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Bamudi Sai Sandeep
Department of Animal Nutrition, C.V.Sc. & A.H., Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Niranjan Panda
Department of Animal Nutrition, C.V.Sc. & A.H., Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Kamdev Sethy
Department of Animal Nutrition, C.V.Sc. & A.H., Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Sudhanya Nath
Department of Animal Nutrition, Institute of Veterinary Science and Animal Husbandry, SOA Deemed to be University, Bhubaneswar, Odisha, India

Corresponding Author:
Kamdev Sethy
Department of Animal Nutrition, C.V.Sc. & A.H., Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Effect of dietary supplementation of amla (*Emblica officinalis*) powder and equivalent synthetic vitamin C on growth performance in black rock broiler chicken

Bamudi Sai Sandeep, Niranjan Panda, Kamdev Sethy and Sudhanya Nath

Abstract
An experiment was conducted to explore the effect of dietary supplementation of amla powder on growth performance in Black Rock broiler chicken in comparative parallel study with equivalent synthetic vitamin C. In total one hundred forty (n=140) day old Black Rock chicks were randomly distributed into 7 dietary treatments with two replicates having 10 birds in each replicate. The dietary treatments were: T_1 (Control group): Basal diet; T_2: Basal diet + 0.5% amla powder; T_3: Basal diet + 1% amla powder; T_4: Basal diet + 2% amla powder; T_5: Basal diet+ Equivalent synthetic vitamin C as present in 0.5% amla powder; T_6: Basal diet + Equivalent synthetic vitamin C as present in 1% amla powder; T_7: Basal diet + Equivalent synthetic vitamin C as present in 2% amla powder. The experiment was scheduled for 7 weeks in two phases with starter (1^{st} - 3^{rd} week) and finisher ration (4^{th}-7^{th} week) during mid-January to March having average temperature-humidity index (THI) value of 76.64. Results revealed that there was no significant difference in body weight and feed intake but significantly better FCR was noticed in T_1, T_2 and T_3 groups than control group. From the above experimental study, the following conclusion could be stated that supplementation of 1% amla powder to basal diet improved FCR. Synthetic vitamin C needs double the dose of natural form of vitamin C to exert same effect on FCR.

Keywords: Amla, black rock broiler chicken, growth, synthetic vitamin C

Introduction
The poultry industry has now emerged as a highly structured and effervescent agri-business enterprise, internationally. India as a leading producer of eggs stands at number third and fifth in broiler meat producer in the world. As recommendation of National Institute of Nutrition (NIN) Hyderabad, per capita meat consumption of animal protein should be 11 kg/year, while India's per capita availability of meat is 3.8 kg/year, which is very low as compared to 43 kg in the United States, 34 kg in South Africa, 31 kg in Canada, 10.5 kg in China, and 17 kg for the whole world [1]. Chicken meat is a rich source of high biological value quality protein with high choice of preference in Indian society due to its reasonable price in comparison to mutton and chevon. There is a wide gap between the recommended and availability of poultry meat, so to meet the need poultry industry in general and broiler sector in particular has emerged as one of the robust emergent sector of the agriculture segment in India. Due course of time, widespread researches have been conducted on feed additives as an key implement in poultry diet to improve FCR, growth performance and disease resistance leading to peak productivity. Supplementations of phyto-based feed additives in poultry nutrition are mainly aimed to improve absorption and assimilation of numerous nutrients [2] thus, augmenting commercial profit margins by minimizing huge expenditure on feed and cost of production [3]. Ban of antibiotics as feed additive, specifically as growth promoters in European Union on March 2006 led towards paying more attention on natural phytogenic remedies. In this regard, natural growth promoters comes into action to play a vital role in feed industry as herbal feed additives to promote growth and optimize production levels with safeguarding consumers' health also [4].
Indian gooseberry, commonly known as Amla (*Emblica officinalis*), a dynamic fruit laid its importance on biological system defined and proved in ancient ayurvedic and unani therapies, which is available in tropical and sub-tropical areas like south-east Asian countries. As per Ayurveda, it has a long range of actions on body by balancing three vital properties of body named vata, pitta and kapha [5]. Amla was preferred as additive due to its wide range of therapeutic values and immune-boosting antioxidant effects reflected in ancient ayurvedic

unani textures. Amla fruit is rich in phyto-active chemical constituents such as polyphenols, flavonoids, alkaloids, gallic acid, phyllembein and hydrolysable tannins and a potential source ascorbic acid [6]. So it has a wide range of pharmacological action such as anti-atherogenic, anti-mutagenic, anti-inflammatory, immuno-stimulant, gastro-protective, hypolipidemic, anti-microbial, anti- viral, anticancer, anti-diabetic, antioxidant, nephro protective, hepato protective, anti-ageing, cyto protective, cardio protective, chemo protective, radio protective, free radical scavenging, ulcer- protective, wound healing, anti-diarrheal properties [7, 8, 9]. Bunch of medicinally effective substances like flavonoids, phyllemblin, vitamin C, gallic acid alkaloids and tannins define its crucial role as feed additive. Among them, antioxidant effect is enhanced by flavonoids, tannin and antiscorbutic vitamin which are present in great amount [10]. It is also considered as affluent wellspring of amino acids, minerals and vitamin C [11]. The active principles of amla invigorate different enzymes like catalase, superoxide dismutase and glutathione peroxidase and thus ameliorates effect of free radicals on cells by activating innate antioxidant mechanism [12]. The ancient ayurvedic polyherbal supplements include amla powder for its potent action against bacteria [13] and fungus [14]. Pulverized amla fruit also enhances performance of broiler bird by incorporating its anti stress, immuno modulatory, adaptogenic [15, 16] and anti-inflammatory [17] functions.

Due to obtainable limited literatures on amla mixed poultry diet formulations and its impact on growth and health status of birds, the experiment was conducted to know the outcome of dietary supplementation of amla powder and synthetic Vitamin C regarding growth performance in commercial broiler chicken (Black Rock).

Materials and Methods

Selections of birds and dietary treatments

The experiment was executed at the Department of Animal Nutrition, C.V.Sc. & A.H., OUAT, Bhubaneswar in alliance with Instructional Livestock Farm, Faculties of veterinary and animal science, OUAT. A total number of one hundred forty (n=140) day old Black Rock chicks were brought from Central Poultry Development Organization (CPDO), Eastern Region, Bhubaneswar and randomly distributed into seven dietary treatment groups with two replicates for each treatment group having ten birds in each replicate. The chicks were reared in deep litter system with optimum brooding conditions from 1 - 49 days of age (marketable age). The dietetic treatments were: T_1 (Control group): Basal diet; T_2: Basal diet + 0.5% amla powder; T_3: Basal diet + 1% amla powder; T_4: Basal diet + 2% amla powder; T_5: Basal diet + Equivalent synthetic vitamin C as present in 0.5% amla powder; T_6: Basal diet + Equivalent synthetic vitamin C as present in 1% amla powder; T_7: Basal diet + Equivalent synthetic vitamin C as present in 2% amla powder.The basal diets were formulated as per the specification of BIS-2017 recommendation [18]. The starter and finisher feed were provided up to 21 and 49 days respectively. The ingredient composition of the basal diets and their proximate composition have been presented in Table 1 and 2 respectively.

Table 1: Ingredients composition of starter and finisher experimental ration

Ingredients	Starter (%)	Finisher (%)
Maize	64	65
Soyabean Meal	33	27
Deoiled Rice bran	-	05
Mineral mixture	2.6	2.6
Common Salt	0.3	0.3
L-Lysine	0.03	0.03
DL-methionine	0.05	0.05
Additives		
Livoline	0.25	0.25
Biocholine	0.50	0.50
K-zyme	0.50	0.50
Biobantox	0.50	0.50

Table 2: Proximate compositions of basal diets (% on DM basis)

Components	Starter	Finisher
Crude protein	22.84	19.47
Ether extract	2.36	2.21
Crude fibre	4.70	6.02
Total ash	8.29	9.03
Nitrogen-free extract*	61.81	63.27
Calcium	1.18	0.89
Available phosphorus	0.62	0.51

*Calculated value

Source of Amla and Vitamin C

Amla

Fresh amla fruits were brought from nearby fruit market. After deseeding, it was cut into small thin slices and dried in cabinet tray dryer with the help of Dept. of Agril. Processing & Food Engg., OUAT. Amla fruit slices were spread over the aluminum trays at a uniform thickness and initially temperature was started at 50°C and within 2hrs temperature was increased gradually which was fixed at 60°C for 21 hrs [19, 20]. The ascorbic acid content of tray dried amla powder was estimated through colorimetric method and valued 494.70mg/100g of amla powder. Thus, 0.5% amla (5g/kg basal diet), 1% amla (10g/kg basal diet) and 2% amla (20g/kg basal diet) contain 25, 50, and 100 mg Vitamin C respectively. After 21hrs of drying, the small dried crunchy pieces were collected from trays and crushed in electric grinder in order to get powder form. Subsequently it was stored in an air tight amber colour bottle to prevent oxidation.

Vitamin C

Limcee tablets of Abbott Health Care Pvt. Ltd. were used as Vitamin C supplementation in the experiment. Each uncoated tablet comprisedof ascorbic acid @ 100 mg and Sodium ascorbate@ 450 mg which is equivalent to 400 mg ascorbic acid. So in total, a tablet had 500 mg ascorbic acid.

Management of experimental birds

The poultry house was thoroughly cleaned, disinfected and dried before the onset of the experiment. Before bringing chicks to the poultry shed, disinfection process was carried out by Malathion (1%), formalin (10%). Circular and linear feeders, fountain waterers and chick guards were thoroughly cleaned with detergent and $KMnO_4$ solution, followed by fumigation. Chicks were weighed individually and tied with wing band on 0 day (day of procurement). Wing band tying was necessary before putting them in to the pen as they are helpful for identification. Adequate light (24 hr) and

ventilation were facilitated during brooding period. Deep litter system was adopted for the maintenance of chicks. The routine vaccination measures were followed as per vaccination schedule. Optimum fresh clean drinking water was provided regularly. Artificial light using 200watt bulb was facilitated during brooding period (0-2 weeks) and in other day for adequate photoperiod.

Measurement of growth traits

Weekly weighing of birds up to 7th week was carried out using electric pan weighing machine. Group wise offering of daily feed to the birds were recorded. Average feed intake for a specific week was determined by deducting total leftover feed from total feed given in that week. FCR was also calculated.All the data generated in the experiment was statistically analyzed using SPSS 21.0.

Results

Effect on body weight

There was no significant difference (p>0.05) in weekly body weight of birds from 0 day to 7th week (Table 3). The final body weights of all group of birds at 7th week varied from 1431.35 to 1522.95 showing no significant variation among the treatments, however numerically lowest body weight of 1431.35 g was observed in control group and highest in T_7 which was of 1522.95 g.

Weekly cumulative feed intake

There was significant difference (p<0.05) in weekly cumulative feed intake of birds during 2nd and 3rd week (Table 4) and in other weeks, there was non-significant (p>0.05) difference of feed intake. It was found that as the body weight advances the feed consumption increased. Up to experimental period of 7th week the total feed consumption was varied from 4420 to 4624 g in different groups.

Effect on weekly cumulative feed conversion ratio (FCR)

The cumulative FCR was calculated dividing the body weight with feed intake up to that week (Table 5). Upto 3rd week the FCR was 1.47 to 2.19 but after that the FCR was increased and at the end of the experiment (at 7th week) the FCR varied from 2.974 to 3.330 in different groups. From the 2ndweek on wards significant variation (p<0.05) of FCR was noticed and it was seen that control has the highest FCR. Upto 3rd week it was found that T_3 which was supplemented with 1.0% amla powder had better FCR of 1.776 which significantly better than control and T_4groups. All the supplemented groups had better FCR than control groups except T_4 group which was fed 2.0% amla powder. During 4th week, all the supplemented groups had better (p<0.05) FCR than control except T_4 and T_5 groups. From 5th to 7th week, there was no significant difference (p>0.05) in FCR values of the birds. After 7th week supplementation highest (p>0.05) cumulative FCR was seen in control groups (3.330) and lowest FCR was noticed in T_7 (2.974). From the analysis it was revealed that T_2, T_3, T_6 and T_7 had significantly (p<0.05) better FCR than control, T_4 and T_5groups.

Table 3: Weekly body weight (g) of birds in different dietary treatments

Week	Treatments*							SEM	P value
	T_1	T_2	T_3	T_4	T_5	T_6	T_7		
0 Day	37.60	37.95	37.70	35.00	34.45	35.45	36.70	0.76	0.080
1st	103.90	101.11	102.95	99.25	100.95	97.90	99.40	2.13	0.214
2nd	237.75	245.17	245.45	236.70	234.90	243.45	247.55	6.34	0.470
3rd	525.50	557.64	549.85	512.60	520.75	544.45	543.80	14.78	0.051
4th	680.15	729.69	721.35	680.05	678.35	724.65	711.50	19.06	0.120
5th	806.60	881.32	861.60	819.70	817.30	860.70	870.05	23.35	0.076
6th	1080.55	1159.58	1154.30	1117.55	1102.50	1138.25	1172.15	32.01	0.353
7th	1431.35	1510.60	1504.80	1468.45	1453.70	1488.80	1522.95	33.21	0.407

*T_1 (Control group): Basal diet; T_2: Basal diet + 0.5% amla powder; T_3: Basal diet + 1% amla powder; T_4: Basal diet + 2% amla powder; T_5: Basal diet + Equivalent synthetic vitamin C as present in 0.5% amla powder; T_6: Basal diet + Equivalent synthetic vitamin C as present in 1% amla powder; T_7: Basal diet + Equivalent synthetic vitamin C as present in 2% amla powder

Table 4: Weekly cumulative feed intake (g) of birds under different dietary treatments

Week	Treatments*							SEM	P value
	T_1	T_2	T_3	T_4	T_5	T_6	T_7		
1st	110	104	95	105	103	103	106	4.44	0.453
2nd	432^{a}	387^{c}	372^{c}	425^{ab}	398^{bc}	398^{bc}	423^{ab}	16.39	0.013
3rd	1022^{a}	972^{ab}	908^{c}	1012^{ab}	963^{b}	963^{b}	1003^{ab}	28.85	0.014
4th	1722	1674	1600	1701	1677	1677	1637	33.11	0.122
5th	2495	2439	2409	2511	2497	2497	2375	50.02	0.381
6th	3513	3450	3354	3483	3507	3507	3365	60.46	0.261
7th	4624	4532	4399	4576	4618	4582	4420	79.68	0.223

*T1 (Control group): Basal diet; T2: Basal diet + 0.5% amla powder; T3: Basal diet + 1% amla powder; T4: Basal diet + 2% amla powder; T5: Basal diet + Equivalent synthetic vitamin C as present in 0.5% amla powder; T6: Basal diet + Equivalent synthetic vitamin C as present in 1% amla powder; T7: Basal diet + Equivalent synthetic vitamin C as present in 2% amla powder

[abc]Values bearing different superscripts in a row differ significantly (p<0.05)

Table 5: Weekly cumulative FCR of birds under different dietary treatments

Week	Treatments*							SEM	P value
	T_1	T_2	T_3	T_4	T_5	T_6	T_7		
1st	1.751	1.626	1.470	1.610	1.552	1.656	1.690	0.09	0.470
2nd	2.199^{a}	1.860^{c}	1.797^{c}	2.131^{ab}	1.986^{abc}	1.916^{bc}	2.006^{abc}	0.11	0.040
3rd	2.112^{ab}	1.868^{c}	1.776^{c}	2.193^{a}	1.981^{bc}	1.894^{c}	1.978^{bc}	0.10	0.015
4th	2.697^{a}	2.417^{bc}	2.343^{c}	2.683^{a}	2.605^{ab}	2.435^{bc}	2.426^{bc}	0.11	0.040
5th	3.264	2.890	2.927	3.277	3.190	3.026	2.850	0.14	0.064
6th	3.387	3.074	3.007	3.260	3.284	3.181	2.964	0.130	0.128
7th	3.330	3.076	3.000	3.225	3.254	3.153	2.974	0.11	0.098

*T1 (Control group): Basal diet; T2: Basal diet + 0.5% amla powder; T3: Basal diet + 1% amla powder; T4: Basal diet + 2% amla powder; T5: Basal diet + Equivalent synthetic vitamin C as present in 0.5% amla powder; T6: Basal diet + Equivalent synthetic vitamin C as present in 1% amla powder; T7: Basal diet + Equivalent synthetic vitamin C as present in 2% amla powder

^{abc}Values bearing different superscripts in a row differ significantly (p<0.05)

Discussion

Effect on body weight

The weekly body weight of the Blackrock birds showed no significant variation among control (T_1), amla supplemented (T_2,T_3,T_4) and Vitamin C supplemented (T_5,T_6,T_7) dietary treatments. Day old BW of Blackrock chicks of all the dietary treatments range from 34.45 to 37.95 g. Birds reared up to 7th week and final body weight varied from 1431.35 to 1522.95 g in different groups. Lowest body weight of 1431.35 was observed in control group (T_1) and highest in T_7 (2% Equivalent synthetic vitamin C) which of 1522.95 g but no significant difference were revealed across the dietary treatments (p>0.05). Similar results were reported by Nakajothi *et al.*, (2009) [21], that there was no improvement in the body weight gain of vitamin C supplementation @ 250 mg/ kg diet and amla supplementation up to 20 g/kg of diet [21]. Untoo (2010) also observed no significant effect on weight gain and final body weight in birds treated amla single or in combination with probiotics [22]. Above researches showed that supplementation of amla either alone or in combination with other herbal sources did not show any significant body weight gain or final body weight. This implies that dietary supplementation of amla might not have any effect on body weight.

In contrast to our studies, some of the research findings revealed significant increase in body weight in commercial broilers fed *E. Officinalis* powder [23, 24]. Same type of investigations was observed on improved body weight [25 - 27]. In some experimental studies, it was reported that there was improved body weight gain, when chicken were supplemented with amla alone or in addition with other phytoactive herbal feed additives [28, 30, 31, 32]. Tangade (2007) also stated that significant rise in weekly body weight gain in natural Vitamin-C (*E. officinalis*) supplemented chicken in comparison to synthetic Vitamin-C [33]. In this experiment, it is quite evident the THI 76.64 (CWO.OUAT) indicating a moderate environmental stress to birds during the period of rearing which might be the reason behind insignificant body weight gain.

Effect on feed intake

The weekly cumulative feed consumption varied significantly (p<0.05) among all the dietary treatments in 2nd and 3rd week but not in 1st week and from 4th to 7th week. Patel *et al.* (2016) [24] and Patil *et al.* (2014) [27] reported that feed intake did not differ significantly up to 6thweek. Lohakare *et al.* (2005) [29] also reported that no significant impact noticed on overall feed intake of Ross chicken up to 6th week. Similar to our results, there was decrease in feed consumption in amla supplemented dietary treatments in comparison to control in 2nd and 3rd week [26, 33 – 36]. Some researchers found that dietary supplementation of *E. officinalis* caused significantly improved feed intake than control [31, 38].

In the experimental study, BlackRock breed which was used is a low-in-put meat type chicken. The genetic potential of growth performance traits of these birds are not yet exploited fully. So the range of growth performance and feed consumption values was not similar with commercial broiler strains (Vencobb, Suguna) and did not show any difference statistically except 2nd and 3rd week of experiment.

Effect on cumulative Feed Conversion Ratio (FCR)

After 7th week supplementation, the highest cumulative FCR was seen in control groups (3.330) and lowest FCR was noticed in T_7 (2.974). From the analysis it was found that T_2, T_3, T_6 and T_7 have significantly better FCR than Control and T_4, T_5. It implies that 2% amla powder addition in basal diet didn't have any effect on FCR. Rather 0.5% or 1% amla supplementation shows better results on FCR. Correspondingly, synthetic vitamin C needs double the dose of natural form of vitamicC to exert same effect on FCR.

Several researches were reported to be similar to the above showing lower FCR in amla supplemented groups either single or with other herbal mixtures than control [21, 25, 26, 30, 35, 39, 40]. In contrast to above, Patel *et al.* (2016) [24] and Patil *et al.* (2014) [27] stated that FCR remains same in amla fed groups with control also and no such high difference noticed.

Due to phytogenic supplements, stimulation of gastric enzymes and enhanced gut morphology [41] contribute towards better intestinal absorption and assimilation of nutrients [42, 43]. The enhanced performance and FCR noticed in *E. officinalis* supplemented groups might be due to antioxidant properties of bioactive constituents such as ascorbic acid, polyphenols, flavonoids, tannic acid and Gallic acid [44]. Hashemi and Davoodi (2011) also reported that the positive effects of phytobased additives on growth performance can be better explained due to its antioxidant properties, immune-boosting activity, gastric juice stimulation, safeguarding and maintaining gut friendly microflora and suppressing harmful microbes [45].

Conclusion

From the above experimental study, the following conclusion could be stated that supplementation of 1% amla powder (10 g/kg feed) to basal diet improved FCR of birds. To get equivalent effect, the supplementation of synthetic vitamin C @ 50 mg/kg feed is recommended in Black Rock birds. Further researches can be suggested to study the exact mechanism of action of amla on antioxidant activity and immune system of body based on molecular changes at

cellular levels.

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