EFFECT OF REPLACING MAIZE (*ZEA MAYS*) WITH PEARL MILLET (*PENNISETUM GLAUCUM*) ON THE PERFORMANCE OF BROILERS

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ABSTRACT

The present investigation was carried out on day old 360 commercial broiler chicks for 42 days duration to evaluate the effect of replacing maize with pearl millet grain on five treatment groups i.e., 0 (T_1), 25 (T_2) , 50 (T_3), 75 (T_4) and 100 (T_5) per cent level on weight basis. Each treatment group had six replications with 12 birds in each replication. The body weight gains (BWG), feed intake (FI) and feed conversion ratio (FCR) were recorded biweekly during the experimental period. The overall means along with standard error of biweekly BWG, FI and FCR at 0-14 days, 0-28 days and 0-42 days were observed as 177.99±1.94 g, 990.36±8.21 g, 1883.57±20.64 g, 404.63±4.51 g, 1896.73±17.05 g, 3769.24±25.05 g, 2.29±0.05%, 1.93±0.03% and 2.01±0.03%, respectively. A metabolism trial was conducted during 6th week of experiment for 06 birds from each treatment group. The overall mean along with standard error of dry matter metabolizability and nitrogen retention % were found 65.09±0.21 and 61.91±0.17, respectively. The relative economics of different dietary treatment groups revealed a profit (in Rs.) of 2.37, 7.02, 13.36, 24.84 and 9.25, respectively, for different treatment groups. The results indicated that, the average body weight gain, feed intake, feed conversion ratio (FCR) improved significantly in dietary treatments by replacing maize with pearl millet. Results of metabolic trials indicated that dry matter digestibility was found to be improved and no effect on nitrogen retention in Pearl millet treatments groups.

Key words: Body weight gain, broilers feed intake, feed conversion ratio, Pearl millet.

Introduction

In India poultry industry is an organized, fast growing and scientifically tempered among the agro-based industries and implement worthy research findings. The country is emerging as the world's 2nd largest poultry market with an annual growth of more than 14%, producing 61 million tonnes or 3.6 per cent of global egg production. India ranks 6th in broiler production with an annual output of 2.39 million tonnes broiler meat (International Poultry and Livestock Expo, 2015). As feed constitutes 60 to 70% of the total production cost, so it is important to reduce the feed cost by using the scientific knowledge for utilizing low cost locally available agro-industrial by-products in poultry feed (Thirumalaisamy *et al.,* 2016)

Pearl millet (*Pennisetum glaucum*) is one of the most widely grown species of millet, in India and Africa since prehistoric times. It is also considered as one of the world's hardiest warm season coarse cereal crop. India is the largest single producer of Pearl millet, both in terms of area (9.3 million hectares) and production (8.3 million tons) (ICRISAT, 2017). Among the millets, Pearl millet has the highest content of macronutrients, and micronutrients such as iron, zinc, Mg, P, folic acid, thiamine and riboflavin (Antony *et al.* 1996). It is also rich in essential amino acids, like lysine, threonine, valine, sulphur containing amino acids (Indira and Naik, 1971; Ravindran and Blair, 1992; Antony *et al.,* 1996).

The recent rise in demand and consequent increase in the cost of corn, has spurred interest in replacing it in poultry diets with locally grown high energy grains. The grain with 11.5% crude protein and 2900 Kcal metabolizable energy (ME) resemble maize (9% C.P and 3300 Kcal M.E.) in most of the qualities, (Rama Rao *et al.,* 2000). Thus, Pearl millet may provide major replacement of Maize in poultry feed as there is striking similarities in nutrient composition of both grains. Studies with broiler chicken have shown that when Pearl millet diets are formulated with correct estimates of protein and energy, broiler performance is equivalent (Sullivian *et al.,* 1990; Amato and Forrester, 1995; Nath *et al.*, 2007) or even superior (Tornekar *et al.,* 2009; Baurhoo *et al.,* 2011) and economical (Rama Rao *et al.,* 2002; Elangovan *et al.,* 2003) to that obtained with Maize; however, the literature available on feeding Pearl millet is very scanty. Therefore, the present investigation was undertaken to evaluate the effect of replacing Maize with Pearl millet on different performance traits of broilers.

Materials and Methods

Study design

The present investigation was carried over a period of 6 weeks to study the effect of Pearl millet replacing Maize, as an energy source, on the performance of broiler chickens at LUVAS institutional farm, Hisar. 360-day-old broiler chicks were randomly distributed into 5 treatment groups with 30 replicates, having 12 birds each. The ingredients and additives used in ration formulation were maize, pearl millet, soybean meal, fish meal, groundnut cake, soybean oil, mineral mixture, vitamins, coccidiostat, antibiotics, lysine and DL-methionine, respectively. The feed ingredients included in ration were analyzed for proximate nutrients (CP, CF, EE and TA) (AOAC, 2007) in Table 1. Five different types of starter and finisher ration were formulated (Table 2 and 3). Maize and soybean meal based control ration (T_1) diet as per BIS, (2007) was formulated. Maize was replaced (w/w) with pearl millet at 25 per cent in T_1, 50 per cent in T_2, 75 per cent in T_4 and 100 per cent in T_5. The chicks from 0 to 3 weeks of age were offered the starter rations and thereafter finisher rations up to 6 weeks of age. Body weight gains,

feed intake, FCR were estimated fortnightly during growth period, a metabolism trial was conducted to study the nitrogen retention and metabolizability of dry matter. Relative economics of feeding was calculated at the end of sixth week. The cost of production included the cost of chick and the cost of feed consumed.

Statistical analysis

The statistical analysis of data was performed using SPSS 21.0 version. One-way ANOVA was used for the differences between groups. When the P-values were significant (P<0.05), a Duncan's multiple range test was performed. All the data were expressed as mean ± standard errors.

Results and Discussion

In the present study, maize in the diet as energy source in treatment T_1 (control) was replaced by Pearl millet at 25, 50, 75 and 100% levels in treatments T_2, T_3, T_4 and T_5, respectively, and fed to broilers for a period of six weeks to observe their growth performance. The overall means of biweekly BWG, FI and FCR at 0-14 days, 0-28 days and 0-42 days were depicted in figure 1 and figure 2, respectively.

Average body weight gain

The data pertaining to average body weight gain of broilers reared under different dietary treatments during various growth periods are presented in Table 4. The data of the study revealed that the body weight gain at 14th day of age increased with the increase in the replacement level of up to 75% (1105.17 g) maize by pearl millet but statistically it was found non-significant. At 28th days of age, the body weight gain increased (P<0.05) with an increase in the level of Pearl millet up to 75% but, further increase in the level of pearl millet to 100% (1038.33 g), decreased the body weight gain. The highest body weight gain was recorded in T_4 (2060.07 g) however, the treatments T_3 and T_5 were found to be statistically similar. During overall growth period of 42th days, the body weight gain was significantly (P<0.05) lower in T_1 as compare to T_3, T_4 and T_5, however, there was no significant difference between T_1 & T_2; whereas, T_4 showed a significantly (P<0.05) higher body weight gain as compared to T_2, T_3 & T_5. The results of present investigation revealed that there was significant (P<0.05) positive effect on average body weight gain at both 4 and 6 weeks of age by replacing Maize at different levels with Pearl millet in the diets of broilers, the body weight gain also increased progressively and the differences were found significant (P<0.05) as compared to control (T_1) group, however, the gain in T_5 (100% replacement) was lower than the gain in T_4 (75% replacement) group. This increase in body weight gain might be due to higher crude protein content of feed, more feed intake and increased dry matter metabolizability by replacement of Maize with Pearl millet in the diets of broiler. The decrease in weight gain despite of higher feed intake in T_5 as compared to T_4 might be due to low energy intake than the requirement as the energy content in feed of this group where maize was replaced at 100% level with pearl millet was less.

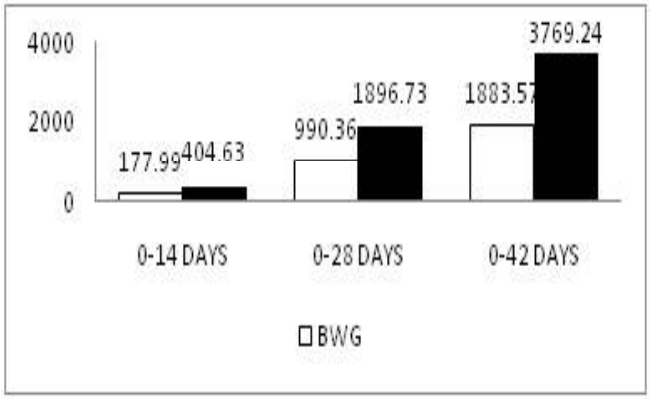

Fig. 1: Overall mean of biweekly body weight gain and feed intake of broilers at different age groups

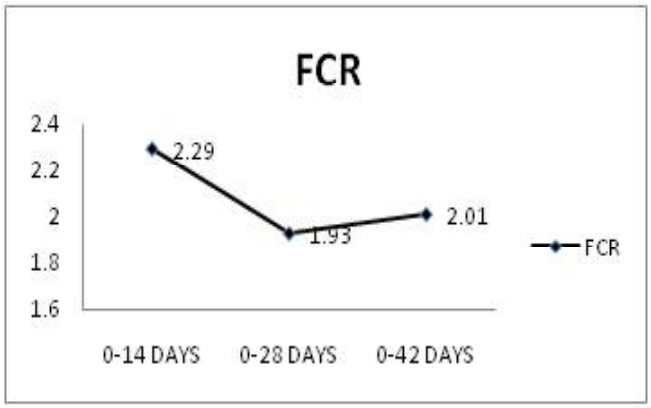

Fig. 2: Overall mean of biweekly body weight gain and feed conversion ratio of broilers at different age groups.

The results are in close agreement with the findings of Tyagi *et al.* (2004), Kumaravel (2006), Rasal *et al.* (2009) and Baurhoo *et al.* (2011) who observed significant improvements in growth of broilers fed with Pearl millet replacing maize at 50, 75 and 100% levels. However, Rama Rao *et al.* (2002), Rama Rao *et al.* (2004); Kwari *et al.* (2014) and Emmanuel *et al.* (2014) reported that Maize can be replaced by millet in the diet of broilers without adverse effect on their performance.

Feed intake (g/bird)

The data pertaining to feed intake of broilers under different dietary treatments during different growth periods are presented in Table 5. Statistical analysis of data revealed that there was significantly (P<0.05) higher feed intake at 0 to 14 and 0 to 42 days of age were recorded in T_5 in comparison to T_1, T_2 and T_3, however, there were no significant differences observed between T_1, T_2 and T_3; between T_3 and T_4 and between T_4 and T_5 treatments. At 0 to 28 days of age significantly (P<0.05) lower feed intake was observed in T_1 compare with T_4 and T_5; T_2 and T_3 neither differed significantly with T_1 nor with T_4 and T_5. The data indicate that the average feed intake of broilers increased (P<0.05) linearly with an increase in replacement levels of Maize with Pearl millet. The increase in intake may be attributed due to low energy contents in feed that lead the birds to consume more to meet their energy needs.

The above results are in agreement with Thakur and Prasad

(1992); Kumaravel (2006); Asha Rajini *et al*. (1986) and Satyanarayana Reddy *et al.* (1991) who observed higher feed intake in groups where Maize was replaced by Pearl millet up to 100 per cent levels in diet as compared to other levels and other cereals group. In contrary to this reduced or no significant difference in feed intake were reported by Raju *et al.* (2003), Ravinder *et al.* (2012), Torres *et al.* (2013), Purushothaman and Thirumalai (1995) and Salah *et al.* (1998) and Tyagi *et al*. (2004) when maize was replaced with pearl millet.

Feed conversion ratio

The data pertaining to feed conversion ratio during different growth periods are presented in Table 6. Result of the study revealed that at 2nd week of age, the FCR affected due to replacement of Maize at different levels by Pearl millet. At 4th week of age FCR was significantly (P<0.05) lower in T_4 as compared with T_1, T_2 and T_3, however, T_5 did not differ among treatments. At 6th week of age, FCR significantly (P<0.05) improved in T_4 as compared to T_1 (control) and T_5 however, there was no significant improvement in T_2 and T_3 as compare to other treatments.

In present study, better FCR was observe in Pearl millet groups with a significant (P<0.05) difference between T_4 and other treatments, may be due to more body weight gain in pearl millet groups as compared to control. The above results are agreement with the finding with Kumaravel (2006), Baurhoo *et al.* (2011) and Tyagi *et al.* (2004) who showed that broiler chickens fed on Pearl millet diets were heavier and had better feed conversion rate than those fed on Maize.

Contrary, Reddy *et al*. (2008) observed that 50% replacement of Maize with sorghum or both did not alter body weight gain and FCR in broilers when compared to the Maize based diet. Smith *et al.* (1989), Tornekar *et al.* (2009) and Rama Rao *et al.* (2004) found no significant difference in feed conversion efficiency.

Dry matter metabolizability and nitrogen retention

A metabolism trial was conducted during 6th week of experiment six birds from each treatment. The overall mean along with standard error of dry matter metabolizability and nitrogen retention % were found that 65.09±0.21 and 61.91±0.17, respectively. The results of per cent dry matter metabolizability and nitrogen retention pertaining to different dietary treatments are presented in Table 7. Result of the study revealed that dry matter metabolizability (%) was significantly (P<0.05) higher in Pearl millet at 75% as compare to T_1 (control) and T_2. Whereas, T_1 and T_2; T_2 and T_3 and T_3, T_4 and T_5 were statistically similar. These results are comparable with the earlier findings of Raju *et al.* (2003) and Elangovan *et al.* (2004) observed better metabolizability of dry matter, crude fibre and crude fat in sorghum and pearl millet fed broilers. In contrary, Tyagi *et al.* (2003) and Jha and Kumar (2008) have reported a non-significant difference in dry matter metabolizability in Sorghum and Pearl millet based broilers diets at 100 % replacement level of Maize.

In present study, the nitrogen retention per cent found to be non-significant among treatment groups. However, it increased numerically with the increase in the replacement level up to 75% and decreased at 100% replacement of Maize with Pearl millet grain. In present study, there was improvement in the dry matter metabolizability in broilers fed Pearl millet based diets; the improvement being significantly (P<0.05) higher in T_3, T_4 and T_5 as compared to T_1 and T_2 treatments, but nitrogen retention was non- significant. The present finding regarding nitrogen retention is also supported by Elangovan *et al*. (2004) and Jha and Kumar, (2008) who recorded a non-significant difference in nitrogen retention in Sorghum and Pearl millet based broiler diets at 100% replacement level of Maize.

Economics of broilers fed on different dietary treatments

The cost of production of broilers considering the cost of chicks and feed consumed in 6 weeks, reared under different dietary treatments is presented in Table 8. Relative economics of different dietary treatment groups was also worked out. The profit (in Rs.) of different treatment groups were 2.37, 7.02, 13.36, 24.84 and 9.25, respectively.

There were 360 experimental birds, costing Rs. 37.46, 37.46, 36.92, 36.92, and 37.46 per bird in treatment T_1, T_2, T_3, T_4 and T_5, respectively. Total cost of production per bird including cost of chick and feed was Rs.140.03, 144.31, 143.92, 143.96 and 145.37 in treatments T_1, T_2, T_3, T_4 and T_5, respectively. Gross return obtained by selling the bird at Rs.80/kg live weight was Rs 142.40, 151.33, 157.28, 168.80 and 154.62 for treatments T_1, T_2, T_3, T_4 and T_5, respectively The profits birds was Rs.2.37, 7.02, 13.36, 24.84 and 9.25 in treatments T_1, T_2, T_3, T_4 and T_5, respectively. The relative profit (Rs.) as compared to control (T_1) was highest in treatment T_4 (22.47) (75% replacement level of Maize with Pearl millet) followed by T_3 (10.99), T_5 (6.88) and T_2 (4.65).

The results of the present study depicted that the replacement of Maize by Pearl millet reduced the feed cost per kg weight gain. A maximum profit of Rs. 24.84 per kg live weight was obtained in T_4 (75% Pearl millet based diet) group compared to control (100% Maize based diet) group. The relative profit to the control was highest in T_4 (Rs. 22.47) followed by T_3 (Rs.10.99), T_5 (Rs. 6.88) and T_2 (Rs. 4.65). The higher relative profit in Pearl millet based diet in comparison to control was due to lower cost of Pearl millet and higher body weight gain in pearl millet based diets than Maize based diet.The results pertaining to economics are in agreement with Rama Rao *et al.* (2002), Singh (2004) and Garcia (2006) who concluded that feed cost per unit gain was less in Pearl millet than Maize based diets. The feed cost per unit meat yield was less in diets with 51 per cent Pearl millet replacing 75 per cent Maize and also supplementation of enzyme reduced the cost of feed per unit gain marginally. Based upon the results of the present study it can be concluded that Pearl millet can effectively replace Maize up to 75% without any adverse effect on the performance of broilers. Relative profit as compared to control was highest in pearl millet at 75% level in broilers diet. Replacement of Maize with Pearl millet in broiler ration was found to be beneficial.

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Table 1: Chemical composition (% DM basis), metabolizable energy (ME, K cal/kg) and cost of feed ingredients used in formulating the experimental diets

Ingredients	Crude Protein	Crude Fiber	Ether Extract	Total ash	Lysine*	Methionine*	Metabolizable Energy*	Cost (Rs/100kg)
Maize	9.50	2.00	4.09	1.54	0.18	0.15	3309*	1539
Pearl millet	11.82	2.20	4.95	2.00	0.43	0.20	2850*	1250
Soyabean meal	44.39	6.50	1.13	6.05	2.37	0.79	2230*	3546
Fish meal	48.00	2.10	8.65	22.01	4.13	1.39	2600*	7020
GNC	39.48	10.00	7.88	8.00	2.5	0.84	2400*	2943

*Panda *et al.* 2002

Table 2: Proportion (%) of feed ingredients, quantities of additives and cost of experimental diets during starter phase (0-3 weeks)

Feed ingredients	Treatments				
	T_1	T_2	T_3	T_4	T_5
Maize	54.0	40.5	27.0	13.5	0.0
Bajra	0.0	13.5	27.0	40.5	54.0
Soybean meal	21.0	21.0	21.0	21.0	21.0
Ground nut cake	10.0	10.0	10.0	10.0	10.0
Fish meal	8.0	8.0	8.0	8.0	8.0
Soyabean oil	5.0	5.0	5.0	5.0	5.0
Mineral mixture	2.0	2.0	2.0	2.0	2.0
Total	100.0	100.0	100.0	100.0	100.0
Feed additives* (g/100 kg feed)	293.5	293.5	293.5	293.5	293.5
Feed cost (Rs/100 kg)	3197.41	3158.39	3119.38	3080.36	3041.35

*Feed additives include Vitamin Mixture-I-10 g, Vitamin, Amino acids and Ca mixture-II-20 g, Coccidiostat (Dinitro-0-Toluamide)-50 g, Choline chloride-50 g, Lysine-50 g, DL-methionine-80 g and CTC-15 g/kg-33.5 g.

Table 3: Proportion (%) of feed ingredients, quantities of additives and cost of experimental diets during finisher phase (3-6 weeks)

Feed ingredients	Treatments				
	T_1	T_2	T_3	T_4	T_5
Maize	60.0	45.0	30.0	15.0	0.0
Bajra	0.0	15.0	30.0	45.0	60.0
Soyabean meal	17.0	17.0	17.0	17.0	17.0
Ground nut cake	8.0	8.0	8.0	8.0	8.0
Fish meal	7.5	7.5	7.5	7.5	7.5
Soyabean oil	5.5	5.5	5.5	5.5	5.5
Mineral mixture	2.0	2.0	2.0	2.0	2.0
Total	100.0	100.0	100.0	100.0	100.0
Feed additives* (g/100 kg feed)	293.5	293.5	293.5	293.5	293.5
Feed cost (Rs/100 kg)	3101.45	3058.10	3014.75	2971.40	2928.05

*Feed additives include Vitamin Mixture-I-10 g, Vitamin, Amino acid and Ca mixture-II-20 g, Coccidiostat (Dinitro-0-Toluamide)-50 g, Choline chloride-50 g, Lysine-50 g, DL-methionine-80 g and CTC-15 g/kg-33.5 g.

Table 4: Average body weight gain (g/bird) during different growth period under different dietary treatments

Treatment	Period (days)		
	0 to 14	0 to 28	0 to 42
T_1	170.81±4.50	870.70^{a} ±14.05	1730.01^{a} ±35.27
T_2	172.92± 4.97	934.80^{b} ±16.58	1841.64^{ab} ±43.61
T_3	181.30±3.75	1010.70^{c} ±19.91	1916.04^{b} ±39.94
T_4	183.63±4.53	1105.17^{d} ±12.41	2060.07^{c} ±42.72
T_5	181.87±3.67	1038.33^{c} ±14.16	1882.80^{b} ±57.19

Means bearing different superscripts in a column differ significantly (P<0.05).

Table 5: Feed intake (g/bird) during different growth period under different dietary treatments

Treatment	Period (days)		
	0 to 14	0 to 28	0 to 42
T_1	387.97^{a} ±8.50	1809.02^{a} ±38.87	3667.19^{a} ±24.12
T_2	390.73^{a} ±7.92	1876.20^{ab} ±35.09	3697.46^{a} ±47.38
T_3	398.05^{ab} ±9.70	1906.51^{ab} ±26.55	3741.26^{ab} ±62.32
T_4	416.04^{bc} ±6.60	1926.30^{b} ±30.25	3845.09^{bc} ±46.66
T_5	430.35^{c} ±7.60	1965.61^{b} ±36.08	3895.10^{c} ±41.57

Means bearing different superscripts in a column differ significantly (P<0.05). Each value is a means of six replicate.

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Table 6: Feed conversion ratio (FCR) during different growth period under different dietary treatments

Treatment	Period (days)		
	0 to 14	0 to 28	0 to 42
T_1	2.30±0.20	2.08^{b} ±0.06	2.13^{b} ± 0.06
T_2	2.28±0.10	2.02^{b} ±0.08	2.01^{a} ± 0.06
T_3	2.25±0.06	1.94^{b} ±0.06	1.98^{ab} ± 0.03
T_4	2.25±0.12	1.74^{a} ±0.02	1.87^{a} ± 0.04
T_5	2.40±0.03	1.90^{ab} ±0.05	2.09^{b} ± 0.09

Means bearing different superscripts in a column differ significantly (P<0.05) each value is a means of six replicate.

Table 7: Dry matter metabolizability and nitrogen retention of the experimentalbirds under different dietary treatments

Treatment	DM metabolizability (%)	N Retention (%)
T_1	63.95^{a}±0.72	61.58±0.31
T_2	64.75^{ab}±0.16	61.86±0.41
T_3	65.21^{bc}±0.21	62.05±0.56
T_4	66.05^{c}±0.31	62.10±0.40
T_5	65.48^{bc}±0.28	61.97±0.29

Means bearing different superscripts in a column differ significantly (P<0.05)
Each value is a means of six randomly selected birds.

Table 8: Economics of broiler production under different dietary treatments

Treatment	Chick cost	Cost of feed / bird				Total production cost*	Live weight at 6 weeks of age	Gross return **	Profit	Relative profit or loss/bird ***
		0-3 Weeks		3-6 Weeks						
		Feed intake	Feed cost	Feed intake	Feed cost					
	Rs/bird	G	Rs	g	Rs	Rs	g	Rs/bird	Rs/bird	Rs
T1	37.46	920.99	29.44	2358.21	73.13	140.03	1780.01	142.40	2.37	-
T2	37.46	1093.15	34.52	2365.31	72.33	144.31	1891.64	151.33	7.02	4.65
T3	36.92	1125.40	35.10	2385.56	71.90	143.92	1966.04	157.28	13.36	10.99
T4	36.92	1140.92	35.14	2420.18	71.90	143.96	2110.07	168.80	24.84	22.47
T5	37.46	1179.33	35.86	2460.78	72.05	145.37	1932.80	154.62	9.25	6.88

*Whole sale market rate of broiler chicken was Rs 80/kg live wt.

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