In the Name of God

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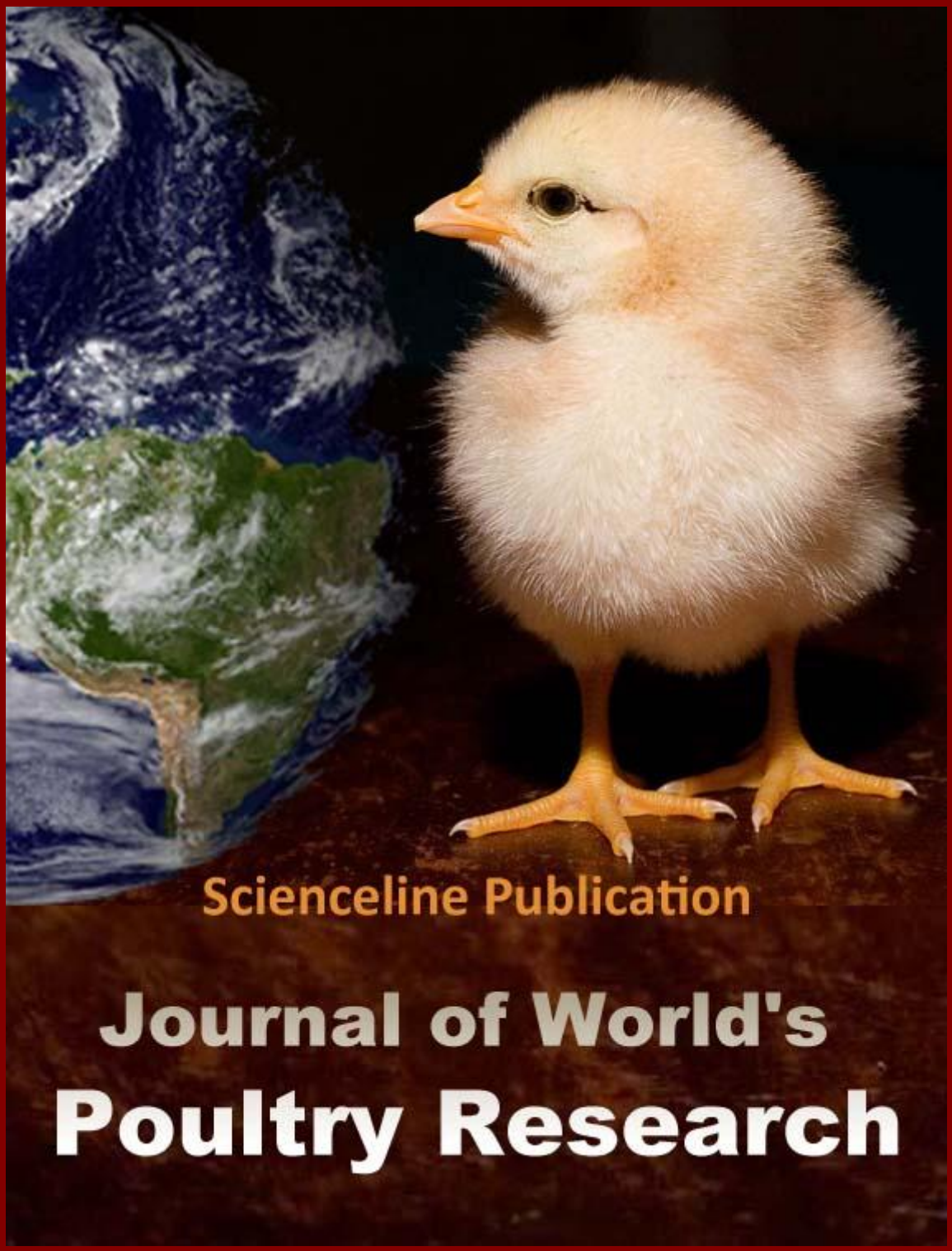

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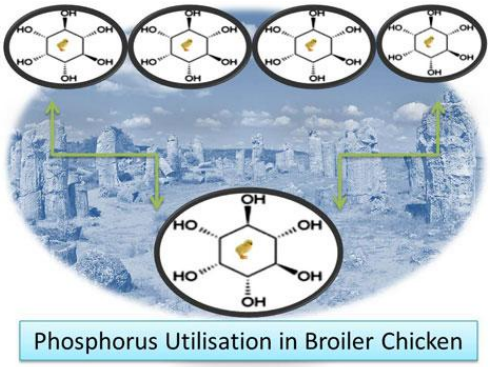
Short Communication

Phosphorus Utilisation and Growth Performance of Broiler Chicken Fed Diets Containing Graded Levels of Supplementary Myo-Inositol with and Without Exogenous Phytase.

Pirgozliev V.R., Bedford M.R., Rose S.P., Whiting I.M., Oluwatosin, O.O. Oso A.O., Oke F.O., Ivanova S.G., Staykova G.P.

J. World Poult. Res. 7(1): 01-07; pii: S2322455X1700001-7



ABSTRACT:
A total of 80 male Ross 308 broiler chickens were used in this study to quantify the response and inter-relationship of bird growth performance, dietary nitrogen corrected apparent metabolisable energy (AMEn), and nutrient digestibility as a result of feeding graded levels of supplementary myo-inositol (MYO) with and without exogenous phytase (PHY). Supplementation of diet that was formulated to be insufficient in available Phosphorus (P) with graded levels of MYO improved daily weigh gain (WG) and AMEn intake ($P < 0.05$; quadratic) and linearly reduced ($P < 0.05$) the concentration and the secretion of sialic acid (SA) in excreta. Supplementation with PHY improved ($P < 0.05$) dietary dry matter (DMD) and nitrogen (ND) digestibility coefficients. Dietary phosphorus digestibility (PD) increased with PHY addition as expected but the effect was much more pronounced in the low MYO group compared with high MYO diets as described by the interaction ($P < 0.05$). The interaction showed that increasing MYO content had no effect in the absence of PHY but it depressed P digestibility in the diets containing PHY. It can be concluded that dietary MYO improves bird growth and possibly intestinal health of broiler chickens. Dietary supplementation with either MYO or PHY may improve growth of chickens although these effects may not always be additive.

Key words: Phytase, Myo-inositol, Broiler, Nutrition

[Full text-PDF] [DOAJ]

Research Paper

Assessment of a New Backyard Poultry Strain "Kaveri" in Farmer's Situation, Rural Odisha, India

Kumar Banja B, Natarajan Ananth P, Singh S, Ranjan Sahoo P and Jayasankar P.

J. World Poult. Res. 7(1): 08-14; pii: S2322455X1700002-7

ABSTRACT:
Backyard poultry plays an important role in livelihoods of Indian farmers. Research and Development efforts on developing improved strains to enhance productivity have enhanced farmer's income. Scaling up of improved strains is based on adaptive trials conducted by extension agencies for location specificity and feasibility. The present study is a first time report in India on the performance of newly released Kaveri poultry in the backyard production system through an on farm trial by Krishi Vigyan Kendra-Khordha, the farm science centre of Indian council of agricultural research at the district level. Kaveri birds have characteristic features like low early chick and laying mortality, excellent flock uniformity, early sexual maturity, withstanding predators, laying brown colour eggs etc. The participatory trial was organised at 30 farmer's fields administering participatory approach by providing 300 chicks to the farmers. The biggest gain of Kaveri poultry in the trial was the body weight, which was recorded to be 3200 gm in male and 2800 gm in female birds at the end of 12 months study period compared to the 1750 gm and 1250 gm respectively with the local strains. Kaveri chicks exhibited superiority in their liveability with a mortality rate of 15% during the critical period of the first 10 weeks of their life compared to the most popular backyard improved strain Vanaraja in which it is up to 24% in the backyard system. Majority of the farmers perceived that this strain can withstand predation which scores better than the other improved strains. The study concluded that Kaveri is suitable for backyard farming system and is highly profitable. Attempts were taken in 2016 to link the results of the strain assessment to the mainstream extension at the district for larger adoption of rural communities.

Key words: Backyard poultry, Kaveri, Rural Odisha

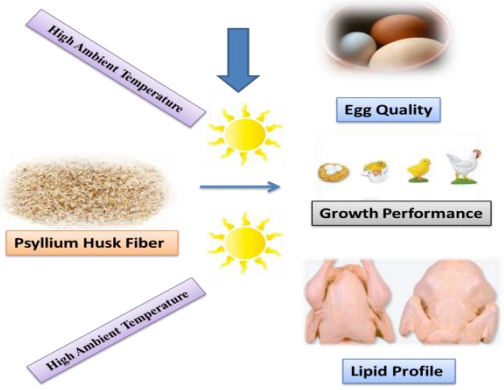
[Full text-PDF] [DOAJ]

Research Paper

Effect of Psyllium Husk Fiber on Growth Performance, Egg Quality Traits and Lipid Profile in Layers under High Ambient Temperature.

Mukhtar N, Mehmood R, Hassan Khan S, Mehmood Ashrif N and Waseem Mirza M.

J. World Poult. Res. 7(1): 15-22; pii: S2322455X1700003-7



ABSTRACT:
The present study was conducted to evaluate the impact of cholesterol lowering effect of Psyllium husk in egg yolk cholesterol through dietary supplementation in white Leghorn layers. A total of 180 commercial layer hens were randomly divided into four equal groups of 45 birds each to be allocated to four dietary regimes, consist of 0, 5, 10 and 20 g of Psyllium per kg diet, each group was subdivided into three replicate containing 15 layers per replicate. Dietary treatments had a non-significant effect on weight gain, egg production, feed intake and mortality. There was a positive impact of dietary Psyllium levels on egg mass and shell thickness, however, haugh unit and egg shape index deteriorated with higher dietary inclusion of Psyllium. Cholesterol levels in yolk and blood reduced significantly ($P < 0.05$) with an increasing level of dietary Psyllium. The results from present study suggested that dietary inclusion of Psyllium can be an effective tool for the reduction of blood and egg yolk cholesterol levels.

Key Words: Psyllium, Egg traits, yolk cholesterol, egg production, lipid profile.

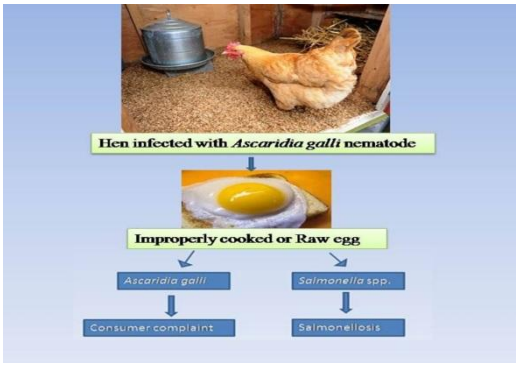
[Full text-PDF] [DOAJ]

Research Paper

A Report of *Ascaridia galli* in Commercial Poultry Egg from India

Gamit A B, Nanda P K, Bandyopadhyay S and Bhar R.

J. World Poult. Res. 7(1): 23-26; pii: S2322455X1700004-7



ABSTRACT:
Ascaridia galli is a major encountered species of nemathelminthes in the domestic fowl from all around the world. The parasite causes many pathological conditions which may lead to production losses in the poultry industry. Life cycle of the nematode is direct and involves a single host. Adult parasites present in the small intestine but, erratically they can migrate to the other visceral organs including oviduct. In the study, we isolated two adult female parasites of species *A. galli* from albumin portion of the poultry egg. Isolated parasites as well as extracted eggs were examined by parasitological techniques. While erratic migration, It may lead the mechanical transmission of enteric pathogens including *Salmonella* spp. to the egg. Such reports may lead to consumer complaints as well as health problems in the people who consume raw eggs. Poultry egg harbouring such nematode and Salmonella organisms is a cause of concern, as it is widely consumed by people.

Keywords: Egg, *Ascaridia galli*, Poultry, Erratic migration

[Full text-PDF] [DOAJ]

Research Paper

Effect of Dietary Mimosa Small Bell (*Dichostachys glomerata*) Fruit Supplement as Alternative to Antibiotic Growth Promoter for Broiler Chicken

Kana JR, Mube KH, Ngouana Tadjong R, Tsafong F, Komguep R, Yangoue A and Teguia A.

J. World Poult. Res. 7(1): 27-34; pii: S2322455X1700005-7

ABSTRACT:
There is a growing interest in plant feed additives as a consequence of the antibiotics growth promoters restriction in livestock farming all over the world. This study was designed to evaluate the effect of *Dichrostachys glomerata* fruit powder on the growth performances of broiler chickens. A group of chickens fed on a basal diet without any supplementation (negative control $R0^-$) was compared to three other groups fed on diets supplemented by 0.1% of antibiotic (positive control $R0^+$), 0.2% (R0.2) and 0.4% (R0.4) *D. glomerata* fruit powder respectively. The results revealed a significant decrease in feed intake as compared to the negative and the positive control. The lowest Feed Conversion Ratio (FCR) was recorded with diet supplemented with antibiotic and 0.2% *D. glomerata*. The Body Weight (BW) and the Body Weight Gain (BWG) of chickens fed on diets supplemented with *D. glomerata* had an upward trend as compared to negative control diet. Apart from the relative weight of the head which tended to increase in coordination with increasing levels of *D. glomerata* in feed, this phytobiotic had no significant effect ($P>0.05$) on carcass characteristics. The increasing level of this phytobiotic tended to decrease serum content of creatinine as compared to the negative and positive control diets. The serum content in ASpartate AminoTransferase (ASAT) tended to increase with the

increasing levels of this phytobiotic mean while no significant effect (P>0.05) was recorded on the serum contents of urea, total proteins and ALanine AminoTransferase (ALAT). In conclusion, 0.2% of *D. glomerata* fruit powder can be used to replace antibiotic, for a better growth performances and to produce antibiotics residues free chicken meat.
Key words: Antibiotic, Broiler chicken, Carcass, *Dichrostachys glomerata*, Growth performance, Phytobiotic, Production cost
[Full text-PDF] [DOAJ]

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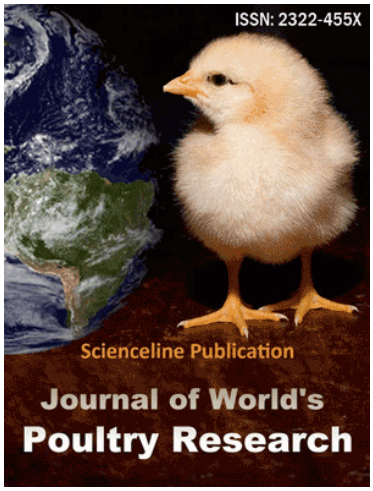
Journal of World's Poultry Research



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Homepage: www.science-line.com
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Emails:
administrator@science-line.com
saeid.azar@atauni.edu.tr

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Short Communication, PII: S2322455X1700001-7

Phosphorus Utilisation and Growth Performance of Broiler Chicken Fed Diets Containing Graded Levels of Supplementary Myo-Inositol with and Without Exogenous Phytase

Vasil R. Pirgozliev[1,3], Mike R. Bedford[2], Stephen P. Rose[3], Isobel M. Whiting[3], Oluseyi O. Oluwatosin[4], Abimbola O. Oso[4], Florence O. Oke[5], Sonya G. Ivanova[6], Genoveva P. Staykova[6]

[1]*ASRC, Scottish Agricultural College, Auchincruive, Ayr, KA6 5HW, UK*
[2]*AB Vista Feed Ingredients, Marlborough, Wiltshire, SN8 4AN, UK*
[3]*NIPH, Harper Adams University, Shropshire, TF10 8NB, UK*
[4]*World Bank African Center of Excellence in Agricultural Development and Sustainable Environment, Federal University of Agriculture PMB 2240 Abeokuta, Nigeria*
[5]*Federal University Dutse, Dutse, Jigawa State, Nigeria*
[6]*Agricultural Institute, 9700 Shumen, Bulgaria*

*Corresponding author`s Email: vpirgozliev@harper-adams.ac.uk

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ABSTRACT

A total of 80 male Ross 308 broiler chickens were used in this study to quantify the response and inter-relationship of bird growth performance, dietary nitrogen corrected apparent metabolisable energy (AMEn), and nutrient digestibility as a result of feeding graded levels of supplementary myo-inositol (MYO) with and without exogenous phytase (PHY). Supplementation of diet that was formulated to be insufficient in available Phosphorus (P) with graded levels of MYO improved daily weigh gain (WG) and AMEn intake ($P<0.05$; quadratic) and linearly reduced ($P<0.05$) the concentration and the secretion of sialic acid (SA) in excreta. Supplementation with PHY improved ($P<0.05$) dietary dry matter (DMD) and nitrogen (ND) digestibility coefficients. Dietary phosphorus digestibility (PD) increased with PHY addition as expected but the effect was much more pronounced in the low MYO group compared with high MYO diets as described by the interaction ($P<0.05$). The interaction showed that increasing MYO content had no effect in the absence of PHY but it depressed P digestibility in the diets containing PHY. It can be concluded that dietary MYO improves bird growth and possibly intestinal health of broiler chickens. Dietary supplementation with either MYO or PHY may improve growth of chickens although these effects may not always be additive.

Key words: Phytase, Myo-inositol, Broiler, Nutrition

INTRODUCTION

The beneficial effect of dietary phytases (PHY) is not only providing the phosphorus but also the destruction of phytate which is considered as anti-nutrient due to its negative effect on digestion and absorption of other minerals, amino acids and energy, besides acting as a gut irritant leading to increased endogenous losses (Selle and Ravindran, 2007). Although the possibility of total conversion of dietary phytate by PHY to myo-inositol (MYO) has not been completely ruled out (Józefiak et al., 2010; Cowieson et al., 2013), the conditions in bird's gastrointestinal tract (GIT) as well as the catalytic properties of supplementary microbial phytases does not permit phytate molecules to be totally converted into free MYO and inorganic phosphate (Żyła et al., 2013). Myo-

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inositol is a structural component in living tissues and normally synthesised in the body of birds and mammals (Lee and Bedford, 2016). Although the NRC (1994) does not stipulate that poultry have a requirement for inositol, dietary inositol deficiency has been demonstrated in most aquatic animals (Mai et al., 2001). Feeding low dietary MYO to fish species has been associated with low growth rates (Boonyaratpalin and Wanakowat, 1993; Waagbø et al., 1998). In some cases, however, *de novo* MYO synthesis by intestinal bacteria in fish is sufficient such that dietary MYO supplementation does not make any difference (Burtle and Lovell, 1989). Rats and gerbils have also been shown to respond to dietary MYO under certain conditions (Karasawa, 1972; Hegsted et al., 1974).

One of the first reports on the biosynthesis of MYO was in rat and chicken embryos (Daughaday et al., 1955). It has subsequently been shown that glucose is the precursor for MYO synthesis (Chu and Geyer, 1983; Charalampous and Chen, 1966) but the efficiency of conversion differs from species to species. Although the biological importance of inositol is well documented (Lee and Bedford, 2016), the impact of supplementary MYO on nutrient availability and performance in poultry has been inconsistent. Some authors found an increase in growth performance in response to dietary MYO (Żyła et al., 2013), while as others (Pearce, 1975) didn't. In addition, Cowieson et al. (2013) reported an interaction between MYO and exogenous PHY as addition of MYO to either the normal or low P diet improved feed efficiency only in the presence of PHY (Cowieson et al., 2013).

In view of the above facts, the objective of the present study was to quantify the response and inter-relationship of bird growth performance, dietary metabolisable energy and nutrient digestibility as a result of feeding graded levels of supplementary MYO with and without exogenous PHY. The impact on endogenous losses (mucin), measured as marker Sialic Acid (SA) was also determined.

MATERIALS AND METHODS

Diet formulation

Eight maize-soy-based diets were offered to male Ross 308 broiler chickens from 7 to 17 days of age (Table 1). A basal diet was formulated to be nutritionally adequate for chicks at that age (12.79 MJ/kg ME, 230 g/kg CP) but designed to have a relatively low available P content (2.5 g/kg non-phytate P). The basal diet was then split in two batches and one of them was supplemented with 500 units/kg of an *Escherichia coli*-derived phytase (Quantum™, EC 3.1.3.26; AB Vista Feed Ingredients, Marlborough, UK). The two batches (with and without phytase) were then split in four equal parts each and the parts were supplemented with MYO (Sigma-Aldrich, Inc., St. Louis, MO 63103, USA) at 0.0, 2.5, 5.0 and 7.5 g/kg diet, respectively to give a total of eight experimental diets. The MYO and the phytase were added on the top of the diets in powder form and mixed in a ribbon mixer for about 5 minutes. All diets were fed as a mash. Each treatment was replicated five times in a completely randomised block design.

Table 1. Ingredient composition (g/kg) of the control experimental diet fed to broiler chicken from 7 to 17 days of age.

Ingredients	**g/kg**
Maize	600
Soybean meal 48	300
Maize gluten meal	40
Vegetable oil	20
Salt	3.6
DL Methionine	4.2
Lysine HCl	3.0
Limestone	17.2
Dicalcium Phosphate	7.0
Vitamin Mineral premix[2]	5.0
	1000
Calculated values (as fed)	
Crude protein (Nx6.25), g/kg	231
ME, MJ/kg	12.79
Calcium, g/kg	8.6
Phosphorus, g/kg	5.2
Phytate phosphorus, g/kg	2.7
Available phosphorus, g/kg	2.5
Determined values (as fed)	
Dry matter, g/kg	867
Gross energy, MJ/kg	16.75
Crude protein (Nx6.25), g/kg	222
Phytate phosphorus, g/kg	2.9

[1]The inositol and the phytase were added over and above this formulation.
[2]The Vitamin and mineral premix contained vitamins and trace elements to meet the requirements specified by NRC (1994). All the experimental diets were designed to be low in P. The premix provided (units/kg diet): retinol 3600 µg, cholecalciferol 125 µg, α-tocopherol 34 mg, menadione 3 mg, thiamine 2 mg, riboflavin 7 mg, pyridoxine 5 mg, cobalamin 15 µg, nicotinic acid 50 mg, pantotenic acid 15 mg, folic acid 1 mg, biotin 200 µg, iron 80 mg, copper 10 mg, manganese 100 mg, cobalt 0.5 mg, zinc 80 mg, iodine 1 mg, selenium 0.2 mg and molybdenium 0.5 mg.

Broiler growth performance and AME determination

Day-old male Ross 308 broiler chickens were obtained from a commercial hatchery (Grampian Ltd., Whitburn, UK). They were placed in a single floor pen at 32°C and fed a proprietary broiler starter feed until 7 d age. On 7th day, the chicks were individually weighed and the heaviest and lightest birds discarded, leaving 80 birds. These were sorted into 5 weight blocks of 16 birds. The birds were randomised to treatment within weight block. Two birds were placed in each metabolism cage (0.35 x 0.35 m floor area) arranged in two tier levels within a controlled environment room. Each of the experimental diets was allocated at random to the cages. All the cages were equipped with metal feeders and cup drinkers. There was a metal tray under each cage for the collection of excreta. At 7d age the temperature was 30°C and it was then gradually reduced by 1°C on alternate days until room temperature reached 24°C. The light regime was 23 h light and 1 h dark throughout experimental period. Access to feed and water was *ad libitum*. The experiment ended when the birds were 17 d of age after a 10 day feeding period.

The nitrogen corrected apparent metabolisable energy (AMEn) of each diet was determined using the total collection procedure (Hill and Anderson, 1958) after recording the *ad libitum* feed intake and the total excreta produced for the last four days of the experimental period, between 13 and 17 d of age. The excreta then were freeze dried, weighed and milled. The feed intake and the weight of the birds were also measured on day 7 and 17 to assess weight gain and feed conversion efficiency on an individual bird basis.

Nutrient digestibility coefficients were determined as the difference between the intake and the output of the nutrient concerned divided by the intake of that nutrient. The daily secretion of sialic acid was obtained after multiplying the dry daily excreta voided by the concentration of sialic acid in excreta.

Ethical approval

The present study was approved by the Animal Experimental Committee of Scottish Agricultural College, United Kingdom.

Analysis of diets and excreta

Diets and freeze-dried excreta were ground (Retsch GmbH, 42781 Haan, Germany) to pass through a 0.75 mm sieve and then analysed for DM (24 h in a force draft oven at 105°C, Baird & Tatlock London Ltd., Chadwell Heath, Essex, UK), crude protein by the method of Sweeney (1989) using a LECO FP-200 Analyser (St. Joseph, Michigan, USA) and gross energy using an isoperibol bomb calorimeter (Parr-6200, Parr Instrument Company, Moline, IL). The content of dietary phytate P was determined using the method of Haugh and Lantzsch (1983). Total P concentrations in feed and excreta were assayed photometrically after wet digestion of samples using a nitric acid-perchloric acid mixture (AOAC, 1990). The crude fat (as ether extract) in the feed and excreta samples was extracted with diethyl ether using a Soxtec system (Foss UK Ltd.) (AOAC, 1990).

The concentration of excreta sialic acid (SA) was determined by the periodate-resorcinol method as described by Jourdian et al. (1971). The method involves conversion of free and glycosidically bound sialic acid to chromogenic substances by treatment with periodic acid followed by resorcinol. The colour of the samples was stabilized by 2-methyl-2-propanol, and after centrifugation the absorbance of the supernatant was determined spectrophotometrically at 630 nm (Spectrone 301, Milton Roy Company, USA). This procedure detects total, free and glycosidically bound N-acetyl neuraminic (sialic) acid.

Statistical analysis

Statistical analysis was performed using the Genstat 16 statistical software package (IACR Rothamstead, Hertfordshire, England). A randomised block analysis of variance was performed and a 2 × 4 factorial structure was used to investigate the main treatment factors (PHY × MYO inclusion levels) and their interaction. An orthogonal partitioning of the dietary MYO inclusion level was used to quantitatively compare the linear and quadratic regression effects. Differences were reported as significant at $P < 0.05$ and trends were noted when the P value was near to 0.1.

RESULTS

The analysed chemical composition of the basal diet is shown in table 1. All birds remained healthy throughout the study period and survived the experiment. Results relating to growth performance and dietary metabolisable energy are presented in table 2. Feed intake, body weight gain and AMEn intake were influenced only by dietary inositol content, and in all cases the effects were deemed to be quadratic, with the optimum appearing to be at approximately 2.5 g/kg. Phytase addition tended to increase weight gain (P=0.055) No treatment effects were noted on FCR or AMEn.

Table 2. The effect of supplementary inositol and phytase on growth performance, dietary AMEn, AMEn intake and AMEn: GE of broiler chickens from 7 to 17 day age (for AMEn data based on collection period from 13 to 17 day age).

Inositol (g/kg)	FI (g/b/d)	WG (g/b/d)	FCE	AMEn (MJ/kg DM)	AMEn int (MJ/d)	AMEn: GE
0.0	39	30	0.770	14.03	0.55	0.835
2.5	43	33	0.773	14.21	0.62	0.848
5.0	41	31	0.774	14.13	0.57	0.845
7.5	40	31	0.765	13.92	0.56	0.830
SEM	1.1	0.9	0.0199	0.147	0.016	0.0088
Phytase (500 FTU/kg)						
-	40	31	0.758	13.97	0.56	0.833
+	41	32	0.784	14.17	0.59	0.846
SEM	0.7	0.6	0.0141	0.104	0.011	0.0062
Inositol X Phytase						
0.0	38	28	0.746	13.66	0.52	0.813
2.5	44	33	0.754	14.26	0.63	0.851
5.0	39	30	0.756	13.95	0.55	0.834
7.5	40	31	0.775	14.00	0.56	0.834
0.0 +	41	32	0.795	14.40	0.58	0.857
2.5 +	42	33	0.792	14.15	0.60	0.845
5.0 +	42	33	0.792	14.31	0.60	0.855
7.5 +	41	31	0.756	13.83	0.56	0.826
SEM	1.5	1.2	0.0281	0.208	0.023	0.0124
Statistical probabilities of treatment differences						
Inositol						
Linear	NS	NS	NS	NS	NS	NS
Quadratic	0.056	0.040	NS	NS	0.024	NS
Phytase	NS	0.055	NS	NS	NS	NS
Inositol X Phytase	NS	NS	NS	NS	NS	NS

FI – daily feed intake; WG – daily weight gain; FCE – feed conversion efficiency; AMEn – nitrogen corrected apparent metabolisable energy; GE – gross energy; AMEn:GE – metabolisability of gross energy; NS – not significant (P>0.05). SEM - standard errors of means. There were 5 observations per treatment.

Table 3. The effect of supplementary inositol and phytase on digestibility of dietary dry matter, nitrogen, fat, phosphorus, excreta sialic acid concentration and sialic acid secretion of broiler chickens (data based on collection period from 13 to 17 day age).

Inositol (g/kg)	DMD	ND	FD	PD	SAc (µg/g)	SA (µg/96h)
0.0	0.673	0.596	0.842	0.550	0.65	20.57
2.5	0.686	0.609	0.840	0.579	0.57	18.98
5.0	0.686	0.615	0.853	0.573	0.56	17.85
7.5	0.670	0.605	0.845	0.539	0.48	15.02
SEM	0.0078	0.0081	0.01146	0.0197	0.055	1.662
Phytase (500 FTU/kg)						
-	0.670	0.597	0.840	0.475	0.57	17.81
+	0.687	0.615	0.851	0.645	0.56	18.40
SEM	0.0056	0.0058	0.0081	0.0139	0.039	1.175
Inositol X Phytase						
0.0	0.652	0.579	0.828	0.437	0.58	18.29
2.5	0.684	0.607	0.832	0.476	0.57	18.92
5.0	0.676	0.606	0.856	0.499	0.57	17.39
7.5	0.669	0.597	0.843	0.489	0.55	16.63
0.0 +	0.693	0.613	0.857	0.663	0.72	22.86
2.5 +	0.689	0.611	0.849	0.683	0.56	19.03
5.0 +	0.696	0.624	0.850	0.646	0.55	18.31
7.5 +	0.671	0.614	0.847	0.589	0.41	13.40
SEM	0.0111	0.01152	0.0162	0.0278	0.078	2.350
Statistical probabilities of treatment differences						
Inositol						
Linear	NS	NS	NS	NS	0.048	0.026
Quadratic	0.076	NS	NS	NS	NS	NS
Phytase	0.040	0.036	NS	<0.001	NS	NS
Inositol X Phytase	NS	NS	NS	0.020	NS	NS

DMD – dry matter digestibility; FD – fat digestibility; PD – phosphorus digestibility; Sac – concentration of sialic acid in excreta; SA – total sialic acid excreted; NS – not significant (P>0.05). SEM - standard errors of means. There were 5 observations per treatment.

Table 3 reports the nutrient digestibility data and the endogenous losses measured as SA. Dry matter digestibility increased in a quadratic fashion with supplementary MYO (P=0.076) and increased with PHY addition. Nitrogen digestibility increased with PHY addition but was not influenced by MYO supplementation. Fat digestibility did not change with treatment whereas phosphorus digestibility increased with PHY addition as expected but the effect was much more pronounced in the low MYO compared with high MYO diets as described by the interaction. Indeed the interaction noted that increasing inositol content had no effect in the absence of PHY but it depressed P digestibility in the diets containing PHY. The SA content of the excreta and the total amount excreted, decreased (P<0.05) with increasing MYO supplementation in a linear pattern. Increasing dietary MYO content by 1g/kg reduced SA concentration in the excreta by 0.02 µg (SAc = 0.64 (SE 0.019) – 0.02 (SE 0.004) * MYO) and the total amount of SA excreted per day by 0.71 µg (SA = 20.77 (SE 0.465) – 0.71 (SE 0.099) * MYO).

DISCUSSION

The analysed dietary protein and phytate P content differed marginally from the calculated values, which could probably be due to the difference between the composition of the actual ingredients that were used in the present study and the values given by the National Research Council (NRC, 1994) for the same ingredients.

The experimental diets were formulated to be marginally deficient in P such that in the presence of the PHY the P requirements would be met. Indeed PHY addition did improve weight gain as was expected but failed to increase feed intake. This design allowed determination of the response to MYO in diets which are marginally deficient or adequate in P. In the present study, the addition of MYO resulted in improved feed intake and weight gain regardless of the presence or absence of PHY which is in agreement with previous reports (Żyła et al., 2004, 2013). It thus suggests that the growth-stimulating effect of MYO is not dependent upon adequate phosphorus levels in the diet for growing broilers. The superior growth rates of birds fed diets containing 2.5 g/kg added MYO correlated with concomitant increased daily AME intake and DMD, although the AMEn intake effect was a direct result of MYO increasing feed intake rather than any effect on AMEn per se. The literature investigating the effects of supplemental MYO on broiler performance is equivocal (Lee and Bedford, 2016). Żyła et al. (2013) demonstrated that supplementation with as little as 1g/kg MYO in wheat- and maize-based diets containing 1.5 g/kg of available P improved growth of broilers of a similar age. However, Cowieson et al. (2013) found that the addition of MYO to a diet low in Ca and digestible P resulted in a negative effect on feed efficiency during the starter phase, although during the finisher phase the effect became positive. Moreover, feeding MYO reduced feed intake (Cowieson et al., 2013) which is in contrast to the current work. Furthermore, Cowieson et al. (2013) reported an interaction between MYO and exogenous phytase whereby addition of MYO to either the positive or negative control diet improved feed efficiency in older birds only in the presence of phytase. Finally, Pearce (1975) and Żyła et al. (2004) did not find any advantage in broiler growth rates when P sufficient diets were supplemented with MYO.

The results suggest that performance response to MYO may interact with dietary and husbandry factors yet to be identified such as diet formulation, age, rearing conditions and perhaps health status of the bird. Although marginal, the reported positive effect of PHY on broiler growth was in agreement with previous studies when a similar dosage of the same product (Cowieson et al., 2006; Pirgozliev and Bedford, 2013) was fed. The relatively low activity of exogenous PHY, i.e. 500 FTU only, may explain the lack of effect on AMEn and nutrient digestibility.

There was MYO by PHY interaction for P digestibility which was explained by the fact that MYO had no effect on P digestibility in the absence of PHY whereas in the presence of PHY it actually depressed this metric. Myo-inositol is the end product of dephosphorylation of phytate and perhaps it may act as an end product inhibitor although most phytase fail to dephosphorlate IP1 and as a result IP1 and not MYO is the end product. Nevertheless, P digestibility in the presence of PHY was always higher than in its absence, regardless of MYO content of the diet. The lack of correlation between performance and P digestibility may simply be because of the fact that in the presence of PHY, the digestible P content of the diet exceeded requirement even at the highest MYO concentration.

Regardless of PHY inclusion level, performance was optimised at approximately 2.5 g/kg MYO. Myo-inositol has been shown to influence multiple pathways of metabolism including increasing the activity of ATPase and improving nerve conduction velocity in rats (Greene and Lattimer, 1983; Yorek et al., 1993). Cowieson et al. (2013) reported an increase in blood glucose content when MYO or a combination of MYO and PHY were fed to birds, compared to a low Ca and P control diet, suggesting improved efficiency and/or rate of nutrient absorption

which facilitated the increased growth rate and feed efficiency.

The results of present study suggest that dietary supplementation with either MYO or PHY may enhance the growth of chickens although these effects may not always be additive. Cowieson et al. (2013) concluded that the presence of both, MYO and PHY in poultry diet may result in some antagonistic interactions mediated via competitive mechanisms.

Increasing dietary MYO content resulted in reduced SA content of the excreta suggesting that mucin excretion is reduced. However, the SA content of the excreta may also be affected by the GIT microflora (Varky, 1992) as the SA content varies with bacterial species. Myo-inositol is involved in the control of cell volume and osmolarity (Kane et al., 1992), and thus likely varies with the total microbial population and its species distribution, thereby contributes to variance in SA excretion from the GIT. Reduction in SA secretion have also been noted with inclusion of high doses of PHY (Cowieson et al., 2004), an effect which was attributed to improved intestinal integrity. In this study no effect of PHY on SA excretion was noted which may be a consequence of the lower dosage employed and thus less destruction of IP6 as compared with other studies. The lack of effect of the PHY on AMEn suggests such a limit on IP6 destruction may indeed have been the case in the present study.

CONCLUSION

The present study demonstrated that dietary MYO improves bird growth and possibly intestinal health of broiler chickens. Further, the dietary supplementation with either MYO or PHY may improve growth of chickens, although these effects may not always be additive. The mechanism of action of dietary MYO in poultry needs further investigation. Moreover, the studies on the interaction between dietary minerals, exogenous PHY and MYO may bring more clarity on the mode of action of MYO.

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Competing interests

The authors declare that they have no competing interests.

Author`s Contributions

The present study was funded by AB Vista Feed Ingredients, Marlborough, Wiltshire, UK. All authors contributed to the planning of the study. V.P., M.R.B. and S.P.R. were involved in the design and execution of the study and also drafting of the manuscript. The rest of the authors were involved in the chemical and statistical analyses, design and revision of the manuscript.

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Assessment of a New Backyard Poultry Strain "Kaveri" in Farmer's Situation, Rural Odisha, India

Bijeya Kumar Banja[1], Pavanasam Natarajan Ananth[1], Surendra Singh[1], Pragyan Ranjan Sahoo[1] and Pallipuram Jayasankar[2]

[1]*Krishi Vigyan Kendra-Khordha, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, Odisha 751002, India*
[2]*ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, Odisha 751002, India*

*Corresponding author's Email: ananthkvk100@gmail.com

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ABSTRACT

Backyard poultry plays an important role in livelihoods of Indian farmers. Research and Development efforts on developing improved strains to enhance productivity have enhanced farmer's income. Scaling up of improved strains is based on adaptive trials conducted by extension agencies for location specificity and feasibility. The present study is a first time report in India on the performance of newly released Kaveri poultry in the backyard production system through an on farm trial by Krishi Vigyan Kendra-Khordha, the farm science centre of Indian council of agricultural research at the district level. Kaveri birds have characteristic features like low early chick and laying mortality, excellent flock uniformity, early sexual maturity, withstanding predators, laying brown colour eggs etc. The participatory trial was organised at 30 farmer's fields administering participatory approach by providing 300 chicks to the farmers. The biggest gain of Kaveri poultry in the trial was the body weight, which was recorded to be 3200 gm in male and 2800 gm in female birds at the end of 12 months study period compared to the 1750 gm and 1250 gm respectively with the local strains. Kaveri chicks exhibited superiority in their liveability with a mortality rate of 15% during the critical period of the first 10 weeks of their life compared to the most popular backyard improved strain Vanaraja in which it is up to 24% in the backyard system. Majority of the farmers perceived that this strain can withstand predation which scores better than the other improved strains. The study concluded that Kaveri is suitable for backyard farming system and is highly profitable. Attempts were taken in 2016 to link the results of the strain assessment to the mainstream extension at the district for larger adoption of rural communities.

Key words: Backyard poultry, Kaveri, Rural Odisha

INTRODUCTION

Interestingly, rearing poultry birds in the backyards, one of the age old practices in India, is a promising option for rural livelihoods. Today in India poultry is one of the fastest growing sectors that support protein requirements for millions. Trends in the poultry sector provide a striking example of how sector growth does not necessarily go hand in hand with poverty reduction (Mehta et al., 2003; Samanta et al., 2015; Patra and Singh, 2016). Family poultry (or the 'traditional scavenging' system), which is based almost entirely on native birds, has been by-passed by the poultry revolution, all the growth virtually occurring in the large-scale 'confined and intensive' (or industrial) sub-sector. By contrast, traditional poultry keeping appears to be a stagnant low-productive sub-sector. The composition of native birds within the poultry strains has dropped from 50% about 30 years ago to about 10% at present (Rangnekar and Rangnekar, 1999).

Livestock and poultry rearing is an imperative factor for improving the nutritional security of the rural poor in India. Rural farmers usually rear desi type chicken having low egg and meat production potential. Most of the backyard poultry production comprises of rearing indigenous birds with poor production performances (Pathak and Nath, 2013; Chakravarthi et al., 2014; Reetha et al., 2016; Patra and Singh, 2016). However, over the

period of time improved strains have been introduced by extension and development agencies. Vanaraja is an example of a superior stock developed by the project directorate on poultry, Indian Council of Agricultural Research (ICAR), Hyderabad for backyard farming in rural and tribal areas of India. It is a choice dual purpose coloured bird and has significantly contributed to the overall economy of the rural people in terms of eggs and meat (Bhattacharya et al., 2005). Development organizations under government of India also have developed improved strains like Kalinga Brown, Chabro, Coloured Cross (Kaveri) etc. (INFPD/FAO/IFAD, 2012).

The potentiality of indigenous birds in terms of egg production is only 50 to 60 eggs/ bird/ year and meat production is also very low (KVK-Khordha, 2015; Patra and Singh, 2016). However, the backyard poultry production can be enhanced by adopting improved strains of chicken that can promise better production of meat and egg. Backyard poultry is a handy and promising enterprise to improve the socio-economic status of farmers in rural areas with low-cost initial investment and high economic return along with guarantee for improving protein deficiency among the poor (Chakrabarti, 2014). Rearing backyard poultry in rural Odisha is a popular livelihood activity and mostly owned by scheduled tribes (63%), scheduled caste (17%) and the rest are from other castes comprising of 20% (Sethi, 2007).

Established in 1977, Krishi Vigyan Kendra (KVK), Khordha, the farm science centre of ICAR works under Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar. The KVK works for the mandated Khordha district in which the present adaptive trial was conducted.

The district has got about 39702 ha of high land, 43499 ha of medium land, 14130 ha of cultivable and 15457 ha of barren land. Animal rearing is one of the major components of existing farming systems of the district. Agro-climatic situation of the district is conducive for rearing cows, buffaloes, sheep, goat, poultry and ducks. Cattle are found in almost all the rural households predominantly for milk and draft purpose. As per the 2012 livestock census report the district has 10675 backyard poultry population, mostly the native strains. Since its inception KVK has been working on its mandatory activities like On-Farm Trials (OFT), Front Line Demonstrations (FLD) and vocational trainings for the animal growers on the latest technologies and improved practices (Ananth et al., 2016) . The KVK has successfully assessed and demonstrated backyard poultry strains viz., Vanaraja, Chabro, Gramapriya, CARI Devendra, Rhode Island Red-OR, Kalinga Brown, Aseel, White Leghorn, Black Rock and Coloured broiler. In addition to that KVK also works on feed management in dairy, mineral supplementation, popularisation of duck farming and many other technologies relevant to dairy, sheep, goat and poultry farming (Ananth et al., 2016). In 2015 and 2016, KVK identified a new poultry strain Kaveri from Central Poultry Development Organisation (CPDO), Bhubaneswar (KVK-Khordha, 2015). The colour pattern of this bird is multicolour with single comb and yellow colour shank and skin. These birds have characteristic features like low early chick and laying mortality, excellent flock uniformity, early sexual maturity, withstanding predators, laying brown colour eggs etc. as reported by CPDO, 2014. The organisation also recommended it as a suitable bird for rural backyard poultry farming. Predation is one of the serious constraints in backyard poultry and withstanding to any predator is the key feature of this strain to be considered for adding in to the backyard poultry production system (CPDO, 2014) .The characteristics of the strain as indicated by CPDO is presented in table 1.

The above characteristics might have been reported from the studies under the intensive (confined) poultry production system. However, by understanding the potentiality of the strain KVK conducted an OFT in 2015 and 2016 to assess its suitability and performance in the backyard farming system to feed into the mainstream extension. This paper is based on the results of the OFT conducted by KVK with the following objectives.

To assess the strain in terms of production and feasibility to backyard farming system.

To assess the farmers perception towards adoption of the introduced strain.

To elicit key recommendations and observations of the strain.

The study was conducted in 2015 and 2016 with the financial assistance from ICAR, New Delhi, India.

Table 1. Characteristic features of Kaveri poultry listed by Central Poultry Development Organisation, Odisha, India, 2014

Serial No.	Characteristics	Values
1.	Body weight at 6 week	750g
2.	Body weight at 20 week	2000-2200g
3.	Age at sexual maturity	183d
4.	Hen house egg production	120
5.	Hen day egg production	140
6.	Egg weight	55g
7.	Feed consumed/bird/day	135g
8.	Liveability	93%

MATERIALS AND METHODS

Khordha is one of the 31 districts of Odisha, India. Its headquarter bearing the same name is situated near the capital city Bhubaneswar in 85^0 37'30"E and 20^0 11'N. The district as a whole is divided into two geographical regions viz. South Eastern coastal plains and North Eastern ghats comprising of 10 blocks and 1567 villages with a total agrarian population of 122000. The present OFT was conducted in Tangi block of the district involving 30 farmers from one village. The sample size of the study was 10 chicks/unit comprising of 300 chicks for the study.

The creation system for this study was normally due to low egg production from native birds and other improved strains and most importantly due to high predation in the backyard system. Hence, look out for a new strain was a demand from farmer's perspective. The sanity of animals was taken care and there were no issues pertaining to the community within which it was promoted. The farmers under the study were randomly selected and were approved by KVK-Khordha for conducting the study. In the whole process of the study a veterinarian of KVK-Khordha was responsible to undertake the study from designing and to implement. Farmers who are progressive and innovators, possessing land and traditional poultry units were selected to try out the strain. The trial was conducted with farmers' rearing practice of traditional strains (T1) and recommended practice of improved strain Kaveri (T2). Un-sexed day old chicks were supplied to the farmers free of cost along with initial chick feed, vitamins and vaccines. A pre tested interview schedule was used to collect data on mortality rate, age at sexual maturity, vaccination schedule, disease incidence, body weight, eggs laid and income. Simple percentage analysis was employed to analyse the data pertaining to egg production and body weight gain.

Ethical approval

This research work did not involve the introduction of any intervention in/on birds, or direct collection of cells, tissues or any material from birds.

RESULTS AND DISCUSSION

Process and results of the trial

The need for an on farm trial was well conceived by KVK as poultry growers in the district used to get less egg production and low economic returns from local strains and high mortality in both native strains and the popularised improved Vanaraja strain. The new strain Kaveri was trialled out in 30 units at farmers' field (T2) compared with the local strain (T1). Each unit comprised of 10 chicks assuming 5 male and 5 female, totalling to 300 chicks. The un-sexed day old chicks were procured from central poultry development organisation, Bhubaneswar and distributed to the selected farmers who are in the practice of rearing local poultry in their backyard. Among the participating farmers, those having recently hatched chicks of local strain were formed into control (T1) groups comprising of 10 chicks/unit for the comparison. Before the trial was initiated, the livelihood status of participant farmers were collected which formed the basis of selection and they were trained on various aspects of care and management of chicks in early life, required medication, feed supplementation, vaccination etc. In addition to that the participatory approach of the trial was also elucidated towards successful accomplishment. Upon implementation of the trial the KVK scientists regularly visited the units in intervals, recorded the observations on each parameter, provided further guidance and demonstrated vaccination technique etc. to them for further use. The trial continued for a period of 12 months and appreciably farmers accepted the vaccination and adopted the practice. The results of the trial are presented in table 2.

The biggest gain of Kaveri poultry in the trial was the body weight, which was recorded to be 3200 gm in male and 2800 gm in female birds at the end of the 12 months study period compared to the 1750 gm and 1250 gm respectively in the local strains. Studies from many states of India indicates that the improved strains had significantly higher achievement than the local chicken in terms of body weight, egg weight, egg production and age at sexual maturity (Vetrivel and Chandrakumarmangalam**,** 2013**;** Mohanty and Nayak, 2011; Yadhav and Khan, 2011; Padhi, 2016).

Kaveri chicks exhibited superiority in their liveability in the backyard system with a mortality rate of 15% during the critical period of first 10 weeks of their life compared to the most popular backyard improved strain Vanaraja, in which it is up to 24%.The other principal gain was with egg production which was 163 eggs/ bird/ year in case of Kaveri compared to the 50-60 eggs of local strains. The trial concluded that Kaveri was found to be the best strain to be popularised in the district in comparison to the analyses of different trials conducted over the years by the KVK as reflected in table 3.

The mortality up to 10 weeks was found to be15% in Kaveri compared to 24% of Vanaraja and 9% of local strain which exhibits superiority of Kaveri over Vanaraja. The total mortality rate from day old stage to adult stage (20 weeks age) for Kaveri, Vanaraja and local strain were

recorded to be 18%, 30% and 10% respectively. From this it is inferred that next to local strain Kaveri has the potential to survive better in the backyard system than other improved strains. Similarly Kaveri birds attained sexual maturity (age at 1st lay) at an average age of 185 days compared to the 190 and 192 days of Vanaraja and local strains respectively. Although the achievement in body weight gain was little less in Kaveri, average being 3000 g compared to the average 3760 g of Vanaraja, still it scores much better in terms of egg and meat production, income generation and farmers' preference. Moreover, this dual purpose bird proves to be viable with its superior egg laying capacity (163 eggs/bird/year) compared to the 150 of Vanaraja and 60 of local strains. The comparative analysis infers that Kaveri is a suitable strain and can be promoted in large scale in the backyard poultry farming system. A comparative economic analysis of rearing Kaveri poultry during the trial is presented below in table 4.

The economics of rearing Kaveri poultry was found to be encouraging in terms of income generation as this strain achieved a better benefit-cost (B: C) ratio (gross return/gross cost). A benefit-cost ratio (BCR)/Profitability Index Rate is an indicator, used in the formal discipline of cost-benefit analysis that attempts to summarize the overall value for money of a project or proposal. In this adaptive trail the B:C ratio with Kaveri was found to be 4.28 compared to 3.81 of local strain. The gross return from a unit of 10 Kaveri birds was Rs. 6860/-.comprising the sale of eggs and live birds which infers that the strain is better in terms of investment and returns. Farmers had a net profit of Rs.5260/-through sale of eggs and live birds in contrast to the gross return of Rs.3425/- and net return of Rs.2525/- from local strain. This economic analysis infers that Kaveri provides better income to the rural poultry keepers and helps in augmenting the production of nutritious food products from rural poultry sector.

Table 2. Results of the trial on Kaveri in backyard poultry system during 2014-2016 in Tangi Block of Khordha district, Odisha, India

Serial No.	Parameter	Results	
		FP (T_1)	RP (T_2)
1.	Chicks/Unit (No.)	10	10
2.	Male-Female Ratio	1:1	1:1
3.	Liveability (%)	92	80
4.	Body weight (M/F) at sexual maturity (g)	775/550	1950/1800
5.	Body weight (M/F) in 12 months (g)	1750/1250	3200/2800
6.	Age at sexual maturity (days)	192	185
7.	Monthly egg production/bird (nos.)	5	14
8.	Annual egg production/unit	280	652
9.	Colour of Egg	Brown	Brown
10.	Annual live weight (kg) produced/unit	14.5	17.15

FP: Farmers' practice, RP: Recommended practice, nos.: numbers

Table 3. Comparative performance of Kaveri, Vanaraja and local poultry strains under backyard farming system in Tangi Block of Khordha district, Odisha, India during 2014-2016

Parameters	Performance of strains		
	Kaveri	Vanaraja	Local strain
Mortality up to 10 weeks (%)	15	24	9
Mortality up to 20 weeks (%)	18	30	10
Annual Mortality Rate (%)	20	31	10
Predation losses (%)	7.5	16.5	4.5
Loss due to diseases (%)	1.5	2.5	5
Loss due to cold temperature (%)	12.5	13.75	-
Average age at first lay (days)	185	190	192
Average body weight at sexual maturity (20-24 weeks) in (g)	1875	2100	662.5
Average annual body weight (g)	3000	3760	1500
Average annual egg production (numbers)	163	150	60
Colour of egg	Brown	Brown	Brown
Average Egg weight at 40th weeks (g)	56	62	48-50

Table 4. Economics of rearing Improved strain Kaveri in the backyard in Tangi Block of Khordha district, Odisha, India during 2014-2016

Breed/ Strain	Unit size	M/F Ratio	Mortality	Survival	M/F survival	Expenses	Gross cost/ Unit (Rs)	Products	Revenue (Rs)	Gross Return /Unit (Rs)	Net Return /Unit (Rs)	B.C.R
Native (T_1)	10	1:1	1	9	4+5	Chick cost, low cost housing, household grains, medicine etc. (Rs100/bird for 9 birds)	900	280 eggs (Av. 56 eggs/hen from 5 hens)	1400 (Rs 5/ egg)	3425	2525	3.81
								13.5 kg live wt. (Av.1.5 kg/bird from 9 birds)	2025 (Rs 150/ kg)			
Kaveri (T_2)	10	1:1	2	8	4+4	Rs100 as above + cost of supplementary poultry feed, vaccine, vitamins etc.(Total Rs 200/ bird for 8 birds	1600	652 eggs (Av.163 eggs/hen from 4 hens)	3260 (Rs 5/ egg)	6860	5260	4.28
								24.0 kg live wt. (Av. 3.0 kg/bird from 8 birds)	3600 (Rs 150/kg)			

B.C.R: benefit-cost ratio, Rs: rupees, wt.: weight, Av.: average

Table 5. Poultry farmers' Perception on the Strain Kaveri in Tangi Block of Khordha district, Odisha, India during 2014-2016

Perception (N=30)			
Serial	**Perception**	**Frequency**	**Percent**
1	Low chick mortality	22	73.3
2	Low incidence of diseases	25	83.3
3	Strain is capable to withstand predation	27	89.9
4	Suitable for backyard	30	100
5	High gain with eggs	30	100
6	High gain in body weight	30	100

Farmer's preference and feedback on the strain

About 83.33% of farmers perceived that Kaveri experienced low incidence of diseases compared to the local strains and this may be due to the reason that farmers seldom vaccinate their local strains against some infectious diseases which account for high mortality rate during disease outbreaks. However, it is a fact that the indigenous birds although low in productivity, they are better resistant to diseases, adaptable to adverse climatic conditions and able to produce even under low input systems (Roy, 2006). About 73.33% of the farmers perceived that Kaveri has low mortality rate which reflects its superiority over other improved strains. Majority of the farmers perceived that Kaveri is a suitable strain and will be a suitable candidate for the backyard farming system. The reason for this perception may due to its high potential for egg production, fast growth rate and other characteristic features which were visible in the trial and hence there was a high response.

About 90% of the farmers perceived that Kaveri is capable to withstand predators. In the backyard system predation is one of the frequently occurring incidences which incur huge loss to the farmers. The reason may be that the farmers who had reared other improved strains before this trial would have experienced high predation rate and heavy loss. However, local poultry birds have the capability of saving themselves from predators.Predators accounted for up to 88 percent of mortality and that coloured birds had a higher survival rate than white birds (Wickramenratne et al., 1994). Similarly another investigation proves that serious problems were identified in both locations, and particularly in the Udaipur villages, with high mortality rates in chickens and poor hatchability rates. In both locations the project found that for the period under investigation predation was a more important cause of mortality than disease (Conroyet al., 2005). A livestock development project funded by the Danish International Development Agency in Koraput district of Orissa found that predation was 'an important problem' and noted that the main predators were crows, foxes, hyenas and wild cats (Das et al., 2003).Therefore Kaveri strain is likely to

be preferred by many farmers as predation is one of the key constraints in backyard poultry farming.

CONCLUSION

Overall results of this on farm trial confirm that the poultry strain Kaveri has a coupled advantage over the other strains in terms of production and escaping predation. The result highlighting the striking factor on this strain is its capability to withstand predators. This will fetch a better score for it than the other strains for further uptake as predation is the major cause of loss in backyard poultry system. On the other hand the economic returns also show a positive trend that will be beneficial for the farmers compared to the native strains. Hence, extension efforts needs to be intensified towards promoting this strain for larger adoption with large scale demonstrations and other extension methods as the country popularised the Vanaraja strain. KVK has planned to work on this strain for a few years more to make farmers aware of this strain and also to promote through the state schemes. Hence, it could be concluded that Kaveri is a superior strain and can be promoted in backyards of rural Odisha and in other parts of India.

Competing interests

The authors declare that they have no competing interests.

Consent to Publish

The authors have full consent to publish this paper.

Author's contribution

Bijeya Kumar Banja identified the new strain under study, designed and implemented the adaptive trial. Pavanasam Natarajan Ananth worked on identification of villages, farmers and also to record the observations and worked on designing paper manuscript, data analysis and also on editions. Surendra Singh, Pragyan Ranjan Sahoo and Pallipuram Jayasankar were involved in the monitoring team for this study.

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Effect of Psyllium Husk Fiber on Growth Performance, Egg Quality Traits and Lipid Profile in Layers under High Ambient Temperature

Nasir Mukhtar[1]*, Rizwan Mehmood[1], Sohail Hassan Khan[2], Naeem Mehmood Ashrif [3]and Muhammad Waseem Mirza[4]

[1]*Department of Poultry Sciences, PMAS -Arid Agriculture University Rawalpindi 46300 Pakistan*
[2]*Poultry Research Institute Murree Road Rawalpindi Pakistan*
[3]*Department of Biochemistry and Biotechnology, University of Gujrat Pakistan*
[4]*Department of Animal Production, Welfare and Veterinary Sciences, Harper Adams University United Kingdom*
*Corresponding author`s Email: nmukhtar@uaar.edu.pk

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ABSTRACT

The present study was conducted to evaluate the impact of cholesterol lowering effect of Psyllium husk in egg yolk cholesterol through dietary supplementation in white Leghorn layers. A total of 180 commercial layer hens were randomly divided into four equal groups of 45 birds each to be allocated to four dietary regimes, consist of 0, 5, 10 and 20 g of Psyllium per kg diet, each group was subdivided into three replicate containing 15 layers per replicate. Dietary treatments had a non significant effect on weight gain, egg production, feed intake and mortality. There was a positive impact of dietary Psyllium levels on egg mass and shell thickness, however, haugh unit and egg shape index deteriorated with higher dietary inclusion of Psyllium. Cholesterol levels in yolk and blood reduced significantly ($P<0.05$) with an increasing level of dietary Psyllium. The results of the present study suggested that dietary inclusion of Psyllium can be an effective tool for the reduction of blood and egg yolk cholesterol levels.

Key Words: Psyllium, Egg traits, Yolk cholesterol, Egg production, Lipid profile.

INTRODUCTION

The egg is the important contributor towards a balanced and nutritious human diets, however, some health conscious are vary of its higher cholesterol contribution and therefore, can be reluctant to be benefited enough from this precious nutritious item. Many dietary products have been applied to reduce the cholesterol contents in eggs. One such dietary intervention is the soluble fiber which has been shown to be supportive to the cholesterol lowering effects of low-fat diets in individuals with mild to moderate Hypercholesterolemia (Anderson et al., 1992, Jenkin et al., 1993, Glore et al., 1994; Ahmedet al., 2010). One such source of soluble fiber is Psyllium which is a herb native to parts of Asia, the Mediterranean regions of Europe and North Africa, and is now widely cultivated in India and the American southwest. It is a good source of natural and concentrated soluble fiber. Psyllium fiber, also known as Ispaghula and Isapgol, is derived from the husk of blonde Psyllium seeds from *Plantago psyllium* which is commonly known as *Plantago ovate* (Kendall, 2004), which is recognized as a potent agent in lowering plasma cholesterol (Anderson et al., 2000a). Psyllium fiberis a gel forming mucilage that lowers blood lipid concentrations (Anderson et al, 2000b, Fischer et al., 2004). Moreover, it is well accepted as a safe and effective bulk laxative and is an adjunct to dietary intervention for individuals who do not adequately respond to a low-fat and low cholesterol diet (Anderson et al., 1988). The supplementation of Plantago Psyllium can lower total cholesterol (TC), and LDL-C (Anderson et al., 2000b). Levels of HDL-C, which isalso known as good cholesterol,were shown to increase by dietary Psyllium supplementation (Oson et al., 1997). The cholesterol-lowering effect of Psyllium has been reported in children (Davidson et al., 1996), as well as in adults (Florholmen et al., 1982). Additional benefits of Psyllium supplementation have also been reported to improved blood sugar

levels in some people with diabetes (Florholmen et al., 1982; Rodriguez-Moran et al., 1998; Anderson et al., 1999).

Previously, Garvin et al. (1965) showed that Psyllium when administered as a hydrophilic mucilloid resulted in a reduction of total cholesterol by 9% in the subject (human) within time period of five weeks. Anderson et al. (1998) also reported that Psyllium, when taken as part of a low-fat diet, resulted in a further of reduction of 3-6% of serum LDL cholesterol concentrations which was an additional of 5-9% relative to placebo, with no effect on serum HDL-cholesterol or triglyceride concentrations. Likewise, Psyllium has also been reported to reduce serum total cholesterol concentration 5-15% and serum LDL-cholesterol concentration 8-20% in hyper holesterolemic men consuming high-fat diets (Everson *et al.*, 1992). Several other studies on animals as well as in humans have also validated the claim of hypocholesterolemic properties of Psyllium (Everson et al., 1992; Turley et al., 1996). It was also reported that consumption of foods containing dietary fiber, may improve the long-term maintenance of low atherogenic LDL-cholesterol (Davidson et al., 1998). Psyllium (*Plantago Ovata*) seed husk fiber, a widely used soluble fiber, has been known to reduce serum total cholesterol and LDL cholesterol (Anderson et al., 2000b; Ganji and Betts, 1995).

So there is a mounting evidence to prove that the Psyllium fiber is a very useful tool in lowering serum total cholesterol or serum LDL-cholesterol concentrations in humans. Chicken eggs are an excellent source of protein and other nutrients and a regular and essential part of our breakfast and meals since long. On the other hand, chicken eggs have high contents of cholesterol (213-280mg) and health advisors recommend limiting or eliminating eggs from human diets in general and especial people with a high blood cholesterol level. So efforts are required to divert resources to develop methods of producing eggs having lower levels of cholesterol. Therefore, there is a need of biological evaluation of Psyllium husk addition in the egg laying poultry diets as a possible opportunity of lowering cholesterol in the blood serum as well as in the egg yolk.

MATERIALS AND METHODS

Ethical approval

Ethical approval of all procedures in this study has not been sought from ethical committee of the PMAS Arid Agriculture University, Pakistan.

Bird husbandry and dietary treatments

A total of 180 Hy-Line W-98 hens, 70 weeks old (50 weeks in to lay) with uniform body weight were collected from a commercial flock of Breeding and Incubation section, Poultry Research Institute, Rawalpindi. The experimental house was thoroughly cleaned and disinfected before the shifting of these hens. Hens were maintained in four major dietary treatment groups for 90 days. Each treatment group was subdivided in to three replicate groups of 15 birds each. A basal diet was formulated to meet the nutrient requirements set according to Hy-Line 2000 guidelines as presented in table 1. Four dietary treatments were then made by addition of Psyllium fiber on the top of basal diet at the inclusion levels of 0, 5, 10 and 20g/kg of diet, representing as T_1, T_2, T_3 and T_4, respectively.

Table 1. Composition of experimental basal diet

Ingredients	Composition (g/kg)
Corn	510.00
Rice Broken	71.00
Rice Polishing	80.00
Canola Meal	70.00
Guar Meal	40.00
Sunflower Meal	20.00
Soybean Meal	104.60
Fish Meal	44.00
Molasses	28.00
Bone Meal	14.00
Marble Chips	67.00
NaCl	0.50
L-Lysine	1.10
DL-Methionine	0.80
Vitamin Pre-mix[1]	2.50
Mineral Premix[2]	2.50
Total	1000.00
Calculate analysis	
Metabolisable Energy (ME Kcal/Kg)	2790.00
Crude Protein (g/kg)	162.00
Crude Fat (g/kg)	34.50
CrudeFiber(g/kg)	40.80
Total Ash (g/kg)	89.80
Calcium (g/kg)	38.00
Av. Phosphorus(g/kg)	3.60
Sodium	1.78
NaCl	3.75
Linolenic acid	14.60

[1]Provided the following per kilogram of diet: vitamin A (as retinyl acetate), 8,000 IU; cholecalciferol, 2,200 ICU; vitamin E (as dl-α-tocopheryl acetate), 8 IU; vitamin B12, 0.02 mg; riboflavin, 5.5 mg; d-calcium pantothenic acid, 13 mg; niacin, 36 mg; choline, 500 mg; folic acid, 0.5 mg; vitamin B1 (thiamin mononitrate), 1 mg; pyridoxine, 2.2 mg; biotin, 0.05 mg; vitamin K (menadione sodium bisulfate complex), 2 mg.[2]Provided the following per kilogram of diet: manganese, 65 mg; iodine, 1 mg; iron, 55 mg; copper, 6 mg; zinc, 55 mg; selenium, 0.3 mg.

Growth performance

Birds were weighed at the beginning (Initial weight), and then biweekly up to the end of the experiment. Egg production was recorded daily at the same time of the day and was calculated on a hen-day basis. As follows: total number of eggs collected divided by total number of live hens per day in each group. Records of the feed intake were also taken on weekly basis.

Egg Quality Analysis

To determine egg quality traits, 30eggs from each treatment groups were used at 14-days interval throughout the experimental period for which a 2-d egg collection was saved during the week. Egg mass was calculated as a factor of egg weight and hen-day egg production. Measures of egg weight and specific gravity were also determined at that time. The short and long diameters of the eggs were measured by a digital caliper with a sensitivity of 0.001 mm and were used to determine the egg shape index. The eggs were then broken on individual basis on a flat surface, and a waiting period of 5 min was given to settle the egg contents naturally. The heights of the yolk and albumen, the long and short diameters of the albumen, and the diameter of the yolk were measured using the caliper. The yolks separated from the albumen and then weighed and recorded. From the values obtained, the following data were calculated using the formulas shown below (Yannakopoulos and Tserveni- Gousi, 1986):

Shape index = short edge/long edge × 100

Yolk index = yolk height/yolk diameter× 100

Haugh units were determined at the same time on same number of eggs (30 eggs from each treatment). Haugh units were calculated from the records of albumen height and egg weight using following equation:

Haugh unit = 100 × log (albumen height + 7.57 − 1.7 × egg weight$^{0.37}$ (Nesheim *et al.*, 1979).

The shells of the broken eggs were washed under gently flowing tap water to release albumen residues, and were then air-dried and weighed. Shell thickness was determined bi-weekly on above same eggs from each treatment group (without the shell membranes): the measure was carried out with a digital caliper with a sensitivity of 0.001 mm at three points of the egg shell (air cell, equator, and sharp end).

Determination of cholesterol concentration in the blood serum

On 14, 28, 42, 56 and 70 days of the experiment, blood samples were collected from the bronchial vein of 9 hens from each treatment (3 hens/ replicate) to determine the serum cholesterol.The collected blood samples were centrifuged at 3000 r.p.m. for 10 min and the serum was decanted into aseptically treated vials and stored in deep freezer at -20ºC up to analysis for total cholesterol. Serum cholesterol was measured by using diagnostic kit (RANDOX Diagnostics, Catalog No. CH 207, 56RANDOX Laboratories Ltd. Ardmore, Diamond Road, Crumlin, Co. Antrim, United Kingdom BT29 4QY) and spectrophotometer apparatus. Atherogenic index (IA) was calculated using the following formula:

AI= log (TG/HDL-C) (Kanthe et al., 2012).

Statistical analysis

Data were analyzed by using the SPSS version 16 (SPSS, Cary, NC, USA) statistical analysis program. A randomized complete block design was used to analyse data by using analysis of variance (ANOVA). The mean values were considered significantly different when P-value was <0.05 whereas trends were reported at P=0.1. The comparison of means was made using Tukey's test. (Steel and Torrie, 1980)

RESULTS

Nutrients composition of Psyllium husk

The Psyllium husk (*Plantago ovate* - as reported in previous studies) are mainly composed of 8.6% moisture, 21.7% crude protein, (CP), 6.1% crude fiber, 29.5% ether extract, 4.5% total ash and 29.7% nitrogen-free extract. Macro-mineral content was 572 mg calcium/100 g; phosphorus was 540 mg/100 g; magnesium (264); sodium (17.8) and potassium (810). Further, micro-mineral content was as follows: copper (2.7), zinc (6.2), iron (9.7) and manganese (8.5).

Effect of Psyllium on layer performance

There were no treatment related mortalities recorded during the entire study period. Dietary treatments had no effect on weight gain (Table 2).

Effect of Psyllium on the internal and external egg quality traits

There was increase (P<0.05) in egg mass and shell thickness with highest being observed when diets contained highest levels of phyllium fibre. However, there was a deterioration (P<0.05) in haugh unit and egg shape index noted as the levels of dietary phyllium increased. The results showed that there was no significance (P>0.05) effect of dietary treatments on shell weights, albumen weights and yolk weight (Table 3).

Effect of Psyllium on blood lipid profile and yolk cholesterol

There was significant (P<0.05) reduction in egg yolk cholesterol levels noted with increasing levels of dietary Psyllium, the best reduction in egg cholesterol contents were noted when dietary Psyllium was added at rate of 20g/kg of diet (Table 4).Similarly a lowered levels (P<0.05) of blood serum cholesterol, triglyceride, low-density lipoprotein (LDL) and very low density lipoprotein contents were noted at higher levels of dietary Psyllium addition. Strangely the high-density lipoprotein (HDL) concentration in the blood serum increased (P<0.05) with increasing the dietary addition of Psyllium. IA is used as a predictor of atherosclerosis in biological system (Ackay et al., 2014) which was reduced with increased addition of dietary Psyllium. .

Table 2. Effect of various dietary treatments of Psyllium husk on body weight gain (grams), egg production and mortality (%) of layers at 70 weeks

Parameter	Psyllium Levels (g/kg diet)				SEM
	0 (T_1)	5 (T_2)	10 (T_3)	20 (T_4)	
Initial body weight (g/b)	1567	1558	1556	1581	0.389
Final body weight (g/b)	1625	1614	1599	1600	0.753
Body weight gain (grams during whole experiment)	58[b]	56[b]	43[b]	19[a]	0.007
Egg production (%, egg/hen/day)	62.05	63.10	64.01	63.85	0.238
Mortality (%)	0.00	0.00	0.00	0.00	--

*T1 = Control; T2= 5 gm Psyllium/ Kg Feed; T3= 10 gm Psyllium/ Kg Feed; T4= 20 gm Psyllium/ Kg Feed; [a,b] Means within a row without common superscripts differ significantly (P≤ 0.05).

Table 3. Effect of various dietary treatments of Psyllium husk on egg quality parameters in layers at 70 weeks

Parameter	Psyllium Levels (g/kg diet)				SEM
	0 (T_1)	5(T_2)	10(T_3)	20(T_4)	
Egg External Quality					
Egg weight (g)	60.99	61.06	60.06	63.09	0.561
Egg mass (g/d/hen)[†]	40.76[b]	42.83[ab]	43.80[ab]	45.66[a]	0.682
Egg shape index	76.80[b]	73.00[a]	71.33[a]	71.00[a]	0.781
Specific gravity	1.088	1.079	1.080	1.080	0.016
Egg Internal Quality					
Haugh units	76.06[a]	70.16[b]	74.83[a]	59.70[c]	2.910
Shell thickness (mm)	0.34[b]	0.35[b]	0.36[a]	0.36[a]	0.004
Shell weight (g)	7.50	7.73	7.06	7.56	0.164
Yolk weight (g)	16.16	15.33	15.00	16.40	0.403
Albumen weight (g)	37.33	38.01	38.00	39.13	0.313
Egg (%)					
Yolk	26.49	25.1	24.97	25.99	0.295
Albumen	61.20	62.23	63.27	62.02	0.399
Shell	12.29	12.65	11.75	11.98	0.210

*T1 = Control; T2= 5 gm Psyllium/ Kg Feed; T3= 10 gm Psyllium/ Kg Feed; T4= 20 gm Psyllium/ Kg Feed; [a,b] Means within a row without common superscripts differ significantly (P≤ 0.05).

Table 4. Effect of various dietary treatments of Psyllium husk on yolk and blood cholesterol in layers at 70 weeks

Cholesterol	Psyllium Levels (g/kg diet)				SEM
	0 (T1)	5 (T2)	10 (T3)	20 (T4)	
Total Cholesterol(mg/dl)	192.95 [a]	190.67 [a]	181.00 [b]	172.07 [b]	5.571
Triglyceride (mg/dl)	94.08 [a]	92.03 [a]	84.43 [b]	83.70 [b]	1.400
High Density Lipoprotein (mg/dl)	39.03 [b]	40.01 [b]	41.71 [a]	44.02 [a]	0.642
Low Density Lipoprotein (mg/dl)	135.11[a]	132.25[b]	122.41[c]	111.30[d]	2.829
Very Low Density Lipoprotein (mg/dl)	18.81 [a]	18.40 [a]	16.89 [b]	16.74 [b]	0.279
Atherogenic index (IA)	3.46 [a]	3.30 [b]	2.94 [c]	2.53 [d]	0.110
Yolk Cholesterol (mg/dl)	17.32[a]	17.26[a]	14.63[b]	14.02[b]	0.032

*T1 = Control; T2= 5 gm Psyllium/ Kg Feed; T3= 10 gm Psyllium/ Kg Feed; T4= 20 gm Psyllium/ Kg Feed; [a,b] Means within a row without common superscripts differ significantly ($P \leq 0.05$).

DISCUSSION

Effect of Psyllium on layer performance

Reduced weight gain in present study was in consistent with the early findings (Anonymous, 2010) this may be justified as Psyllium husk fiber reduces the energy intake under a restricted feeding regime. In addition to that there is another explanation for this phenomenon of reduced weight gain and that is as the dietary fiber level increase it resulted in a stabilization of insulin and glucose responses which then relates with poor nutrient utilisation (Leeuw et al., 2004) resultantly, it reduces the weight gain (Anonymous, 2010). No improvement in egg production in present study was in agreement with the findings of Roberts et al. (2007) who described that dietary fiber does not improve the egg production in layers.

Effect of Psyllium on internal and external egg quality parameters

Findings of the present study were in accordance with Roberts et al. (2007) who described that dietary fiber does not improve the egg weight, however, on the contrary to the previous findings egg mass founded to be higher with increasing levels of dietary fiber in the present study. These findings were indeed surprising as the egg mass increased even when weight gain went down due to lower energy intake in higher Psyllium fed birds this is beyond authors understanding at this stage and therefore, needs further investigation.

Effect of Psyllium on blood lipid profile and yolk cholesterol

Psyllium husk has a hypercholesterolemia effect in biological system (Anderson et al., 2000b) these findings are in consistent with the results of present study. Wolever *et al.* (1994) and Sprecher et al. (1993) reported that 10g Psyllium supplementation per day reduced 5-9% low density Lipid (LDL) cholesterol without altering HDL cholesterol or serum cholesterol or serum triglycerides concentrations (Levin et al. 1990; Stoy et al. 1993) largely by increasing their faecal excretion in animals (Arjmandi et al., 1992a; Turley et al., 1996 and Matheson and Story, 1996). Similarly, findings of Olson et al. (1997) are in agreement with present findings who reported that Psyllium reduce the 5% total cholesterol concentration than control diets. Likewise, Anderson et al. (2000a) reported that Psyllium decreased the serum's Low density lipoproteins cholesterol and total cholesterol concentration significantly. In another study, Ziai et al. (2004) reported that the Psyllium significantly decrease the High-density lipoproteins and reduces the Low-density lipids, lower cholesterol / high-density lipoproteins ratio and further reported that Psyllium improves the glycemic control. However, in present study data indicated an increase in the HDL in the blood serum which is contrary to the findings of Ziai et al. (2004). Likewise, Ganji and Kuo (2008) also reported that Psyllium fiber reduces the concentration of total cholesterol and decreases the high density lipoproteins cholesterol. In another study, Buhman et al. (1998)reported that Psyllium hydrocolloid significantly reduces the liver cholesterol in rats and further reported an increase in faecal excretions of total bile acid and steroid in high fiber fed rats compared to the controlled diet fed groups. Terpstra et al. (1998) reported that dietary addition of Psyllium in Hamsters reduces the plasma cholesterol ester transfer. Similar findings were reported and supported by Olson et al. (1997) who reported that dietary inclusion of cereal products enriched in Psyllium reduce

the total cholesterol, HDL cholesterol and LDL cholesterol levels in the blood this can be explained due to a possible improvement in the intestinal viscosity (Dikeman et al., 2006) and a lowering of blood glucose concentrations in higher fiber diets. Likewise, Terpstra et al. (2000) proposed that Psyllium lower the concentration of plasma cholesterol, very-low-density-lipoprotein cholesterol and triglyceride by reducing the energy intake and less a depression in hunger signals which ultimately resulted in reduction in the serum glucose and insulin concentration in animals (Pastors et al., 1991). Shrestha et al. (2007) reported that Psyllium lower down the concentrations of cholesterol and Low-density lipoproteins by reducing the activity of cholesteryl-ester-transfer-protein and by increasing the LDL receptor-mediated uptake and by modification in the intravascular processing of lipoproteins. Vega-López et al. (2003) reported that Psyllium as functional fiber reduces the plasma low density lipoprotein cholesterol in functional physiology of both sexes in human due to increase in HMG-CoA reductase gene expression in monocytes while the effect of Psyllium on plasma triglycerides are sex related property, it decreases in male but increases in females. In another study, Uehleke et al. (2008) reported that Psyllium reduce the cholesterol by minimizing the unfavourable effects on the Gastrointestinal Tract (GIT) and increase in the the GIT mass of many mammals (Cannon et al., 2010) in dairy cows and also increase the populations of bifido-bacteria and lactobacilli in the reticulo-rumen and fermentation in the colon. The finding of low egg yolk cholesterol in present trial was supported by McNaughton (1978) who reported that dietary fiber reduces the egg yolk cholesterol in layers. On contrary, Roberts et al. (2007) described that the dietary fiber has a non-significant effect on the egg yolk cholesterol in laying hens. Likewise, Weiss and Scott (1979) also investigated that the dietary fiber has non-significant result on the cholesterol contents of the eggs in laying hens.

CONCLUSION

Data from present research trial suggests that Psyllium can lower the blood serum and egg cholesterol contents without negatively affecting the egg mass and shell thickness. However, an increase in HDL contents and reduction in hugh units needs to be understood through a more refined study model.

Competing interests

The authors declare that they have no competing interests.

Author`s contributions

Mukhtar N., Mehmood R., Hassan Khan S. and Mehmood Ashrif N. deigned and performed the experiment. Waseem Mirza M. analysed data and wrote the paper.

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A Report of *Ascaridia galli* in Commercial Poultry Egg from India

Gamit Amit Bharat *, Nanda Pramod Kumar, Bandyopadhyay Subhasish, Bhar Ria

Division of Veterinary Parasitology, Eastern Regional Station, ICAR-Indian Veterinary research Institute 37, Belgachia Road, Kolkata-700 037, West Bengal, India

*Corresponding author's Email: amit.gamit96@gmail.com

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ABSTRACT

Ascaridia galli is a major encountered species of nemathelminthes in the domestic fowl from all around the world. The parasite causes many pathological conditions which may lead to production losses in the poultry industry. Life cycle of the nematode is direct and involves a single host. Adult parasites present in the small intestine but, erratically they can migrate to the other visceral organs including oviduct. In the study, we isolated two adult female parasites of species *A. galli* from albumin portion of the poultry egg. Isolated parasites as well as extracted eggs were examined by parasitological techniques. While erratic migration, It may lead the mechanical transmission of enteric pathogens including *Salmonella* spp. to the egg. Such reports may lead to consumer complaints as well as health problems in the people who consume raw eggs. Poultry egg harbouring such nematode and Salmonella organisms is a cause of concern, as it is widely consumed by people.

Keywords: Egg, *Ascaridia galli*, Poultry, Erratic migration

INTRODUCTION

There are many helminth parasites affecting and causing production losses to the poultry industry (Permin et al., 1999). Among them, *Ascaridia galli* is a most common nematode of domestic fowl and causing ascaridiosis in the hens, turkeys, geese and some other birds (Ramadan and Znada, 1991, 1992). It is cosmopolitan in distribution and reported from many countries including India (Bhalerao, 1935; Manna, 1992). Life cycle of the nematode is direct but earthworms can ingest eggs and act as a transport host. Birds become infected by ingestion of infective eggs directly with contaminated food and water or indirectly by consumption of transport host. After ingestion, the eggs are mechanically transported to the duodenum and hatch within 24hrs. After hatching larvae penetrates the intestine for histotrophic phase and return to the lumen and finally get matured (Ackert, 1931; Permin et al., 1998). Adult parasites present in the small intestine and eggs are passed out in the droppings (Pankavich et al., 1974; Ramadan and Znada, 1992; Permin et al., 1998). The infection is found in both deep litter as well as cage system, but infection rate is more in deep litter system (Hemalatha et al., 1987). Occasionally, live or calcified adult parasites are found in the albumin portion of the egg (Akinyemi et al., 1980; Omran, 1982; Soulsby, 1982; Hoglund and Jansson, 2011). Probably it reaches to the egg while egg formation via cloaca or penetration of intestine (Akinyemi et al., 1980; Fioretti et al., 2005).

Ingestion of such eggs can not cause any clinical disease in the human as nematode will be destroyed by peptic digestion (Fioretti et al, 2005). Although presence of parasite worm in the hen's egg is not considered as hazard for public health, it can cause potential consumer complaint. While this erratic migration, parasite may lead the mechanical transmission of bacterial, parasitic, or viral

enteric organisms like *E. coli*, *Salmonella* spp., *Campylobacter* spp., *Cryptosporidium* spp., *Giardia intestinalis*, Rotavirus, avian Influenza virus etc. into the egg (Goodwin and Brown, 1989; Ahmed and Ahmed, 2006; Permin et al., 2006; Roussan et al., 2012; Zambrano et al., 2014). These pathogens may cause severe morbidity with diarrhea, vomiting, nausea, abdominal cramps and fever in immunocompromised persons, children and old aged persons (Chadfield et al., 2001). Such eggs become a potential source of pathogenic organisms for humans who consume raw egg and cause hazard for public health.

Moreover, it is also indication of presence of *A. galli* infection in the poultry production system. Poultry egg harbouring such nematode and pathogenic organisms is a cause of concern, as it is widely consumed by people. In the study, we report a case of erratic migration of *A. galli* parasite in the commercial poultry egg.

MATERIALS AND METHODS

A fresh egg with worms was bought by private consumer and submitted to our attention. As per history, the egg was purchased by consumer from the local market located in the Kolkata, India. The egg was from a poultry farm with deep litter system and a healthy and normal flock. The farm did not have veterinarian but all the deworming, vaccination and other routine practices were performed regularly at the farm. While examination, two worms were isolated from the albumin portion of the commercial poultry egg. The nematodes were viable and moving in the albumin portion. Worms were isolated and immediately examined using parasitological techniques. After isolation, worms were washed properly with the normal saline solution. Worms were cleared in lacto-phenol solution and examined under microscope for their morphological characteristics. For further confirmation, uterus of nematode was teased on glass slide to extract the eggs. Eggs and worms were examined using morphological features described by Ramadan and Znada (1991, 1992). Because of the egg was brought from the market, so it was not possible to examine other eggs of the same bird.

Ethical approval

Not applicable. This research did not involve the introduction of any intervention with birds.

RESULTS

While examination, yellowish white colored and large nematodes were found in the albumin portion of commercial poultry egg. The cuticle was semitransparent and striated throughout the body. Both the worms were approximately 50 to 55 mm long with tapering ends. The anterior end of the worm was pointed and was covered by three lips. The posterior end of the worm was blunt. The eggs were unsegmented and oval shaped. The egg shell was thick and smooth. Based on the observations, both the worms were confirmed as adult female *A. galli*.

DISCUSSION

Although very few literatures is available on pathogenecity of *A. galli*, it can cause haemorrhage, enteritis, emaciation, weight loss etc. and leads to decrease egg production in poultry industry (Reid and Carmon, 1958). Adult parasites present in the small intestine, but they can migrate up to the oviduct through cloaca or penetration of intestine and participate in the egg formation (Akinyemi et al., 1980; Fioretti et al., 2005). Occasionally, erratic migration is reported as calcified or viable worms in the albumin portion of the egg (Akinyemi *et al.*, 1980; Omran, 1982; Soulsby, 1982; Hoglund and Jansson, 2011). The occurrence of the erratic migration may be frequent but unnoticeable because of common use of boiled eggs for consumption (Fioretti et al., 2005).

In the study, we found two viable adult female parasites of *A. galli* in the albumin portion of the single poultry egg. The size of the worms was comparatively smaller than the adult female worms of Ramadan and Znada (1992). The smaller size of the worms might be due to arrested development in unusual organs.

In past, a similar case of erratic migration was reported by Fioretti et al. (2005) in an egg where private consumer submitted the egg with the history of white filiform structure in the egg. After examination, they confirmed as an adult *A. galli*. Nikitin and Pavlasek (2014) reported the case of unusual localization of *A.galli* in the chicken egg. After isolation, they carried out the morphological study of different body parts of the parasite. In addition to this reported cases, Akinyemi et al. (1980) also reported the case of erratic migration of *A. galli* in the albumin portion of the poultry egg. Machado et al. (2007) recovered viable and adult female of *A. galli* from the albumin portion of the red bark egg of poultry. From India, a case of erratic migration of *A. galli* was reported by Manna (1992) in the albumin of the hen's egg.

Although, *A. galli* does not infect the human beings as it is not zoonotic, it can cause potential consumer complaint. While erratic migration, it may lead the mechanical transmission of the enteric pathogens like *E. coli*, *Salmonella* spp., *Campylobacter* spp.,

Cryptosporidium spp., *Giardia intestinalis*, Rotavirus, avian Influenza virus etc. into the egg. These pathogens are causative agents of various gastrointestinal problems. Among them, salmonellosis and campylobacteriosis can cause the major bacterial food borne gastroenteritis (EFSA and ECDC, 2012). Such egg becomes potential source of infection to the persons who consumes raw egg (Okorie-Kanu et al., 2016). Moreover, such reported cases also indicate the presence of *A. galli* parasite in the poultry raising system.

Since helminth parasites can be easily detected in the egg by candling, candlers should be properly trained to find and remove such eggs from the channels (Reid et al., 1973). Detection and removal of such infected eggs in the marketing channel is highly desirable for both consumers and producers. Additionally, regular deworming and monitoring should be carried out regularly in the poultry raising system to minimize the infection.

CONCLUSION

The eggs sold in the market may harbour *A. galli* parasite and may cause a health hazard to the public who consumes improperly cooked or raw eggs. Detection and removal of such eggs by proper candling can cause great benefit to the consumer as well as producer. It is essential to maintain strict hygiene and timed anthelmintic treatments in the poultry raising system to minimize the infection.

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Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Gamit Amit Bharat and Nanda Pramod Kumar: Designed the experiments and performed the experiments. Bandyopadhyay Subhasish and Bhar Ria: Analyzed the results, drafted and revised the manuscript. All authors have read and approved the final manuscript.

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Effect of Dietary Mimosa Small Bell (*Dichostachys glomerata*) Fruit Supplement as Alternative to Antibiotic Growth Promoter for Broiler Chicken

Kana Jean Raphaël*, Mube Kuetché Hervé, Ngouana Tadjong Ruben, Tsafong Francklin, Komguep Ronald, Yangoue Antoine and Teguia Alexis

University of Dschang, Faculty of Agronomy and Agricultural Sciences, Department of Animal Productions, Laboratory of Animal Production, PO Box 70 Dschang, Cameroon

*Corresponding author's Email: kanajean@yahoo.fr

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ABSTRACT

There is a growing interest in plant feed additives as a consequence of the antibiotics growth promoters restriction in livestock farming all over the world. This study was designed to evaluate the effect of *Dichrostachys glomerata* fruit powder on the growth performances of broiler chickens. A group of chickens fed on a basal diet without any supplementation (negative control $R0^-$) was compared to three other groups fed on diets supplemented by 0.1% of antibiotic (positive control $R0^+$), 0.2% (R0.2) and 0.4% (R0.4) *D. glomerata* fruit powder respectively. The results revealed a significant decrease in feed intake as compared to the negative and the positive control. The lowest Feed Conversion Ratio (FCR) was recorded with diet supplemented with antibiotic and 0.2% *D. glomerata*. The Body Weight (BW) and the Body Weight Gain (BWG) of chickens fed on diets supplemented with *D. glomerata* had an upward trend as compared to negative control diet. Apart from the relative weight of the head which tended to increase in coordination with increasing levels of *D. glomerata* in feed, this phytobiotic had no significant effect ($P>0.05$) on carcass characteristics. The increasing level of this phytobiotic tended to decrease serum content of creatinine as compared to the negative and positive control diets. The serum content in ASpartate AminoTransferase (ASAT) tended to increase with the increasing levels of this phytobiotic mean while no significant effect ($P>0.05$) was recorded on the serum contents of urea, total proteins and ALanine AminoTransferase (ALAT). In conclusion, 0.2% of *D. glomerata* fruit powder can be used to replace antibiotic, for a better growth performances and to produce antibiotics residues free chicken meat.

Key words: Antibiotic, Broiler chicken, Carcass, *Dichrostachys glomerata*, Growth performance, Phytobiotic, Production cost

INTRODUCTION

Due to side effects of the residues in animal products and the resistance developed by bacteria in the poultry farms, antibiotics feed additives have been banned in many countries. As reported by previous studies, up to 81% of the poultry meat and environmental isolates analyzed were resistant to enrofloxacin, ciprofloxacin, tetracycline or erythromycin (Ma De Cesare et al., 2012). As this has negatively affected the poultry profitability, the feed industry has now turned its attention to search for new growth promoter alternatives to antibiotics. Potential alternatives to antibiotics may be found among plant products which have been used for centuries as food and medicines.

Many local plants and spices have also been used as feed additives for poultry all over the world (Alloui et al., 2012; Muneendra et al., 2014). These spices and their extracts represent a new class of growth activators in livestock, but knowledge is still limited concerning their mode of action and their application (Windisch et al., 2008). Some studies have showed that spices contain active substances which have a positive impact on the production performances of domestic animals (Nuhu et al., 2000; Okerulu and Chinwe 2001; Alloui, 2011,

Odoemelam et al., 2013; Vivian et al., 2015). These compounds act indirectly through their antimicrobial, antioxidant and regulator effects on animal's intestinal microflora (Alloui, 2011). It has also been shown that phytobiotics improve the digestive activity of enzymes and the absorption of the nutrients (Lopez-Boot, 2004; Burt, 2004). The fruit of mimosa small bell (*Dichrostachys glomerata)* has antioxidant properties (Abdou Bouba et al., 2012), and thorough studies undertaken by Kambizi and Afolayan (2001) emphasizedon an active ingredient called "Apivirine" which is not only an antiviral but also an effective substance in the treatment of gastric ulcers not leaving out the high appetite stimulation effect of this substance. Also, *D. glomerata* contain flavonoïds and phenols (Abdou Bouba et al., 2012) which are known for their anti-inflammatory and antimicrobial effects (Nuhu et al., 2000; Jane et al., 2014). Okerulu and Chinwe (2001) highlighted the inhibitory effects of these substances on the growth of *Staphylococcus epidermidis*, *Streptococcus viridans* and *Escherichia coli.*

This study was designed to find natural feed additives, available, cheap with no harmful effect on animals, man and the environment in order to mitigate the problems involved in antibiotic feed additives.

MATERIALS AND METHODS

Site of study

The study was conducted at the poultry unit of the Teaching and Research Farm of the University of Dschang, Cameroon. This farm is located at 5°26' North and 10°26' EST and at an altitude of 1420 m above sea level. Where annual temperatures vary between 10°C and 25°C. Rainfall ranges from 1500 to 2000 mm per annum over a 9 months rainy season (March to November).

Birds, dietary treatments and experimental design

A total of 192 day-old Cobb 500 strain broiler chicks were randomly assigned to four experimental diets including negative control in a completely randomized design with 48 birds per treatment. Each group was further sub divided into 4 replicates of 12 birds each (06 males and 06 females). The average initial weight of chicks was 39±0.04g. Vaccination and other routine poultry management practices were maintained. Chicks were weighed at the beginning of the experiment and on a weekly basis thereafter. Feed and water were offered *ad libitum*.

Dichrostachys glomerata was bought at the local market, ground in a Harmed mill, sieved and incorporated in experimental diets. Antibiotic (Doxycyclin®) used in positive control diet was bought from a local veterinary pharmacy. Three experimental diets were formulated from a negative control diet (R0-) (Table 1) by incorporating 0.1% of antibiotic ($R0^{+}$), 0.2% (R0.2) and 0.4% (R0.4) of *D. glomerata* fruit powder.

Measurements and blood sampling

Data on feed intake, body weight gain were collected and used to calculate feed to weight gain ratio (FCR). At the end of the feeding trial (49 days), 10 birds (5 males and 5 females) from each treatment group were randomly selected, fasted for 24 hours and slaughtered for carcass evaluation. Blood from each slaughtered bird was collected in test tubes without an anticoagulant and left to rest for 12 hours, and the serum was then collected and preserved in the freezer for serum biochemical analysis. Animals were humanly handled in respect of the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Serum biochemical analysis

Serum biochemical analysis (using colorimetric method as prescribed by the Chronolab® commercial kits) consisted of the quantification of total proteins, urea, creatinin, aspartate aminotransferase (ASAT) and alanine aminotransferase (ALAT). The ASAT and the ALAT were quantified by applying the kinetic colorimetric method of Reitman and Frankel (1972) and Bergmeyer (1972), creatinine was assessed by the colorimetric method described by Newman and Price (1999), serum urea content by the colorimetric method described by Searcy et al. (1967) and Tobacco et al. (1979), total proteins by the Biuret's colorimetric and the bromocresol green methods as described by Gornall et al. (1949).

Production cost

The cost of a kg of feed was calculated based on the price of each ingredient as practiced in the local market. The cost of feed intake was obtained by multiplying the average feed intake by the price of a kg of the corresponding diet.The cost of production of a kilogram of live body weight was calculated by multiplying the cost of the kg of feed by the corresponding feed conversion ratio.

Ethical approval

This study was carried out in strict accordance with the recommendations of institutional guidelines for the care and use of laboratory animals. Chickens were humanly handled in respect of the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Statistical analysis

The data were analyzed using Analyses of Variance test by General Linear Model procedure of Statistical Package for Social Science (SPSS 21.0) software. The differences observed were tested using a Duncan's multiple range's test and probability values less than 0.05 were considered as significant (**Steel and Torrie, 1980**).

Table 1. Proximate nutrients composition and price of experimental diets

Ingredients (%)	**Starter**	**Finisher**
Maize	59	60
Wheat grain	3	8
Soybean Meal 49	23	13
Coton meal	3	6
Fish meal	5	5.5
Borne meal	0.5	0.5
Osher shell meal	0.5	0.5
Palm oil	1	1.5
Premix 5%*	5	5
Total	100	100
Calculated proximate nutrients composition		
Metabolizable Energy (kcal/kg)	2961.71	3005.80
Crude Protein (%)	23.32	20.54
Energy/protein	126.98	146.37
Lysine (%)	1.4	1.20
Methionine (%)	0.48	0.45
Calcium (%)	1.11	1.32
Phosphore (%)	0.54	0.58
Crude fibre (%)	4.76	4.91
Price (francs CFA/ kg)	311	283.75

Premix 5%: crude proteins=40%, Lys=3.3%, Meth=2.40%, Ca=8%, P=2.05%, Metabolizable energy=2078kcal/kg

RESULTS

Performances and carcass traits

The incorporation of *D. glomerata* in the diet significantly improved (P<0.05) growth performances of broiler chickens as compared to the negative control diet (Table 2). During the brooding phase (1 to 21 days), there was no significant (P>0.05) difference between treatment groups for feed intake. Throughout the production period (1 to 49 days), the lowest feed intake was recorded with *D. glomerata* as compared to the negative and positive control diets.

The inclusion of *D. glomerata* in the diet tends to increase BW and BWG as compared to negative control diet (Table 2). The highest BW and BWG were recorded with the antibiotic ($R0^+$) irrespective of the study phases followed by 0.2% of *D. glomerata*. However, BWG of chickens fed on diet supplemented with 0.2% *D. glomerata* during the brooding phase (1-21 days) were comparables to the control diets. During the finisher phase (22 to 49 days) and throughout the experimental period (1 to 49 days), BWG had an upward trend with inclusion of *D. glomerata* in the diet.

During finisher phase and throughout the production period, FCR was significantly higher with the negative control diet without any supplement as compared to diets supplemented with antibiotic and *D. glomerata*. However, the lowest FCR were recorded with antibiotic and 0.2% *D. glomerata.*

The effects of *D. glomerata* incorporation level on carcass characteristics of broiler chickens are presented in Table 3. Except for the relative weight of the head, all the carcass parameters were not significantly (P>0.05) affected by the inclusion of this phytobiotic in the diet.

Cost of production

Irrespective of the study phase, dietary inclusion of *D. glomerata* led to a significant decrease (P<0.05) in the

cost of production as compared to the positive control diet (R0+) which recorded the highest cost of feed intake and cost of production of a kg of chicken (Table 4).

Serum biochemical parameters

The effects of *D. glomerata* inclusion level on serum biochemical parameters of broiler chickens are presented in Table 5. Serum content in protein, urea and ALAT were not significantly (P>0.05) affected by the inclusion of *D. glomerata* in the rations whereas creatinine content significantly decreased (P<0.05) with increasing level of this phytobiotic. The ration R0.4 containing the highest level of *D. glomerata* induced the lowest level of creatinine as compared to the positive and the negative control diets. The reverse trend was recorded in serum content of ASAT with the highest concentration recorded in chickens fed on the highest level of this phytobiotic as compared to the control diets ($R0^-$ and $R0^+$).

Table 2. Growth performances of broiler chickens as affected by *Dichrostachys glomerata* from one to 49 days

Study phases (days)		Rations				SEM	P
		$R0^-$	**$R0^+$**	**R0.2**	**R0.4**		
Feed intake (g)	1 – 21	1003.29^{a}	1024.38^{a}	988.42^{a}	994.06^{a}	6.36	0.204
	22 – 49	4746.38^{bc}	4825.37^{c}	4602.53^{ab}	4509.66^{a}	39.85	0.006
	1 – 49	5749.67^{bc}	5849.74^{c}	5590.95^{ab}	5503.73^{a}	42.22	0.003
Body weight (g)	1 – 21	763.92^{ab}	774.60^{b}	742.29^{ab}	732.38^{a}	6.59	0.070
	22 – 49	2584.00^{a}	2929.83^{b}	2702^{a}	2604.97^{a}	41.42	0.001
Body weight gain (g)	1 – 21	726.96^{ab}	737.64^{b}	705.33^{ab}	695.42^{a}	6.59	0.070
	22 – 49	1820.08^{a}	2155.22^{b}	1959.71^{a}	1872.59^{a}	39.73	0.002
	1 – 49	2547.04^{a}	2892.87^{b}	2665.04^{a}	2568.01^{a}	41.42	0.001
Feed conversion ratio	1 – 21	1.38^{a}	1.39^{a}	1.40^{a}	1.43^{a}	0.01	0.281
	22 – 49	2.62^{b}	2.24^{a}	2.35^{a}	2.41^{a}	0.04	0.04
	1 – 49	2.26^{c}	2.02^{a}	2.10^{ab}	2.14^{b}	0.03	0.002

a, b, c: Means with the same superscript on the same row are not significantly different (P>0.05). SEM= standard error of mean. p= probability, **$R0^-$ =** control diet (without any additive); **$R0^+$** = $R0^-$ + 0.1% of Doxycycline® ; **R0.2 =** $R0^-$ + 0.2% of fruit powder of *D. glomerata* ; **R0.4**= $R0^-$ + 0.4% of fruit of powder of *D. glomerata*

Table 3. Carcass characteristics of broilers fed on diets supplemented with the fruit powder of *D. glomerata* at 49 days

Parameters (%BW)	Treatments				SEM	P
	$R0^-$	**$R0^+$**	**R0.2**	**R0.4**		
Carcass yield	74.29^{a}	76.66^{a}	74.61^{a}	74.60^{a}	43.92	0.218
Head	2.27^{b}	2.01^{a}	2.17^{ab}	2.24^{b}	1.40	0.044
Leg	3.43^{a}	3.36^{a}	3.36^{a}	3.59^{a}	3.10	0.705
Liver	1.79^{a}	1.62^{a}	1.54^{a}	1.77^{a}	1.04	0.178
Heart	0.47^{a}	0.46^{a}	0.44^{a}	0.45^{a}	0.48	0.968
Pancreas	0.16^{a}	0.19^{a}	0.14^{a}	0.20^{a}	0.30	0.292
Gizzard	1.57^{a}	1.43^{a}	1.50^{a}	1.62^{a}	0.99	0.945
Abdominal fat	1.68^{a}	1.39^{a}	1.48^{a}	1.27^{a}	2.61	0.195

a, b: means on the same row with different superscripts are significantly different (P < 0.05). SEM= standard error of mean. P= probability. $R0^-$ = control diet (without any additive); $R0^+$ = $R0^-$ + 0.1% of Doxycycline® ; R0.2 = $R0^-$ + 0.2% of fruit powder of *D. glomerata* ; R0.4= $R0^-$ + 0.4% of fruit of powder of *D. glomerata*

Table 4. Effects of *Dichrostachys glomerata* on production costs of broiler chickens from one to 49 days

Study phases (days)		Treatments				SEM	P
		R0$^-$	R0$^+$	R0.2	R0.4		
Cost of feed intake (FCFA)	1 - 21	312.02^a	395.41^b	309.37^a	313.13^a	9.54	0.00
	22 - 49	1346.79^a	1731.10^b	1315.17^a	1297.66^a	46.81	0.00
	1 - 49	1658.81^a	2126.51^b	1624.55^a	1610.79^a	56.05	0.00
Cost of production of kg of live weight (FCFA)	1 - 21	429.44^a	536.36^c	438.57^{ab}	450.55^b	11.32	0.00
	22 - 49	743.17^b	803.65^c	671.38^a	693.61^{ab}	15.05	0.00
	1 - 49	652.49^b	735.23^c	609.66^a	627.67^{ab}	13.18	0.00

a, b. c: means along the same row with different superscripts are significantly different (P < 0.05). SEM= standard error of mean. P= probability. R0$^-$ = control diet (without any additive); R0$^+$ = R0$^-$ + 0.1% of Doxycycline® ; R0.2 = R0$^-$ + 0.2% of fruit powder of *D. glomerata* ; R0.4= R0$^-$ + 0.4% of fruit of powder of *D. glomerata*

Table 5. Serum biochemical parameters of broilers fed on diets supplemented with *Dichrostachys glomerata*

Parameters	Treatments				SEM	P
	R0$^-$	R0$^+$	R0.2	R0.4		
Protein (g/dl)	2.48^a	2.57^a	2.45^a	2.61^a	0.27	0.604
Urea (mg/dl)	1.02^a	1.32^a	0.78^a	1.31^a	0.37	0.146
Creatinin (UI/L)	1.20^b	1.08b	0.81^{ab}	0.56^a	0.33	0.020
ALAT (UI/L)	19.83^a	15.83^a	13.28^a	21.33^a	5.60	0.229
ASAT (IU/L)	123.67^a	121.36^a	204.00^b	220.00^b	51.52	0.002

a, b, c: means on the same row with different superscripts are significantly different (P < 0.05). SEM= standard error of mean. P= probability. R0$^-$ = control diet (without any additive); R0$^+$ = R0$^-$ + 0.1% of Doxycycline® ; R0.2 = R0$^-$ + 0.2% of fruit powder of *D. glomerata* ; R0.4= R0$^-$ + 0.4% of fruit of powder of *D. glomerata*

DISCUSSION

Positive features of plant extract, essential oils and spices are being increasingly used as feed additives in poultry farms. They contain active substances and their activity vary to a great extent between plant species, depending also on the harvesting period, technology of drying and extraction processes. Beneficial effects of plant extract and spices related to their bioactive compounds such as flavonoids that affect feed intake in poultry were reported in many recent studies (Khaligh et al., 2011; Khan et al., 2012). In the present study the *Dichrostachys glomerata* supplementation did not improve broiler feed intake. It induced a significant (P<0.05) decrease as compared to the control (positive and negative) diets. This result contradicted the findings of Herawati (2010), who reported that the incorporation of 2% of ginger (*Z. officinal*) in broiler feed increased their feed intake. The decrease in feed intake in the present study could be due to the strong odor of this spice. As reported by Hernandez et al. (2004), optimization of feed intake with feed additives from plant origin is controversial and depends on the amount and duration of administration.

Throughout the study period, the BW and the BWG of the birds fed on diets supplemented with the fruit powder of *D. glomerata* were higher as compared to chickens fed on the negative control diet but lower than chickens fed on positive control diet supplemented with antibiotic (R0$^+$). This result is similar to the findings of Vivian et al. (2015) who reported that the aqueous extract of ginger markedly improved the growth performances of chickens. The present result contradicted the findings of El-Deek (2012) who reported that the incorporation of Hot Pepper (*Capsicum annuum*) at 1.5g/kg in broiler feed induced an increase in BW and BWG of about 21.2% above the weight of the batches consuming the diet

supplemented with the antibiotic (Oxytetracycline). The improvement in BWG with this spice could be attributed to their antimicrobial properties and impact on gut function (Alloui, 2011; Jane et al., 2014). In fact, this spice contains phenolic and flavonoïds compounds which act by forming the complexes with many proteins, cause the destructuration of the bacterial membranes, making unavailable certain substrates for the bacteria and inactivate bacterial enzymes (Abdou Bouba et al. 2012).Thus the reduction of the microbiota could lead to a greater availability of some nutriments for the host and consequently improve BWG. This is in agreement with Mcmullin (2000) who observed that the growth promoting effect of most herbs and extracts of spices act by killing parasites that hinder digestibility and growth performance of birds. Moreover, the secondary metabolites present in the spices exhibited antioxidant properties and it could be probably the case with *this spice*. Several studies reported that phytobiotics improved intestinal health, animals are less exposed to microbial toxins and other undesired microbial metabolites (Nuhu et al. 2000; Kambizi and Afolayan, 2001). As a result, animals are relatively relieved from immune defense stress during critical situations and there is increased availability of essential nutrients for absorption, thereby helping the animals to grow better within the framework of their genetic potential. The low performances recorded with the fruit of *D. glomerata* compared to antibiotic could be explained by the presence of the high content of tannins in this spice (281mg/100g) (Abdou Bouba et al., 2010) which would have unably used digestive nutrient like protein by chickens. Odoemelam et al. (2013) reported that the favorable attributes of spices can be masked by tannins which affect the use of the nutrients and depress growth.

Incorporation of phytobiotic in the diet have led to a significant ($P<0.05$) reduction of FCR as compared to negative control diet (R0-). This result is in close agreement with the findings of Al-harthi (2002) who recorded a decrease in FCR with the inclusion of 0.3% of *Capsicum annum* in broiler feed. The decrease in feed conversion ratio can be understood because of the increase in the body weight gain of birds fed on *Dichrostachys glomerata*. Furthermore, this is in agreement with Mcmullin (2000), Nuhu et al. (2000), Okerulu and Chinwe (2001), Kambizi and Afolayan (2001) and Abdou Bouba (2012) who reported that most herbs and extracts of spices work as growth promoters by killing parasites that hinder digestibility and growth performances of birds.

The serum content of urea and proteins were not affected ($P>0.05$) by the supplementation of feed with *D. glomerata*. This suggests that the inclusion of *D. glomerata* fruit powder in broiler diet does not have harmful effects on kidney function (serum rate of urea) and the immune system (serum protein rate).This result contradicts the study of Zhang et al. (2009) which revealed that the incorporation of the powder of ginger (*Z. officinal*) in broiler feed increased their total protein ratio. It can be explained by the presence of active substances such as gingerole, shogaoles, gingerdiole and the gingerdione in ginger (Kikuzaki and Nakatani, 1996; Zhang et al, 2009; Zhao et al., 2011) which are absent in *D. glomerata* fruit. In addition, the serum creatinin content rather decreased with *D. glomerata* in the feed. This fall materializes the presence of active substances in this phytobiotic, allowing the correct function of the kidneys. The serum contents of ALAT (alanine amino-transferase) and ASAT (aspartate amino-transferase), were not significantly affected by the incorporation of 0.2 and 0.4% of *D. glomerata* in their diet. However, the serum content in ALAT and ASAT had an upward trend with the increasing rate of this additive in feed. This observation contradicted the finding of Rehman et al. (2011) who reported that feeding broiler with a mixture of aqueous extracts of medicinal plants induced a reduction in ALAT and ASAT ratios. This contradiction can be due to the multitude of the active compounds in the mixture of the extracts used by these authors which could have affected liver function.

CONCLUSION

This study revealed that 0.2% *D. glomerata* fruit powder is a profitable feed supplement since it is produced at a relative low cost meat and can then be used as good alternative to antibiotics growth promoters in broiler diet. The dietary supplementation of *D. glomerata* powder can lead to the production of antibiotics residues free chicken meat as demanded by consumers.

Competing interests

The authors declare that they have no competing interests.

Author's contributions

Ngouana, Komguep, Yangoue and Tsafong went to the field to carry out the research and collect the samples. Kana supervised the overall research work. Mube wrote the first draft before being revised by Kana and Teguia, and approved by all the authors.

Consent to publish

All persons gave their informed consent prior to their inclusion in the study.

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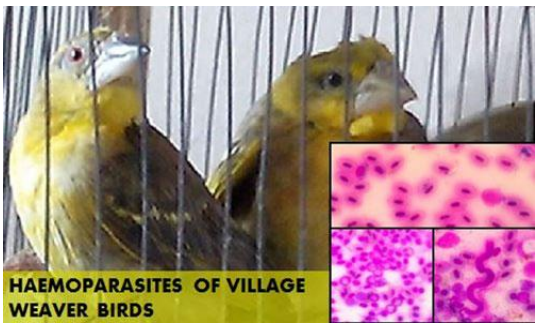

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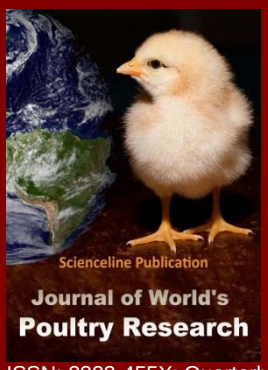

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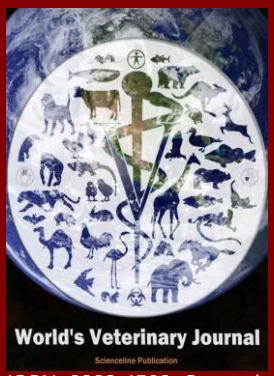

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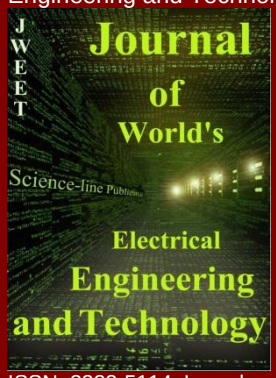

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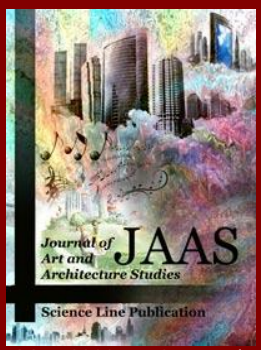

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