The Pharma Innovation Journal 2022; SP-11(10): 362-366

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(10): 362-366

www.thepharmajournal.com
Received: 07-07-2022
Accepted: 11-08-2022

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Effect of substituting rice polish with mulberry (*Morus alba*) leaf powder on average weekly feed intake and egg production of commercial laying hens

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Abstract
The present study was conducted to determine the effect of replacing rice polish with mulberry (*Morus alba*) leaf powder on the average weekly feed intake and egg production of commercial laying hens. A 12-week feeding experiment was conducted on 72 White Leghorn laying chickens of 28 weeks of age. Hens were randomly assigned to one of four treatment groups, each having 18 birds and three replicates of six birds. T_1 (control) hens were fed a basal diet that included rice polish as one of the feed ingredients, but in T_2, T3, and T_4 treatment groups, rice polish was replaced with mulberry leaf powder at 1/3rd, 2/3rd, and full levels, respectively. The results revealed that substituting mulberry leaf powder for rice polish had no effect on cumulative performance of laying hens in terms of feed intake and egg production (p>0.05). According to the findings of this study, rice polish (up to 4.5 percent in the diet) can be completely substituted for mulberry leaf powder in chicken feed without affecting the performance of the laying hens. Furthermore, because mulberry leaves can be procured at no cost, their incorporation is cost-effective and can help reduce feed expenditures.

Keywords: Mulberry leaf powder, phytase, feed intake, egg production, rice polish

Introduction

In India, poultry production is recognized as a well-organized and scientifically based sector. India's poultry sector accounts for more than 3% of the world's poultry population and ranks third in egg production and sixth in meat output (DAHD, 2019) [5]. The poultry sector accounts for 1% of total GDP and approximately 13% of livestock GDP, and it is one of India's fastest growing sectors, with yearly growth rates of 6-8% in egg production and 10-12% in broiler chicken production. Its use for food can be traced back to the Roman Empire, which is credited with the evolution of breeds, particularly for egg production (Elson, 2011) [6]. The unavailability and consequently high costs of conventional chicken feed has hampered poultry production in the tropics. Rice polish, for example, is a major cereal by-product widely used for poultry feeding; nevertheless, its optimal utilisation is limited by the presence of antinutritional compounds such as NSP, phytin, and so on (Attia *et al*., 2003) [3] as well as adulteration with rice husk and saw dusts. As a result, there has been an increase in the search for alternative feed sources that can replace rice polish in chicken diets. Mulberry leaves can be added to the list of potential feed alternatives for chicken feeding since they provide high dry matter, protein, and minerals, as well as a high level of accessible digestible energy (comparable to rice polish) and little or no anti nutritional components. It is frequently cultivated for its leaves, which are used to raise silkworms in the sericulture industry. Mulberry leaves contain beta-carotene, which can be converted to vitamin A by chickens with various degrees of effectiveness (Moller *et al*., 2000; Srivastava *et al*., 2006) [3, 21]. Mulberry plant has also been utilised in traditional medicine to treat diabetes, hypertension, and neutral fat levels (Wu *et al*., 2013) [22]; the phenolic content with effective antioxidant qualities (Gundogdu *et al*., 2011) [7] of the plant is mostly responsible for these medicinal advantages.

Mulberry leaves have a high protein content (15-35%), minerals (2.42-4.71%), and metabolizable energy (1,130-2, 240 Kcal/kg) (Omar *et al*., 1999; Saddul *et al*., 2004) [14, 16]. The higher amino acids content of mulberry leaves may also help in compensating the adverse effect of the fibre present in the leaves. By including phytase enzyme in the basal ration, the phytate phosphorus found in mulberry leaves can be utilised. No work till date has probably been done to replace rice polish with Mulberry leaf powder, hence the following study was planned to investigate the effect of replacing rice polish with mulberry (*Morus alba*) leaf powder in diet containing phytase enzyme on average weekly feed intake and egg production in commercial laying hens.

Material and Methods

Procurement of Mulberry leaves and preparation of Mulberry leaf powder: Mulberry (*Morus alba*) leaves were procured from the local region and shade dried for 3-4 days before being sun-dried on a clean concrete surface. After that, the leaves were placed in a hot air oven set to 70 °C until they reached a constant weight. Following that, the required amount of mulberry leaves was finely processed to powder and stored in air tight polythene bags in a cold and dry place to prevent moisture.

Experimental Birds, their Housing and Management: The experiment was carried out on 72 white leghorn laying hens aged 28 weeks at the Instructional Poultry Farm, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, for a period of 12 weeks. The laying hens were housed in a deep litter system. During the trial, they were provided enough light (for 18 hours) and adequate ventilation. The chickens were fed ad libitum and had access to clean, fresh drinking water throughout the trial. The experiment was conducted in strict compliance with the guidelines of Institutional Animal Ethics Committee (IAEC), GBPUA&T, Pantnagar, India.

Experimental Design and treatments: The suggested study employed a Completely Randomized Design (CRD). For the 12-week feeding trial, four dietary treatments were prepared by substituting mulberry leaf powder for rice polish in the following proportions: control (T1): basal diet (containing 4.5% rice polish); treatment 2 (T2): 1.5% Mulberry leaf powder + 3% Rice polish; treatment 3 (T3): 3% Mulberry leaf powder + 1.5% Rice polish; and treatment 4 (T4): 4.5% Mulberry leaf powder + 0% Rice polish. All four treatment groups received the same amount of phytase enzyme (250 FTU).

Details of experimental treatment groups

Treatment Group	No. of layer chickens/ Replicate			Description of treatment
	R_1	R_2	R_3	
T_1(18 birds)	6	6	6	Basal diet containing rice polish as one of the feed ingredient (control)
T_2(18 birds)	6	6	6	Basal diet incorporated with 1/3rd replacement of rice polish with mulberry leaf powder
T_3(18 birds)	6	6	6	Basal diet incorporated with 2/3rd replacement of rice polish with mulberry leaf powder
T_4(18 birds)	6	6	6	Basal diet incorporated with complete replacement of rice polish with mulberry leaf powder

Experimental diets: According to BIS 2007 [4], four experimental diets were prepared for four separate treatment groups. Table 1 shows the dietary composition of the various treatment groups (kg/100kg). Phytase was obtained from the local market and integrated at a level of 250 FTU in all the treatment groups.

Analysis of feed samples: The feed samples from all four dietary treatment groups, were collected, and proximate analysis was performed by using the standard principles (AOAC 2003) [2]. The following parameters were determined: dry matter, crude protein, crude fibre, ether extract, ash, and NFE. The nitrogen content was calculated using the Kjeldahl technique, which was then used to compute crude protein. The Soxhlet extraction procedure was employed to estimate the ether extract, while the fat-free samples were treated with acid and alkali solution to measure crude fibre. The samples were burned in the muffle furnace at 550 °C to estimate the ash content. The nitrogen-free extract content was then estimated on a DM basis by subtracting the sum total of crude protein %, ether extract%, crude fibre% and total ash% from 100.

Production parameters

Feed intake: The feed was offered to the various treatment groups every day at 8:00 a.m., and a record was kept. In each replication, residual feed was weighed and documented weekly. The feed intake in various groups was calculated on weekly basis by subtracting the weight of left-over feed from the weight of total feed provided in each week, during the experimental feeding period.

Egg Production: Egg production in all the replicates of each treatment group was recorded daily for a period of 12 weeks. Eggs were collected twice a day, in the morning and evening, in all replicates of each treatment group. Each treatment group's weekly average egg production was reported. The following formulae were used to calculate the egg production % for each treatment group, replicate wise:

$$\text{Egg Production (\%)} = \frac{\text{Total no.of egg produced per replicate}}{\text{Total no.of hen per replicate} \times \text{Total no.of days}} \times 100$$

Statistical methods

The experimental data obtained collected from the proposed study was statistically analysed utilising one way analysis of variance (ANOVA) by general linear model procedure SPSS software (Snedecor 1994) [20]. Duncan's Multiple Range Test was used to analyse the variations in treatment means (Kramer 1957) [9].

Result and Discussion

Chemical Composition of Experimental Diets

Proximate analysis revealed that mulberry leaf powder contained a higher crude protein, crude fibre concentration and a lower ether extract concentration than rice polish as given in Table 2. The chemical composition of experimental diets fed to laying hens in different treatment groups have been presented in Table 3. According to the results of the proximate analysis, the crude protein content of all treatment groups was found to be similar and in accordance with the requirements for laying hens as specified by BIS (2007) [4]. The CF content of all treatment groups was comparatively higher than the control group due to the higher fibre content of mulberry leaf powder than rice polish, with the highest CF content in T4 group, in which rice polish was completely replaced by mulberry leaf powder, but the CF content in all groups was within the recommended level as per the BIS (2007) [4] specifications.

Production parameters

Production performance of different treatment groups T_1, T_2, T_3 and T_4 in terms of average weekly feed intake and average weekly egg production is presented in Table 4 and 5 respectively. No significant ($p>0.05$) difference was found in the average feed intake among the different treatment groups during the 1st and 2nd week of the experimental feeding trial. However, during the 3rd week, feed intake was found to be significantly ($p<0.05$) higher in treatment group T_2 (111.96 g) while, significantly lower in T_3 (108.37 g) group. The results on average feed intake suggested no statistical difference ($p>0.05$) among various treatment groups during 4th, 5th and 7th week also. However, again, during the 6th week, average feed intake of laying hens of group T_2 (112.74 g) was significantly ($p<0.05$) higher than the treatment groups T_1 (109.40 g) and T_4 (109.80 g) group. The feed intake during 8th week differed significantly ($p<0.05$) among various treatment groups. Average feed intake during 9th, 10th and 11th week in different treatment groups was also found to be non-significant ($p>0.05$), but, during 12th week of experimental feeding trial the average feed intake in all the treatment groups T_2, T_3 and T_4 was significantly ($p<0.05$) reduced as compared to the control group T_1. Although, average feed intake during 3rd, 6th, 8th and 12th week were significantly ($p<0.05$) different among various treatment groups, however, overall average feed intake per day during the experimental feeding trial in groups fed diet containing phytase enzyme and incorporated with mulberry (*Morus alba*) leaf powder in place of rice polish was non- significant ($p>0.05$). The present findings are in accordance with Lokaewmanee *et al*. (2009) [10], Al-Kirshi *et al*. (2010) [1], Olteanu *et al*. (2012) [13] and Kamruzzaman *et al*. (2014) [8] who reported a similar non-significant effect on feed intake of laying hens fed with mulberry leaves at different levels. Zhang *et al*. (2009) [23] found insignificant differences in the performance between the groups with 2 and 5% MLP supplementation in laying hens. Saenthaweesuk (2009) [17], Simol *et al*. (2012) [19] and Olteanu *et al*. (2012) [13] also reported similar non-significant effect on average daily feed intake (g/day/broiler), in the broiler birds fed with mulberry leaves. Panja *et al*. (2013) [15] showed non-significant ($p>0.05$) difference in the feed intake among different treatment groups in broiler as well as in layer chicken in two different experiments. Shelke *et al*. (2018) [18] concluded that mulberry leaf meal can be successfully added to broiler diets without affecting broiler performance.

Average Weekly Egg Production

Average weekly egg production (%) during the 12 weeks experimental feeding trial was non- significant among various treatment groups T_1, T_2, T_3 and T_4. However, the egg production percentage in the T_4 group was numerically higher as compared to T_1, T_2 and T_3 group at all weeks during the experimental feeding trial. Overall weekly egg production in the treatment groups T_1, T_2, T_3 and T_4 fed diet containing phytase enzyme and incorporated with mulberry *(Morus alba*) leaf powder by replacing rice polish was also non- significant. Hence, incorporation of mulberry leaf powder in place of rice polish had overall non- significant ($p>0.05$) effect on egg production percent of laying hens among various treatment groups. According to Lokaewmanee *et al*. (2009) [10], Olteanu *et al*. (2012) [13], and Kamruzzaman *et al*. (2014) [8], egg production in laying hens was non-significant, which is supported by the current study. On the contrary, Al-Kirshi *et al*. (2010) [1] discovered that increasing the quantity of mulberry leaf meal reduced egg production while having no effect on FCR.

Table 1: Composition of diet of different treatment groups (kg/100 kg)

Ingredients	Treatments/groups			
	T1	**T2**	**T3**	**T4**
Yellow Maize	57	57	57	57
Deoiled Rice bran	6.5	6.5	6.5	6.5
Rice polish	4.5	03	1.5	-
Mulberry leaf powder	-	1.5	03	4.5
Groundnut cake-solvent extracted	09	09	09	09
Soyabean meal	18	18	18	18
Marble powder	03	03	03	03
Dicalcium Phosphate	01	01	01	01
DL- methionine	0.15	0.15	0.15	0.15
Choline Chloride	0.10	0.10	0.10	0.10
Mineral mixture	0.10	0.10	0.10	0.10
Common salt	0.40	0.40	0.40	0.40
Hepatocare	0.10	0.10	0.10	0.10
Vitamin Premix	0.10	0.10	0.10	0.10
Toxin binder	0.05	0.05	0.05	0.05
Total	100	100	100	100

Table 2: Chemical Composition of Mulberry (*Morus alba*) leaf powder and rice polish (on % dry matter basis)

Particulars	Mulberry leaf powder	Rice polish
Crude protein	15.64	12.75
Ether Extract	5.48	8.67
Crude fibre	14.24	5.26
Total ash	10.36	9.54
Nitrogen Free Extract	54.28	63.78

Table 3: Chemical composition of layer ration (% dry matter basis) of different treatment groups

Nutrients	Treatments/groups			
	T_1 (Basal diet containing rice polish as one of the feed ingredient)	**T_2 (1/3rd replacement of rice polish with mulberry leaf powder)**	**T_3 (2/3rd replacement of rice polish with mulberry leaf powder)**	**T_4 (Complete replacement of rice polish with mulberry leaf powder)**
Crude protein	17.76	17.94	17.87	18.22
Ether extract	3.82	3.25	3.98	3.40
Crude fibre	4.21	4.86	4.32	5.95
Ash	8.05	8.15	7.66	6.84
Nitrogen Free Extract	66.16	65.80	66.17	65.59

Table 4: Average weekly feed intake (gm/day) of White Leghorn laying hens fed diet incorporated with Mulberry *(Morus alba*) leaf powder by replacing rice polish

Week	Treatments/groups					
	T_1 (Basal diet containing rice polish as one of the feed ingredient)	T_2 (1/3rd replacement of rice polish with mulberry leaf powder)	T_3 (2/3rd replacement of rice polish with mulberry leaf powder)	T_4 (Complete replacement of rice polish with mulberry leaf powder)	SE_m value	CD at 5%
1	110.37±0.14	112.02±1.06	110.91±1.17	110.40±1.48	1.088	3.548
2	109.62±0.54	110.74±0.09	110.05±1.69	110.07±0.10	0.895	2.919
3*	109.82^{ab}±0.80	111.96^{a}±0.48	108.37^{b} ±1.55	109.56^{ab}±0.28	0.917	2.990
4	110.56±0.93	111.72±0.28	110.88±0.24	109.70±0.90	0.677	2.206
5	110.04±0.38	111.20±0.30	109.40±1.63	109.01±1.00	0.991	3.230
6*	109.4^{b}±0.42	112.74^{a}±0.89	111.66^{ab}±0.60	109.80^{b}±0.91	0.739	2.447
7	109.93±0.17	110.18±0.31	109.38±2.21	107.96±0.90	1.209	3.943
8*	109.06^{b}±0.24	111.12^{ab}±1.21	112.52^{a}±0.57	110.89^{ab}±0.52	0.732	2.386
9	110.01±1.39	111.08±0.39	110.85±0.28	109.39±0.99	0.892	2.907
10	110.63±1.15	111.25±1.62	109.86±1.32	111.40±1.40	1.388	4.526
11	110.29±0.12	109.70±0.63	109.17±1.40	109.16±0.64	0.836	2.727
12*	111.03^{a}±0.46	107.00^{b}±0.01	106.86^{b}±0.90	108.37^{b}±1.21	0.793	2.625
Average intake/day	110.06±0.28	110.89±0.04	109.99±0.70	109.64±0.18	0.395	1.286

a,b Mean values bearing different superscripts within a row differ significantly from each other, *P<0.05

Table 5: Average weekly egg production (%) of White Leghorn laying hens fed diet incorporated with Mulberry *(Morus alba*) leaf powder by replacing rice polish

Week	T_1 (Basal diet containing rice polish as one of the feed ingredient)	T_2 (1/3rd replacement of rice polish with mulberry leaf powder)	T_3 (2/3rd replacement of rice polish with mulberry leaf powder)	T_4 (Complete replacement of rice polish with mulberry leaf powder)	SE_m value	CD at 5%
1	58.02±2.08	55.55±2.09	54.76±2.38	59.52±4.95	3.121	10.178
2	62.69±1.58	58.72±3.17	69.04±2.38	65.87±6.49	3.888	12.678
3	67.48±3.48	59.52±4.12	61.90±2.74	58.72±3.45	3.488	11.373
4	57.93±2.09	65.86±4.19	61.90±6.29	64.28±7.65	5.483	17.880
5	65.86±3.46	76.98±4.82	69.83±4.42	73.80±2.75	3.949	12.879
6	80.95±2.38	70.63±2.86	73.80±2.38	76.98±4.20	3.049	9.943
7	66.66±1.37	71.42±1.37	70.62±0.79	69.83±3.46	2.024	6.599
8	67.45±4.42	69.83±4.42	78.56±4.95	73.80±9.62	6.250	20.382
9	83.33±3.63	78.56±3.63	81.74±4.20	80.94±6.87	4.779	15.583
10	78.57±2.74	80.94±4.95	84.91±1.58	83.32±7.27	4.678	15.256
11	80.95±1.37	86.50±0.79	84.12±4.82	90.47±3.63	3.123	10.185
12	88.09±5.98	86.50±2.86	82.53±6.78	80.15±3.46	5.050	16.469
Overall average egg production	66.72±0.64	67.52±0.86	67.95±1.21	68.20±3.87	2.100	6.848

Conclusion
Based on the findings of this study, it can be stated that rice polish (up to 4.5% of the diet) can be totally replaced by mulberry leaf powder in poultry feed without affecting laying hen performance. Furthermore, because mulberry leaves can be procured at no cost, their inclusion is cost-effective and can help decrease feed expenditures.

Acknowledgement
Authors are grateful to the Hon'ble Vice-Chancellor, Dean, CVASc, Dean PGS, and authorities of GBPUA&T, Pantnagar for fund and facilities provided to conduct this research work.

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