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Research Article

EFFECT OF REPLACING MAIZE WITH SORGHUM ON THE PERFORMANCE AND UTILIZATION OF NUTRIENTS IN BROILERS

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ABSTRACT

Two hundred and eighty, broiler chicks were randomly divided into seven treatments with two replicates of 20 each. Maize based starter (0-4 weeks) and finisher (4-6 weeks) rations were formulated as control (T1). In other treatments viz. T2, T3 and T4, 33.3%, 66.6% and 100% maize was replaced with ground sorghum; while in T5, T6 and T7, 33.3%, 66.6% and 100% maize was replaced with unground sorghum, respectively. Body weight gain and feed intake in birds at 42 days was significantly ($P<0.05$) lower in T7 and T4 treatments as compared to T1. feed conversion ratio was significantly ($P<0.05$) poor in T4 and T7 treatments irrespective of the physical form of sorghum as compared to T1. Dry matter metabolizability (%), nitrogen retention (%) and gross energy metabolizability decreased significantly ($P<0.05$) in T7 as compared to T1. Gross energy metabolizability (%) was the highest in T5 and the lowest in T7. Calcium and phosphorus retention (%) in different dietary treatments was not affected by replacement of maize with different levels of sorghum irrespective of grain form. Based upon the results of the present study, it can be concluded that sorghum can effectively replace maize up to 66.66% without any adverse effect on the performance and nutrients utilization in broilers.

Key words: Performance, gross energy metabolizability, sorghum, maize, broilers

In poultry raising, 70% of the recurring expenditure accounts for feed alone (Reddy *et al.,* 2008). In India there is a huge gap between demand and availability of poultry feeds (Anon, 2009). Efforts have been made by several workers in the past to utilize cereals such as sorghum, finger millets and pearl millets as a source of energy in poultry rations to replace maize. The use of whole grains, especially sorghum, in poultry rations has gained favour in many European countries as a way to reduce feed cost. Feeding whole grains at low levels can improve starch digestibility and is not detrimental to feed utilization in broiler rations (Khatri, 2009). High percentage of whole sorghum grains are broken down in the gastro intestinal tract of broiler and can be successfully incorporated into broiler diets without compromising bird performance (Hidalgo *et al.*, 2004). The use of whole grains will eliminate the cost associated with grinding and therefore, incorporating sorghum in poultry rations can further reduce the feed cost. The present study was therefore conducted to observe the effects of replacing maize with sorghum on performance and utilization of nutrients in commercial broiler chickens.

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MATERIALS AND METHODS

The study was conducted on 280, day-old broiler chicks for a period of six weeks. The birds were randomly divided in seven groups having two replicates of 20 each. Seven diets were formulated for starter (0-4 weeks) and finisher (4-6 weeks) phases separately. Maize based control diet was prepared as per BIS (1992) and was given as T1. Feed ingredients were ground through 3mm sieve size by using hammer mill whereas sorghum was ground through 2mm sieve size. The diets T2, T3 and T4 were prepared by replacing maize with 33.3%, 66.6% and 100% ground sorghum, respectively. The diets T5, T6 and T7 were prepared by replacing maize with 33.3%, 66.6% and 100% unground sorghum, respectively (Tables 1 and 2). The birds were weighed individually at biweekly intervals and the body weight gain was calculated. Biweekly record of feed offered and residual amount was kept to calculate intake per bird. The feed conversion ration (FCR) was calculated as the ratio of total feed consumed (g) to total body weight gain (g). A metabolism trial was conducted at the end of growth period for each treatment for nutrients retention and energy metabolizability. The data was statistically

Table 1
Per cent proportion of feed ingredients, additives, chemical composition (% on DM basis) and metabolizable energy of starter diets

Feed Ingredients	Treatments						
	T1	T2	T3	T4	T5	T6	T7
	52	34.66	17.34	-	34.66	17.34	-
Ground sorghum	-	17.34	34.66	52	-	-	-
Whole sorghum	-	-	-	-	17.34	34.66	52
Soybean meal	32	32	32	32	32	32	32
Fish meal	9	9	9	9	9	9	9
Rice polish	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Mineral Mixture	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Total	100	100	100	100	100	100	100
Feed additives*(g/100kg feed)	350	350	350	350	350	350	350
Feed cost (Rs./100kg)	1876.98	1898.98	1920.97	1942.38	1897.78	1918.57	1939.38
Chemical Composition							
ME** (Kcal/kg)	2800.36	2764.19	2728.00	2691.76	2764.19	2728.00	2691.76
Crude protein (%)	23.02	23.17	23.33	23.49	23.17	23.33	23.49
Crude fiber (%)	2.81	2.76	2.71	2.67	2.76	2.71	2.67
Ether extract (%)	4.33	4.27	4.21	4.17	4.27	4.21	4.17
Total ash (%)	6.86	6.81	6.77	6.74	6.81	6.77	6.74
Lysine** (%)	1.21	1.21	1.21	1.21	1.21	1.21	1.21
Methionine** (%)	0.44	0.45	0.45	0.45	0.45	0.45	0.45

*Feed additives included Spectromix (10g), Spectro BE (20g), coccidiostat (50g), choline chloride (50g), cygro (20g), lysine (50g), methionine (150g). **Calculated values

T1=control diet; T2=33.3% maize replaced with ground sorghum; T3=66.6% maize replaced with ground sorghum; T4=100% maize replaced with ground sorghum; T5=33.3% maize replaced with unground sorghum; T6= 66.6% maize replaced with unground sorghum; T7=100% maize replaced with unground sorghum

Table 2
Per cent proportion of feed ingredients, additives, chemical composition (% on DM basis) and metabolizable energy of finisher diets

Feed Ingredients	Treatments						
	T1	T2	T3	T4	T5	T6	T7
Maize	59	39.34	19.66	—	39.34	19.66	—
Ground sorghum	—	19.66	39.34	59	—	—	—
Whole sorghum	—	—	—	—	19.66	39.34	59
Soybean meal	21	21	21	21	21	21	21
Fish meal	10	10	10	10	10	10	10
Rice polish	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Mineral mixture	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Total	100	100	100	100	100	100	100
Feed additives* (g/100kg feed)	350	350	350	350	350	350	350
Feed cost (Rs./100kg)	1753.68	1778.47	1803.28	1827.48	1777.27	1800.80	1824.48
Chemical Composition							
ME** (Kcal/kg)	2900.88	2859.89	2818.66	2777.57	2859.89	2818.66	2777.57
Crude protein (%)	20.01	20.17	20.32	20.48	20.17	20.32	20.48
Crude fiber (%)	2.91	2.86	2.80	2.74	2.86	2.80	2.74
Ether extract (%)	4.69	4.64	4.58	4.52	4.64	4.58	4.52
Total ash (%)	6.99	6.94	6.90	6.85	6.94	6.90	6.85
Lysine**(%)	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Methionine** (%)	0.40	0.40	0.41	0.41	0.40	0.41	0.41
Calcium (%)	1.69	1.72	1.73	1.76	1.72	1.73	1.76
Phosphorus (%)	0.81	0.83	0.84	0.86	0.83	0.84	0.86

*Feed additives included Spectromix (10g), Spectro BE (20g), coccidiostat (50g), choline chloride (50g), cygro (20g), lysine (50g), methionine (150g)., **Calculated values

T1=control diet; T2=33.3% maize replaced with ground sorghum; T3=66.6% maize replaced with ground sorghum; T4=100% maize replaced with ground sorghum; T5=33.3% maize replaced with unground sorghum; T6= 66.6% maize replaced with unground sorghum; T7=100% maize replaced with unground sorghum

Table 3
Effect of replacement of maize with sorghum on performance of broiler chickens

Treatment	Periods (Weeks)					
	Body weight gain (g/bird)		Feed intake (g/bird)		FCR	
	0-4	0-6	0-4	0-6	0-4	0-6
T1	932.42^{a}+27.62	1827.59^{a}+10.79	1790.00^{a}+50.0	3850.00^{a}+100.0	1.91^{c}+0.01	2.10^{bcd}+0.02
T2	935.73^{a}+18.15	1831.95^{a}+15.04	1789.00^{a}+21.5	3837.50^{a}+50.5	1.90^{c}+0.02	2.09^{bcd}+0.01
T3	933.92^{a}+12.22	1829.81^{a}+13.89	1775.00^{a}+25.0	3795.00^{a}+60.0	1.89^{c}+0.02	2.07^{d}+0.03
T4	840.35^{b}+12.75	1678.69^{b}+12.93	1702.05^{b}+20.5	3622.05^{b}+20.5	2.01^{b}+0.01	2.15^{ab}+0.03
T5	928.81^{a}+11.86	1819.76^{a}+12.19	1780.00^{a}+10.0	3820.00^{a}+60.0	1.91^{c}+0.02	2.09^{bcd}+0.01
T6	927.45^{a}+19.09	1815.85^{a}+14.05	1770.00^{a}+20.0	3780.00^{a}+20.0	1.90^{c}+0.01	2.08^{cd}+0.01
T7	828.08^{b}+16.72	1629.69^{b}+14.05	1692.50^{b}+50.5	3572.00^{b}+21.5	2.07^{a}+0.03	2.19^{a}+0.01

Means bearing different superscripts in the same column differ significantly (P< 0.05)
T1=control diet; T2=33.3% maize replaced with ground sorghum; T3=66.6% maize replaced with ground sorghum; T4=100% maize replaced with ground sorghum; T5=33.3% maize replaced with unground sorghum; T6= 66.6% maize replaced with unground sorghum; T7=100% maize replaced with unground sorghum; FCR=Feed conversion ratio

Table 4
Effect of replacement of maize with sorghum on performance of broiler chickens

Treatments	Dry matter metaboliz-ability	Nitrogen retention	Calcium retention	Phosphorus retention	Gross energy of feed (Kcal/kg)	Gross energy of excreta (Kcal/kg)	Nitrogen corrected metabolizable energy (Kcal/kg)	Gross energy metaboliz-ability (%)
T1	64.35^{a}±3.05	62.11^{a}±1.01	45.52^{a}±1.50	56.05±1.45	4215.40	3113.06^{abcd}±0.79	2905.52^{ab}±5.10	68.93^{a}±2.02
T2	65.93^{a}±3.02	63.02^{a}±1.02	45.77^{a}±4.72	56.05^{a}±1.25	4122.59	3122.44^{abcd}±1.01	2864.78^{c}±4.10	69.48^{a}±3.23
T3	64.74^{a}±2.05	62.43^{a}±2.05	46.00^{a}±3.40	57.50^{a}±1.00	4127.62	3099.01^{abcd}±0.99	2862.49^{c}±2.01	69.34^{a}±1.02
T4	63.77^{a}±2.05	61.86^{ab}±1.09	46.35^{a}±2.85	55.85^{a}±1.45	4092.34	3178.16^{a}±1.01	2754.54^{f}±2.10	68.82^{a}±2.22
T5	64.55^{a}±4.45	62.54^{a}±2.05	45.65^{a}±1.15	55.55^{a}±3.95	4179.29	3110.31^{abcd}±1.25	2922.95^{a}±10.80	69.76^{a}±3.33
T6	64.02^{a}±3.55	61.89^{ab}±1.05	45.85^{a}±1.65	56.15^{a}±4.05	4121.65	3078.59^{cd}±3.95	2848.31^{cd}±12.20	69.10^{a}±1.10
T7	61.27^{b}±3.25	58.12^{b}±3.10	44.35^{a}±0.85	55.30^{a}±0.60	4109.24	3147.39^{abc}±0.50	2755.69^{f}±15.10	67.05^{b}±2.05

Means bearing different superscripts in the same column differ significantly (P< 0.05)
T1=control diet; T2=33.3% maize replaced with ground sorghum; T3=66.6% maize replaced with ground sorghum; T4=100% maize replaced with ground sorghum; T5=33.3% maize replaced with unground sorghum; T6= 66.6% maize replaced with unground sorghum; T7=100% maize replaced with unground sorghum

analyzed using completely randomized design as described by Snedecor and Cochran (1994). Analysis of variance was used to study the differences among treatment means and they were compared by using Duncan's Multiple Range Test (DMRT) as modified by Kramer (1956).

RESULTS AND DISCUSSION

The body weight gain at 42 days was significantly lower in T7 (1629.69g) and T4 (1678.69g) diets as compared to T1 (1827.59g) which might be due to 100% replacement of maize with sorghum leading to reduced feed intake. Korane *et al.* (1996) and Reddy *et al.* (2008) recommended 50% replacement of maize with pearl millet and sorghum. Similarly significantly lower feed intake was observed in T4 (3622.05g) and T7 (3572g) as compared to T1 (3850g). Non-significant difference in feed intake was observed in sorghum based diets irrespective of the physical form upto 66.6% replacement level as compared to control. These results are in conformity with Gupta and Kishore (2006). At six weeks of age, higher FCR was observed in T7 (2.19) and T4 (2.15) as compared to T1 (2.10). The FCR was significantly (P<0.05) higher in 100% sorghum based diets as such and ground as compared to T1 (2.10) which may be due to lower growth rate in these groups. The results of our investigation are in

conformity with Subramanian and Metta (2000) and Mandal *et al.* (2004). Contrary to our findings, Tyagi *et al.* (2003) and Jha and Kumar (2008) reported no effect on FCR by complete replacement of maize with sorghum and pearl millet, respectively.

Dry matter metabolizability decreased significantly in T7 (61.27) as compared to T1 (64.35) and other treatments. However, there was no difference among T2, T3, T4, T5 and T6 treatments. Further it was found that there was no effect of physical form of sorghum upto 66.6 % replacement on dry matter metabolizability. Similarly, nitrogen retention also decreased significantly in T7 as compared to T1 treatment. Whereas there was no difference observed among sorghum based treatments upto 66.6% with or without grinding. The results of this study indicated that grinding may be required to utilize 100% sorghum based diets. Similar results were also reported by Elangovan *et al.* (2004) and Gupta (2004). The gross energy (GE) metabolizability was the lowest in T7 (67.05%) treatment which might be due to lower energy and presence of anti-metabolites in sorghum (Tyagi *et al.*, 2003). Similar results were also reported by Raju *et al.* (2003). Percent calcium and phosphorus retention in different dietary treatments was not affected. These findings are in agreement with Ahmad *et al.* (2000), Rama Rao *et al.* (2004) and Mandal *et al.* (2004).

Based upon the results of the present study, it can be concluded that sorghum can effectively replace maize up to 66.6% without any adverse effect on the performance and nutrients utilization in broilers.

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