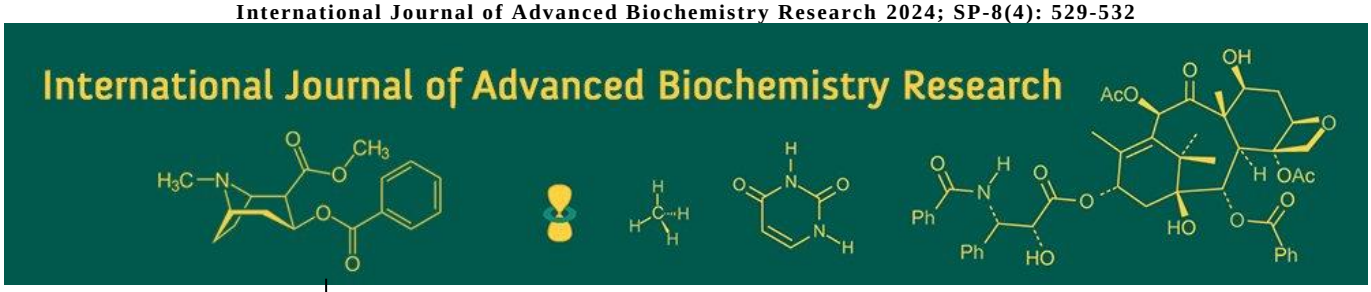

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Effect of dietary supplementation of Arjun bark powder on production and egg quality parameters in Uttara layers

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Abstract
In the present investigation, a feeding trial of 12 weeks of duration was conducted on 96 Uttara layers of 20 week age to study the effect of dietary supplementation of Arjun (*Terminalia arjuna*) bark powder on the production performance and egg quality parameters. The laying hens were randomly divided in to four treatment groups (T_0, T_1, T_2 and T_3) and each treatment having four replications of six birds. Supplementation with Arjun bark powder was done at the rate of 0, 1g, 2g, and 4g/100gm respectively to standard feed. Egg production and Egg quality parameters were studied in different Phase I (26th week of age), Phase II (32nd week of age) and overall period. The results of the present trial indicated that dietary inclusion of Arjun bark powder increase egg production and egg weight and it also improves feed conversion ratio significantly ($P \leq 0.05$) in T_2 group. The shell thickness increases significantly however no significant difference observed in other egg quality traits. From the results of present study, it can be concluded that Arjun bark can be used as herbal feed additive/ Phyto biotic in poultry diet for higher production by incorporating 2 percent of Arjun (*Terminalia arjuna*) bark powder in the basal diet of Uttara chicken.

Keywords: Arjun bark powder, egg production, egg quality parameters, feed conversion ratio

Introduction
Poultry farming is a significant industry in India because of its huge potential for quick economic expansion, which benefits the poorest section of the population in particular due to the little investment required. Eggs and poultry meat are protective foods that are also the cheapest sources of high-quality animal protein in India. Poultry production has evolved from a simple household/backyard farming to a full-fledged industry as demand for poultry products has grown. The most hygienic circumstances and excellent application of scientific knowledge have resulted in spectacular development in Indian poultry. Poultry includes chickens, turkeys, geese and ducks, is a large category of domesticated food animals reared for meat or eggs. The chicken (*Gallus gallus domesticus*), a subspecies of the red jungle fowl, is a domesticated fowl. In India, chicken production has increased dramatically during the previous few decades because of variety of current growth-promoting methods as well as disease-prevention measures (Kataria *et al.*, 2005; Angelakis *et al.*, 2013) [6, 1].

In India indigenous Chicken breeds are rapidly gaining popularity due to their distinctive characters. These breeds have ability to survive in variety of climates. Local farmer sometimes favours these native varieties because these take very little input to raise. They have high level of illness tolerance and do well on local forage. They can also be excellent mothers. In addition to providing meat and eggs for consumption and income, indigenous chickens serve as an investment and a source of security for rural households (Muchadeyi *et al.*, 2007) [7].

Feed additives are a set of nutrient and non-nutrient substances that aid in enhancing feed utilisation efficiency and thereby lowering feed costs. Phytochemicals, also known as Phyto biotics or phytogenic, are naturally occurring bioactive molecules obtained from plants that are added to animal feed to improve production (Gadde *et al.*, 2017) [2]. *Terminalia arjuna*is an essential medicinal herb in ayurveda belonging to Combretaceae family. Arjuna, Indradu,

Partha and Veeravriksha are some of the names given to it (Sharma *et al.* 2005) [10]. *Terminalia arjuna* is about 60–80 feet in height, buttressed trunk and horizontally spreading crown and drooping branches distributed in India, Burma, Mauritius, and Sri Lanka (Kapoor *et al.* 2014) [5].

Materials and Methods

The location of study

This study was conducted with a total of 96 Uttara layers of 20-week age at Instructional Poultry Farm, Nagla, College of Veterinary and Animal Sciences, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, for a period of 12 weeks of duration to examine the effect dietary supplementation of Arjun bark powder on Egg production and Egg quality parameters.

Experimental design and diets

A total of 96 Uttara layers of 20-week-old experimental birds were randomly distributed to 4 treatment groups. Each treatment was divided into four replicates having 6 birds in each. So, each treatment group had 24 layers. The ration was formulated as per BIS (2007) Specification. The control group (T0) was fed a basal diet having no Arjun bark powder. While the rations T_1, T_2 and T_3 are supplemented with Arjun bark powder was done at the rate of 1g, 2g, and 4g/100gm respectively to standard feed.

Observations recording

Daily egg production was recorded replicate by replicate during the experiment and was divided by the total number of hens available in each replicate to calculate egg production percentage. The quantity of eggs was collected twice a day and collected on egg box attached to each Ingredient. Data on daily egg production was compiled and divided into two phases, the first of which ended on the 6th week of the experiment and the second on the 12th week.

Records of the food served to different treatment groups were kept. Left over feed was weighed daily. The feed intake in different groups was drawn by deducting the weight of left over feed from the weight of total feed offered during the experimental period in the starting and after 3-week, 6-week, 9-week and 12-week intervals of the trial and the weight of each layer hen in each treatment group was recorded. The weight gain of each layer was recorded in both phase I and phase II.

For the purpose of calculating egg mass, the number of eggs produced over the course of two weeks was recorded and the amount of feed consumed during that time was also recorded. The FCR tells about the efficiency of animal to convert feed in to food. The lower the FCR the more efficient the animals are in converting feed in to food. Feed conversion ratio on egg mass basis was calculated by dividing Feed consumed in grams by total egg mass in grams. Feed conversion ratio on per dozen egg basis was calculated by dividing Feed consumed in kilograms by dozen eggs.

2 eggs from each replicate at the end of phase's I and II were used for egg quality measures. The eggs were first individually weighed before shattered to examine the characteristics of the egg quality. 32 eggs in total were utilized for each phase's egg quality attributes. Electronic balance was used to calculate weight of egg, egg shell, albumen and yolk. A digital Vernier calliper was used to calculate length and width of egg, width of thick albumen and yolk. Dial indicator was used to calculate height of thick albumen and yolk. Screw gauge was used to calculate thickness of egg shell. Shape Index, Albumen Index, Yolk Index and Haugh Unit were calculated manually by formulas.

Statistical analysis

Statistical analysis was done with help of one-way ANOVA (for more than two groups of data) using SPSS software package version 22.0. The significant mean differences were separated by Tukey post-hoc analysis with significance level defined at $p<0.05$.

Results and Discussion

The data collected over the course of the research was compiled, statistically analysed, evaluated, and discussed as following.

Chemical composition of Arjun bark powder

Chemical composition of Arjun bark powder calculated by proximate analysis.

Table 1: Chemical composition of Arjun (*Terminalia arjuna*) bark powder (on % dry matter basis)

Sl. No.	Parameter	Chemical composition
1.	Moisture	6.15 %
2.	Crude Protein	3.99 %
3.	Crude Fibre	12.5 %
4.	Ether Extract	4.5 %
5.	Ash	31 %
6.	Nitrogen Free Extract	48.01%

Effect on body weight

The average body weights on 20th week, 26th week and 32nd week age of bird was observed as given in Table 2. The body weight gain in T_0, T_1, T_2 and T_3 in Phase I and II were observed as given in Table 3. There was no significant difference observed in the weight gain in different groups. The weight gains in T_2 and T_3 was less than weight gain in T_1 and Control. Opeoluwa *et al.* (2021) [8] reported a significant increase in weight gain in Baobab tree bark supplementation in broiler chickens which is not in agreement with present findings.

Table 2: Means ± S.E. of body weight (Kg) of Uttara layers during experimental period.

AGE	T_0	T_1	T_2	T_3
20 Week	1.24± 0.02	1.08±0.03	1.09±0.03	1.42±0.06
26 Week	1.39±0.02	1.21±0.03	1.20±0.02	1.52±0.06
32 Week	1.52±0.02	1.36±0.03	1.28±0.02	1.63±0.06

Table 3: Means ± S.E. of body weight gain (Kg) of Uttara layers during experimental period.

Weight Gain	T_0	T_1	T_2	T_3
Phase I	0.14±0.01	0.14±0.01	0.09±0.01	0.10±0.02
Phase II	0.14±0.01	0.14±0.01	0.10±0.01	0.10±0.02

Effect on production performance

The average egg production in different groups T_0, T_1, T_2, T_3 in Phase I, Phase II and overall period were observed as given in Table 4. The average egg production of the T_0 group was significantly lower ($P<0.05$) than that of the

Arjuna bark supplemented groups T_1 and T_2, and significantly greater ($P<0.05$) than that of the Arjuna bark supplemented group T_3. The results of this study revealed that Arjun bark supplementation increased egg production among laying hens in the T_1 and T_2 groups by a significant ($P<0.05$) amount, which could be due to Arjun bark's growth promotive, anti-stress, antioxidative, antibacterial, antiviral, anthelmintic and hepatoprotective properties. Arjun bark has a nutritive effect, as it contains many essential elements such as calcium, magnesium, potassium, chlorine, iron, chromium, manganese and zinc all of which are thought to be important for cellular metabolism.

The average feed consumption per bird per day in T_0, T_1, T_2 and T_3 groups in Phase I, Phase II and overall period were observed as given in Table 4. Mean feed Intake in all the groups decreased from T_0 to T_3 but non significantly. Reid and Weber (1975) [9] suggested that high levels of dietary fat, cause a decrease in feed consumption. *Terminalia arjuna* contain more fat than the basal feed hence as fat increases in treatment group from T_1 to T_3 the feed intake decreases. These findings match with Hamood and Abdalhussain (2018) [3] those found that treatment of Terminalia chebula powder result in a significant decrease in feed intake in treated group as compared to control group.

Table 4 shows the average Feed Conversion Ratio egg mass basis and per dozen egg basis of laying hens over Phase I, II and the overall period. The average FCR egg mass basis of the T_0 group was significantly poor ($P<0.05$) than that of the Arjuna bark supplemented groups T_2, and significantly better ($P<0.05$) than that of the Arjuna bark supplemented group T_3. T_1 and T_2 were significantly better ($P<0.05$) than T_3 in FCR. The average FCR per dozen egg basis of the T_0 group was significantly poor ($P<0.05$) than that of the Arjuna bark supplemented groups T_1 and T_2, and significantly better ($P<0.05$) than that of the Arjuna bark supplemented group T_3. Jha *et al.* (2015) [4] found that in poultry diets, dietary fibre has been regarded as an anti-nutritional component and diluents. Dietary Fibre shows a substantial negative relationship between fibre content and protein and fat digestion. As a result, increasing fibrous components in the diet lower chicken growth performance and nutrient retention that in turns increase the FCR value that was seen in T3 group in present study.

Table 4: Least square Means ± S.E. of Production performance of Uttara layers. (20 weeks to 32 weeks of age)

Traits	Period	T_0	T_1	T_2	T_3
Hen housed egg production (%)	I Phase	42.04^{b}±0.49	48.61^{c}±0.46	49.17^{c}±0.51	29.72^{a}±0.32
	II Phase	49.54^{b}±0.55	60.92^{c}±0.72	62.50^{c}±0.61	38.61^{a}±0.71
	Overall	45.78^{b}±1.46	54.77^{c}±2.36	55.83^{c}±2.55	34.17^{a}±1.72
Feed intake (g/day)	I Phase	91.70^{d}±0.19	89.42^{c}±0.21	88.23^{b}±0.10	87.31^{a}±0.24
	II Phase	106.87^{d}±0.10	103.75^{c}±0.11	102.75^{b}±0.11	101.69^{a}±0.09
	Overall	99.28±2.86	96.58±2.71	95.49±2.74	94.50±2.71
FCR (feed consumed/egg mass)	I Phase	3.99^{b}±0.10	3.56^{ab}±0.07	3.32^{a}±0.16	5.46^{c}±0.19
	II Phase	3.94^{b}±0.07	3.30^{ab}±0.07	3.04^{a}±0.16	4.91^{c}±0.24
	Overall	3.96^{b}±0.06	3.43^{a}±0.07	3.18^{a}±0.12	5.18^{c}±0.18
FCR (feed consumed in kg/ dozen egg)	I Phase	2.62^{b}±0.03	2.21^{a}±0.02	2.15^{a}±0.02	3.53^{c}±0.04
	II Phase	2.59^{b}±0.03	2.04^{a}±0.02	1.97^{a}±0.02	3.16^{c}±0.06
	Overall	2.60^{b}±0.02	2.13^{a}±0.03	2.06^{a}±0.04	3.34^{c}±0.07

Effect on egg quality

The average egg weight of eggs during Phase I, Phase II and overall period in different treatment groups were observed as given in Table 5, 6 and 7. Higher egg weight recorded in T_3 group and lower egg weight recorded in T_0 group. Though the egg weights were found in increasing manner but there was non-significant difference observed in Phase I and Phase II among the groups. In overall period the egg weight significantly increases from control towards the treatment groups. The shell thickness values of Arjun bark supplemented group T_1, T_2 and T_3 were significantly higher ($P<0.05$) than T_0. Since, Arjun bark contains various phenolics and high calcium concentration that is responsible for increase in shell thickness significantly.

Table 5: Least square Means ± S.E. of egg quality traits of Uttara layers during phase I. (20 weeks to 26 weeks of age)

Traits	T_0	T_1	T_2	T_3
Egg weight (g)	51.97±0.43	53.95±0.62	54.33±1.46	54.65±1.38
Shape Index	73.85±0.52	73.89±0.66	75.79±0.58	75.04±0.96
Albumen Index	8.47±0.24	8.18±0.22	8.13±0.15	8.30±0.18
Yolk Index	42.82±1.30	43.13±1.18	43.57±1.33	43.61±1.34
Haugh Unit	79.75±1.05	77.61±1.14	76.89±0.96	77.65±1.11
Shell thickness(mm)	0.38^{a}±0.01	0.41^{b}±0.01	0.43^{b}±0.00	0.43^{b}±0.01
Albumen weight(g)	28.77±0.52	28.79±0.51	28.89±0.52	28.94±0.49
Yolk weight(g)	16.80±0.44	16.99±0.39	17.18±0.32	17.49±0.37
Shell weight(g)	6.16±0.16	6.19±0.16	6.19±0.17	6.36±0.05

Mean bearing different superscript column wise differ significantly ($P\leq0.05$)

Table 6: Least square Means ± S.E. of egg quality traits of Uttara layers during phase II. (26 weeks to 32 weeks of age)

Traits	T_0	T_1	T_2	T_3
Egg weight (g)	52.09±0.38	54.36±1.23	54.46±0.54	54.96±1.33
Shape Index	73.90±0.62	74.34±0.64	74.53±0.55	74.47±0.71
Albumen Index	8.38±0.14	8.18±0.18	8.36±0.21	8.12±0.20
Yolk Index	45.51±0.65	43.23±1.38	42.18±1.45	44.00±0.80
Haugh Unit	79.02±0.67	77.37±0.91	78.09±1.27	76.95±1.27
Shell thickness(mm)	0.37^{a}±0.01	0.42^{b}±0.01	0.43^{b}±0.01	0.44^{b}±0.00
Albumen weight(g)	27.95±0.21	28.53±0.40	29.43±0.53	29.48±0.56
Yolk weight(g)	16.99±0.43	17.00±0.43	17.07±0.33	17.14±0.33
Shell weight(g)	6.16±0.16	6.21±0.05	6.27±0.16	6.27±0.17

Mean bearing different superscript column wise differ significantly ($P \leq 0.05$)

Table 7: Least square Means ± S.E. of egg quality traits of Uttara layers during Overall Period. (20 weeks to 32 weeks of age).

Traits	T_0	T_1	T_2	T_3
Egg weight (g)	52.03^{a}±0.28	54.15^{ab}±0.67	54.40^{ab}±0.75	54.80^{b}±0.93
Shape Index	73.88±0.39	74.12±0.45	75.16±0.42	74.75±0.58
Albumen Index	8.43±0.13	8.18±0.14	8.24±0.13	8.21±0.13
Yolk Index	44.17±0.78	43.18±0.88	42.87±0.96	43.81±0.75
Haugh Unit	79.38±0.61	77.49±0.70	77.49±0.78	77.30±0.82
Shell thickness(mm)	0.37^{a}±0.01	0.43^{b}±0.01	0.43^{b}±0.01	0.44^{b}±0.00
Albumen weight(g)	28.42±0.30	28.66±0.32	29.10±0.37	29.21±0.37
Yolk weight(g)	16.93±0.27	17.06±0.25	17.09±0.26	17.25±0.28
Shell weight(g)	6.16±0.11	6.20±0.08	6.23±0.12	6.32±0.08

Mean bearing different superscript column wise differ significantly ($P \leq 0.05$)

Conclusion

Based on above findings, it is concluded that supplementation of Arjun bark powder in the basal diet of laying hens increased the egg production and improve feed conversion ratio with best effect observed at 2% inclusion levels. Egg weight and Shell thickness were improved in Arjun bark supplemented groups. Arjun bark can be used as herbal feed additive/ Phyto biotic in poultry diet for higher production by incorporating 2 percent of Arjun (*Terminalia arjuna*) bark powder in the basal diet of Uttara chicken.

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Conflict of Interest

There is no conflict regarding this research.

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