.88
Crude fibre	5.43	5.53	5.19	5.75	6.60	4.33	4.12	4.73	5.28	5.27
Ash	6.8	6.3	6.39	6.77	7.14	5.5	6.2	4.25	4.91	6.50
AIA	0.47	0.36	0.41	0.32	0.39	0.56	0.61	0.56	0.66	0.75
Ca	1.16	1.07	1.07	1.13	1.07	1.18	1.20	1.07	1.07	1.02
Av. P	0.49	0.48	0.51	0.48	0.47	0.48	0.49	0.47	0.51	0.49

* Additives :Each 100 kg ration contained: Vitamin A 8,25,000 IU; vitamin D3, 1,20,000 IU; riboflavin 500mg; vitamin K, 100mg; vitamin E, 800mg; thiamin 80mg; pyridoxine 160mg; cynacobalamin 800mg; niacin 1200mg; calcium pentothenate 800mg; manganese sulphate 25g; zinc sulphate 25g; ferrous sulphate 10g; copper sulphate 500mg; potassium iodide 100mg; lysine 0.070g (S) 0.010g (F), methionine 0.170g (S) 0.100g (F) coccidiostat 100g, toxin binder 100g, salt 370g.

ether extract, 10.82% crude fibre, 0.2% calcium, 0.43% phosphorus, 4.376 ppm copper, 32.09 ppm zinc, 188.5 ppm iron, 1.414 ppm manganese and 3,615.30 kcal/kg gross energy. Diets T3 to T5 were supplemented with this WBGP @ 1.0, 1.5 and 2.0% level replacing maize in the ration respectively. All the experimental diets were analysed for proximate principles, phosphorus (AOAC 2000) and calcium (Talapatra *et al*. 1940) content. Ingredients and chemical composition of starter and finisher diets are presented in Table 1. Weighed amount of respective diet was offered daily to all groups to ensure *adlib* feeding. Fresh clean water was made available to the birds throughout the experimental period. The birds were reared on deep litter system maintaining standard managemental practices.

Growth performance and carcass characteristics: Body weight was recorded at weekly interval up to 35 days to determine the weekly body weight gain. Feed residue left from each replicate was quantified weekly to calculate feed intake and feed conversion ratio. Mortality if any was recorded daily. At the end of experiment i.e on 35th day, 2 birds, 1 male and 1 female, of identical body weight from each replicate were sacrificed. The birds were starved for 12 h but drinking water was provided *ad lib*. The birds were killed by serving the jugular vein and carotid artery on one side of the neck and allowed to bleed. Each bird was defeathered and eviscerated maintaining proper hygiene. The eviscerated weight and weight of liver, gizzard, heart, and abdominal fat parameters were recorded and expressed as g/100g of body weight.

Sensory evaluation of meat: The dressed birds were also assessed for meat sensory evaluation. A seven member experienced panel of department of Livestock Product Technology, GADVASU, evaluated the samples for appearance, colour, flavour, tenderness, juiciness and overall acceptability using 8 point descriptive scale (Keeton 1983), where 8 = extremely desirable and 1 = extremely undesirable. The panelists were acquainted with the descriptive scale in two session before the start of experiments 3 sittings (n=21) were conducted for each replicate. The panelists were seated in a room free of noise and odors and suitably illuminated. The meat was cooked in salt and water for around 15 min till the internal temperature reached to 72°C. This full done meat sample was coded and served warm to the panelists. Water was provided in between samples to cleanse the mouth palate.

Statistical analysis: Growth performance, carcass characteristics and sensory evaluation data were subjected to analysis of variance using SPSS (version 18) and treatments mean were compared using Duncan's multiple range tests at 95% significance level.

RESULTS AND DISCUSSION

Initial body weight (IBW), final body weight (FBW), body weight gain (BWG), feed intake / bird / day (FI/B/D), feed conversion ratio (FCR) and protein efficiency ratio (PER) data for the starter (0–3 weeks), finisher (4–5 weeks) phase, overall growth (0–5weeks) period, feed cost/kg weigh gain and benefit cost ratio (BCR) are presented in Table 2.

Starter (0–3 weeks) phase: The dietary regimes

Table 2. Effect of dietary WBGP on growth performance and cost effectiveness in broilers

Treatments/ parameter	T1	T2	T3	T4	T5	SEM
			Starter phase			
I BW	48.10	48.16	48.33	48.67	47.83	0.138
FBW	574.63^{a}	627.15^{b}	598.90^{ab}	614.77^{b}	594.85^{ab}	6.258
BWG	526.53^{a}	578.98^{b}	550.57^{ab}	566.11^{b}	547.02^{ab}	6.236
FI/B/D	41.70	43.52	42.73	41.32	40.99	0.507
FCR	1.66^{b}	1.58 ^{ab}	1.63^{ab}	1.53 ^{a}	1.57 ^{ab}	0.017
PER	2.76 ^{a}	2.84 ^{ab}	2.77 ^{a}	3.16 ^{c}	3.00 ^{bc}	0.046
			Finisher phase			
FBW	1287.40^{a}	1368.94^{c}	1316.95^{ab}	1351.88^{bc}	1302.64^{a}	9.750
BWG	712.77	741.79	718.04	737.11	707.79	9.640
FI/B/D	111.70	116.89	108.36	108.99	107.84	1.503
FCR	2.19^{ab}	2.21^{b}	2.11^{ab}	2.07^{a}	2.13^{ab}	0.019
PER	2.38^{a}	2.37^{a}	2.61^{b}	2.65^{b}	2.65^{b}	0.039
			Overall period			
I BW	48.10	48.16	48.33	48.67	47.83	0.138
FBW	1287.40^{a}	1368.94^{c}	1316.95^{ab}	1351.88^{bc}	1302.64^{a}	9.750
BWG	1239.30^{a}	1320.78^{c}	1268.62^{ab}	1303.22^{bc}	1254.81^{a}	9.712
FI/B/D	67.57 ^{a}	72.31^{b}	68.71^{ab}	67.28^{a}	67.18^{a}	0.724
FCR	1.91 ^{b}	1.91 ^{b}	1.90^{b}	1.81 ^{a}	1.87 ^{ab}	0.014
PER	2.53^{a}	2.56^{ab}	2.68^{bc}	2.85 ^{d}	2.79 ^{cd}	0.037
Feed cost/kg weight gain and benefit cost ratio (BCR)						
Feed cost/kg weight gain	50.09^{b}	49.18^{ab}	48.71 ^{ab}	47.03^{a}	48.48^{ab}	0.384
BCR	1.30^{a}	1.33^{ab}	1.33^{ab}	1.38^{b}	1.33^{ab}	0.010

a, b, c, Means values with different superscripts are significantly different at P<0.05.

significantly (P<0.05) influenced the body weight and weight gain during this phase. The highest (P<0.05) body weight gain was recorded in T2 group (antibiotic fed group) followed by T4 group (1.5% garlic) and are statistically comparable. Weight gain in T3 and T5 group did not differ significantly (P<0.05) from each other but are better (P<0.05) than the weight gain in control (T1) group having lowest weight gain. The same pattern of significance (P<0.05) was reflected in body weight (Table 2). No significant (P<0.05) influence was recorded on feed intake per bird per day (FI/B/D) during this phase (Table 2). The best (P<0.05) FCR and PER was observed in birds fed diet having 1.5% garlic (T4). However, the poorest FCR and PER was observed in T1.

Finisher phase (4–5 weeks): Antibiotic fed (T2) birds attained highest (P<0.05) final body weight which was statistically comparable with the body weight of chicks fed 1.5% WBGP (T4) diet. Best (P <0.05) FCR was observed in T4 group where 1.5% WBGP was added in the diet and poorest (P<0.05) FCR was in antibiotic fed group (T2). PER was significantly (P <0.05) better in all the WBGP supplemented groups than the control (T1) and antibiotic fed (T2) groups (Table 2).

Overall performance (0–5 weeks): During the overall growth performance period, gain in weight in 1.5% WBGP fed group (T4) was statistically (P<0.05) comparable with the highest gain in weight observed in antibiotic supplemented (T2) group. BW was improved (P<0.05) even at 1% WBGP supplemented level than the control. The dietary regimes significantly (P<0.05) influenced the feed consumed, FCR and PER during the overall performance phase. The feed consumed/bird/day was found higher (P<0.05) in T2 group than the rest of treatments studied. Best (P<0.05) FCR was achieved in 1.5% WBGP containing diet (T4). PER improved (P<0.05) in all WBGP supplemented diets compared to control (T1) and antibiotic (T2) groups.

The present study showed that inclusion of WBGP at 1.5% level (T4) during both starter and finisher stage improved the body weight which is comparable with antibiotic fed group (T2) but feed conversion ratio was better at 1.5% garlic supplementation (T4) during overall growth. Phytogenic's antibacterial, antioxidant, antistress, gut microflora manipulation, immune enhancement and digestive enzymes stimulation were the major mechanism behind the positive effects exerted by them on the growth and health performance of animals (Durrani *et al*. 2007, Hashemi and Davoodi 2011). Garlic powders enhance pancreatic enzymes activity (Ramakrishna *et al.* 2003) and activate the digestive process (Masoud 2006) which improves absorption of nutrients and ultimately the growth.

The present study results were in agreement with results of Raeesi *et al.* (2010) who revealed that supplementation of 1 and 3% garlic powder during the finisher period had shown better performance than the control. Mansoub and Mohammad (2011) also found the higher body weight and

best FCR in 1g/kg garlic supplemented group over the control.

Cost effectiveness and benefit cost ratio (BCR): Significant (P<0.05) lowest feed cost /kg weight gain was observed in T4 group (1.5% WBGP inclusion level) followed by T3 and T5 and the highest (P<0.05) feed cost/ kg weight gain of rupees 50.09 was observed in control group. Inclusion of WBGP at all the three level studied improved the BCR. Best (P<0.05) BCR of 1.38 was observed in 1.5% WBGP containing diet (T4), however the lowest (P<0.05) BCR was in control group (T1). BCR in T2 (antibiotic fed group) and T3 (1.0% WBGP) and T5 (2% WBGP) was statistically (P<0.05) comparable (Table 2). Benefit cost ratio (BCR) was significantly better in 1.5% WBGP inclusion group (T4) due to better FCR than the control (T1) and antibiotic fed group (T2). The present results are in agreement with Hossain *et al.* (2014) who also reported significantly higher BCR with 1% garlic than the control.

Carcass characteristics: Different dietary treatments studied had no significant (P<0.05) effect on carcass characteristics except heart weight which was highest (P<0.05) in T3 group (Table 3).

No effect of dietary treatments was observed on the carcass characteristic except the heart weight, which was highest in 1% WBGP inclusion group. However, Raeesi *et al.* (2010) reported the significant impact of garlic powder inclusion (0.5,1.0 and 3%) on the carcass parameters studied, they found that 0.5% garlic powder supplemented group had the greatest (P<0.001) relative heart weight compared with 1 and 3% garlic powder supplemented groups.

Table 3. Effect of WBGP on carcass characteristics of broilers

Parameters	T1	T2	T3	T4	T5	SEM
Carcass characteristics						
Dressing percentage	55.87	54.89	55.21	55.89	55.31	0.432
Liver*	3.16	2.89	3.23	3.44	3.12	0.100
Gizzard *	2.98	2.60	3.12	2.79	2.59	0.086
Heart *	0.544^{a}	0.621^{a}	0.719^{b}	0.592^{a}	0.588^{a}	0.019

*g/100g.

Table 4. Effect of WBGP on sensory evaluation of meat

Parameters	T1	T2	T3	T4	T5	SEM
Sensory evaluation of meat						
Appearance and colour	6.25^{c}	6.78^{b}	6.80^{b}	6.75^{b}	7.10^{a}	0.067
Flavour	6.42^{c}	6.64^{b}	6.66^{b}	6.82^{ab}	7.00^{a}	0.082
Tenderness	6.33^{c}	6.28^{c}	6.82^{ab}	6.50^{b}	7.08^{a}	0.078
Juiciness	6.08^{d}	6.28^{c}	6.45^{b}	6.50^{b}	7.02^{a}	0.088
Overall acceptability	6.17^{c}	6.34^{c}	6.52^{b}	6.58^{b}	7.01^{a}	0.086

a, b, c, Means values with different superscripts are significantly different at P<0.05.

Sensory evaluation of meat: All WBGP supplemented treatments have significantly (P<0.05) better appearance, colour flavour, tenderness, juiciness and overall acceptability than control (T1) and Antibiotic (T2) groups. Contrary to common folk assumption that inclusion of garlic powder in broiler diets may impart strong garlic odour to the meat, however, the present results revealed that inclusion of garlic did not impart any strong repulsive odour to chicken meat rather it improved the sensory parameters of meat and the overall acceptability (Table 3). Improvement in sensory evaluation in the present study are in agreement with Toghyani *et al*. (2011) who reported that supplementation of garlic at 4 g/kg in broiler diets improve the meat sensory evaluation. Kim *et al.* (2009) also observed positive influence of garlic supplementation on culinary traits of poultry meat. The positive influence of garlic supplementation on meat can be correlated to the presence of volatile compounds, phenolic content and antioxidant active compounds (Canogullari *et al.* 2010), in addition to S-containing enzymes, amino acids and minerals (Newall *et al*. 1996)

It could be concluded that 1.5% sun dried WBGP supplemented group had better performance during both starter and finisher period than the control and had significantly higher benefit cost ratio than all other treatments. Sun dried WBGP @1.5% is an economical alternative to antibiotic growth promoters and can be easily made and adopted by the poultry farmers.

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