RESEARCH ARTICLE

Effects of Replacement of Maize with Pearl Millet on Laying Performance of Aravali Breed of Chicken

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Abstract

The present experiment was conducted to evaluate the effect of replacement of maize with bajra on the laying performance, feed efficiency, economics and livability of Aravali breed of chicken. A total of 200 sixteen-week-old pullets were randomly allotted to five dietary treatments with eight replicates of five birds each. The treatments consisted of a basal maize-based diet (T_1) and diets in which maize was replaced with bajra at 20% (T_2), 40% (T_3), 60% (T_4) and 80% (T_5) levels. The results revealed that body weight at 16th and 40th weeks of age, age at first egg, total and daily feed intake, feed consumption per dozen eggs, egg number, hen-day and hen-housed egg production and egg weight were not significantly affected by dietary treatments. However, numerically higher body weight was observed in T_3, while birds in T_4 attained age at first egg earlier and exhibited superior egg production parameters, including total egg number, hen-day and hen-housed egg production. Feed intake and feed consumption per dozen eggs were numerically lower in T_4, indicating improved feed utilization. Economic analysis showed that the highest return over feed cost was obtained with 20% maize replacement (T_2), whereas a negative return was observed at the 80% replacement level (T_5). Livability remained high and comparable across treatments, ranging from 92.50 to 97.50%. Overall, the findings suggest that maize can be safely replaced with bajra up to 60% in layer diets without adverse effects on performance, while a 20% replacement level is economically most advantageous in Aravali breed of chickens.

Key words: Aravali, Bajra, Economics, Egg production, Maize replacement.

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Introduction

Poultry farming has emerged as one of the most dynamic and rapidly expanding livestock sectors due to its short production cycle, efficient feed conversion and ability to supply affordable animal protein. It provides a significant source of income for small and marginal farmers, particularly women and elderly individuals, thereby contributing to poverty alleviation and improved rural livelihoods. India's poultry sector has witnessed remarkable growth in recent decades, ranking among the leading producers of eggs and poultry meat globally (BAHS, 2024). Nutrition is a major determinant of poultry health, productivity and profitability, with feed costs accounting for nearly 70-75% of the total production expenditure. Maize serves as the predominant energy source in poultry diets in India, typically constituting 60-70% of the ration due to its high metabolizable energy, low fibre content, palatability and contribution of essential fatty acids and natural pigments (BIS, 2024). However, increasing maize prices, driven by competition from human consumption, livestock feeding and the expanding ethanol industry, have substantially increased feed costs. This has negatively impacted the profitability of layer farming, especially among small and marginal producers, highlighting the need to explore alternative and cost-effective energy sources.

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Pearl millet (bajra; *Pennisetum glaucum*) is one such promising alternative cereal. It is drought-tolerant and widely cultivated in arid and semi-arid regions of India, as well as in several parts of Asia and Africa (Meena *et al*., 2021; Raheem *et al*., 2021). Bajra is nutritionally comparable to maize, with relatively higher crude protein, a favourable amino acid profile and appreciable levels of minerals and vitamins, making it a potential substitute in poultry rations (BIS, 2024). However, the presence of anti-nutritional factors

such as tannins and phytic acid may influence nutrient availability and performance, necessitating systematic evaluation under practical feeding conditions (Nour *et al*., 2014; Dhewa *et al*., 2021). Moreover, maize is a major dietary source of carotenoids, particularly xanthophylls, which play an important role in egg yolk pigmentation. Since bajra contains comparatively lower pigment levels, partial or complete replacement of maize may affect yolk colour and consumer acceptability (Kean *et al*., 2008; Sathya *et al*., 2018; Ashokkumar *et al*., 2020). Therefore, evaluating bajra-based layer diets is essential to understand their effects on productive performance, livability and economic returns. In view of the rising feed costs and the need for sustainable poultry production, the present study was undertaken to evaluate bajra as an unconventional energy source in layer nutrition. The study aimed to assess the effects of dietary replacement of maize with bajra on laying performance, livability and economic efficiency in Aravali breed of chicken.

Materials and Methods

The study was carried out for 24 weeks between February 18, 2025, to August 4, 2025 at the Poultry Research Station, College of Veterinary Science & Animal Husbandry, Kamdhenu University, Anand, Gujarat (India). The study was started from 17th week of age and lasted till 40th week of age (168 days). The average ambient temperature and relative humidity during the experiment were 29.78 °F and 63.33%, respectively.

Experimental Design and Diets

A total of 200 Aravali pullets of 16 weeks of age were used in this study. The initial weight of birds at 16th weeks of age was recorded. The birds were randomly assigned to five different experimental groups, each consisting of eight replicates with five birds in each replicate, resulting in 40 birds in each treatment, following a completely randomized design. The dietary treatments used in these groups were: T_1 - Basal diet with 0% bajra, while in T_2, T_3, T_4 and T_5 the maize was replaced with 20%, 40%, 60% and 80% Bajra, respectively, in the basal diet and it was made iso-caloric and iso-nitrogenous with alteration in levels of other ingredients (Table 1).

Management of Birds

Birds were placed in individual California cages for the experiment. All necessary management and biosecurity precautions were strictly followed. All the birds were vaccinated against Marek's Disease, Infectious Bronchitis, Newcastle Disease, Infectious Bursal Disease and Fowl Pox under standard vaccination schedule at PRS, KU, Anand and health care practices were followed to protect the birds against various infectious diseases. Other operations such as deworming and debeaking were carried out as per the standard procedure under proper technical supervision. Birds were fed iso-caloric and iso-nitrogenous diets for Layer phases I with the different locally accessible feed ingredients (Table 1).

Productive Performance

Age at first egg (AFE) was measured by recording the first egg laid by experimental birds. Body weight, Daily feed consumption, Feed intake (4 weekly), Feed consumption per dozen of eggs, Egg number, Hen day egg production, Hen house egg production and Egg weight were measured at the end of every four week. Return over Feed Cost (ROFC) was calculated by subtracting income by selling of eggs from total feed cost. Livability was also calculated.

Statistical Analysis

The data were subjected to statistical analysis for all the parameters as per Snedecor and Cochran (1994), considering treatments as the only variable and using Completely Randomized Design, and the mean differences were compared by Tukeys *post hoc* test at $p<0.05$.

Table 1: Feed formulation for different treatment diets

Sr. No.	Ingredients	Layer Phase I (17-40 weeks)				
		T_1	T_2	T_3	T_4	T_5
1	Yellow maize	51.000	40.800	30.600	20.400	10.200
2	Bajra*	0.000	10.200	20.400	30.600	40.800
3	Soyabean DOC	21.000	20.000	18.950	18.300	17.500
4	DORB	19.100	19.100	20.000	19.400	19.150
5	Oil	0.000	1.000	1.850	3.000	4.100
6	Calcite powder	3.350	3.350	3.000	3.050	3.000
7	Limestone	3.350	3.350	3.000	3.050	3.000
8	Feed supplements*	2.200	2.200	2.200	2.200	2.250
Total		**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

*Feed supplements included constant levels of DCP, Trace minerals, Choline chloride (60%), L-Lysine, DL-Methionine, Phytase, Enzymes, Salt, Sodium bicarbonate, Vitamins, Vitamin B_{12}, Liver tonic, Immunomodulators, Toxin binder and Probiotic in all groups.

Results and Discussion

Growth Performance and Feed Utilization

The effect of dietary replacement of maize with bajra on growth performance and feed utilization of laying hens is presented in Table 2. Final body weight at 40 weeks of age, daily feed consumption, total feed intake per bird and feed consumption per dozen eggs did not differ significantly ($p>0.05$) among the dietary treatments. Birds fed diets containing 40% and 80% bajra replacing maize showed numerically higher body weight compared to the control group. Daily feed consumption and total feed intake remained non-significant across all dietary treatments. Feed consumption per dozen eggs was numerically lower in birds receiving 20%, 40% and 60% bajra diets; however, these differences were statistically non-significant.

The present findings indicate that replacement of maize with bajra did not significantly influence body weight, feed intake, or feed efficiency of laying hens. These results are in strong agreement with earlier studies by Kumar *et al.* (1991), Abd-Elrazig *et al.* (1998), Filardi *et al.* (2005), Garcia and Dale (2006), Amini and Ruiz-Feria (2007), and Cisse *et al.* (2017), who reported that substitution of maize with pearl millet, either partially or completely (up to 75%), did not result in significant changes in body weight, daily feed consumption, or feed efficiency in laying hens. The comparable growth performance and feed utilization observed in the present study may be attributed to the formulation of experimental diets on an isocaloric and isonitrogenous basis, ensuring similar metabolizable energy availability and nutrient supply across treatments. Although Mehri *et al.* (2010) reported higher feed intake and reduced feed efficiency at very high levels of maize replacement (75-100%), such trends were not observed in the present study, even at higher levels of bajra inclusion (60-80%).

Age at First Egg and Egg Production Performance

The effect of dietary replacement of maize with bajra on age at first egg and egg production performance of laying hens is presented in Table 3. Age at first egg did not differ significantly ($p>0.05$) among the dietary treatments, although birds fed the 60% bajra diet attained sexual maturity numerically earlier than other groups. Total egg number, hen-day egg production and hen-house egg production were comparable among all treatment groups throughout the experimental period. Egg weight at 40 weeks of age also did not show significant variation ($p>0.05$) among the dietary treatments, indicating that inclusion of bajra had no adverse effect on egg production or egg weight. In the present study, replacement of maize with bajra at varying inclusion levels did not significantly influence age at first egg, egg production parameters, or egg weight of laying hens. Information regarding the effect of pearl millet on age at first egg is limited; however, the comparable age at sexual maturity observed across treatments in the present study suggests that bajra inclusion does not interfere with the onset of lay when diets are formulated to meet nutrient requirements.

The observed similarity in total egg number, hen-day egg production (HDEP) and hen-house egg production (HHEP) among dietary treatments was in agreement with earlier reports of Kumar *et al.* (1991), Abd-Elrazig *et al.* (1998), Garcia and Dale (2006), and Amini and Ruiz-Feria (2007), who reported no significant effect of pearl millet inclusion on egg production performance of laying hens. In contrast, Filardi *et al.* (2005) and Mehri *et al.* (2010) reported a linear decline in egg production with increasing levels of maize replacement by pearl millet. Such discrepancies among studies may be attributed to differences in dietary formulation, inclusion levels, processing methods, or overall nutrient balance.

Egg weight at 40 weeks of age was not significantly affected by dietary treatments in the present study, which is consistent with findings reported by Abd-Elrazig *et al.* (1998), Amini and Ruiz-Feria (2007), Mehri *et al.* (2010), Singh *et al.* (2014) and Cisse *et al.* (2017). However, Kumar *et al.* (1991) and Filardi *et al.* (2005) observed a reduction in egg weight with increasing pearl millet inclusion, while Sabo *et al.* (2020) reported heavier eggs in quails fed diets containing 100% pearl millet. The lack of adverse effects on egg weight in the present study may be attributed to adequate dietary protein and energy balance, ensuring sufficient nutrient availability for egg formation.

Table 2: Body weight and feed utilization parameters of laying hens fed with different levels of bajra

Replacement level of bajra (%)	BW_{40} (g)	Daily feed consumption (g/b/d)	Total feed intake (g/bird)	Feed consumption per dozen eggs (kg)
0	1615.55±67.02	86.83 ± 0.20	14588.00± 33.98	3.11 ± 0.40
20	1587.18±27.04	87.73 ± 0.25	14738.28 ± 41.09	2.65 ± 0.07
40	1647.80±14.00	87.06 ± 0.12	14625.07± 20.24	2.68 ± 0.20
60	1588.50±41.01	86.67 ± 0.40	14560.25 ± 67.62	2.65 ± 0.20
80	1616.91±35.22	87.53 ± 0.52	14704.60± 87.52	3.07 ± 0.37
SEM	40.85	0.33	59.63	0.28
CD at 5%	NS	NS	NS	NS

Economic Efficiency

Economic parameters of laying hens fed diets containing different levels of bajra are presented in Table 4. Total feed consumption per bird was non-significant across all dietary treatments. Feed cost per kilogram increased progressively with increasing levels of bajra inclusion due to addition of bajra and oil for fulfilling energy requirement, which resulted in a corresponding increase in total feed cost per bird in diets containing 60% and 80% bajra. Income from the sale of eggs varied among treatments in accordance with total egg production. Return over feed cost differed numerically among treatments and was highest in birds fed the 20% bajra diet, followed by the 40% bajra diet.

The results of the present study indicate that dietary replacement of maize with bajra influenced economic efficiency primarily through changes in feed cost rather than through alterations in biological performance. Although growth performance and egg production parameters remained non-significant among treatments, the higher cost of bajra at increased inclusion levels led to increased total feed cost and reduced economic returns, particularly at the 80% replacement level. Consequently, return over feed cost was lower in diets containing higher levels of bajra despite similar production performance. These findings are in contrast with those of Filardi *et al.* (2005), who reported non-significant differences in cost per kilogram egg or cost per dozen eggs among dietary treatments. Singh *et al.* (2014) also observed a consistent reduction in feed cost with increasing levels of pearl millet inclusion. The variation in economic outcomes among studies may be attributed to differences in market prices of feed ingredients, geographical location, duration of the study and period-specific fluctuations in ingredient availability. The present results therefore emphasize that the economic feasibility of bajra inclusion in layer diets is highly dependent on prevailing market conditions rather than solely on nutritional or biological factors.

Livability

Livability remained high throughout the experimental period and ranged from 92.50 to 97.50% among the treatment groups. Mortality was low and distributed across all treatments, with no marked differences observed among dietary groups. The consistently high survival rates observed across all treatment groups indicate that inclusion of bajra, even at higher levels, did not exert any adverse effects on bird health or viability. These findings are in agreement with earlier reports by Kumar *et al.* (1991), Collins *et al.* (1997) and Abd-Elrazig *et al.* (1998), who similarly reported no negative impact of pearl millet inclusion on livability of laying hens. The absence of any contrary findings for livability in the present study further supports the safety of bajra as an alternative energy source in layer diets. When diets are properly formulated to meet nutrient requirements, bajra can be incorporated without compromising bird survival or overall flock health.

Table 3: Age at first egg and production parameters of laying hens fed different levels of bajra

Bajra level (%)	AFE (days)	Total egg number	Egg weight at 40 weeks (g)	HDEP (%)	HHEP (%)
0	153.75 ± 2.58	61.23 ± 5.89	43.58 ± 0.65	39.45 ± 3.72	36.44 ± 3.51
20	152.50 ± 2.46	67.05 ± 1.84	44.26 ± 0.51	41.17± 1.70	39.91 ±1.10
40	154.31 ± 2.16	67.88 ± 4.46	42.11 ± 0.78	41.63 ± 2.83	40.40 ± 2.66
60	150.13 ± 2.82	68.05 ± 4.36	42.77 ± 0.43	42.68 ± 2.83	40.51 ± 2.60
80	154.00 ± 4.12	61.88 ± 5.32	43.12 ± 0.29	38.84 ± 3.47	36.83 ± 3.16
SEM	2.91	4.59	0.56	2.93	2.73
CD at 5%	NS	NS	NS	NS	NS

Table 4: Economic parameters of laying hens fed diets containing different levels of bajra

Bajra level	0%	20%	40%	60%	80%
Total feed consumption (kg/bird)	14.59	14.74	14.63	14.49	14.70
Feed cost (Rs/kg)	29.65	31.21	32.59	34.49	36.42
Total feed cost	432.59	460.04	476.79	499.76	535.374
TEN_{17-40} (Nos.)	61.23	67.05	67.88	68.05	61.88
Income from sale of eggs (₹ 8/egg)	489.84	536.40	543.04	544.40	495.04
Return over feed cost (Rs./bird)	57.25	76.36	66.25	44.64	-40.33

Conclusion

The present findings suggested that birds fed with layer diet having 20% replacement of maize with bajra showed the highest Return over Feed Cost without affecting any of the parameters measured. However, bajra can replace 60% maize in the layer diet of Aravali breed of chicken to obtain higher egg production.

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