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Utilization

Performance of Layers on Sorghum-Based Poultry Feed Rations

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Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] in India is grown in the rainy as well as postrainy seasons, generally by resource-poor small farmers in the semi-arid regions. The rainy season sorghum is often vulnerable to grain deterioration due to grain mold attack, making it unfit for food use. However, normal and molded grain has enormous demand for industrial uses such as preparation of animal/poultry feed and alcoholic beverages. A lack of assured supply of the sorghum grain produced in rainy season limits its use to only about 10% of the potential industrial demand. By 2010, the demand for rainy season sorghum for industrial use is estimated to increase by 10–30%; with the major demand expected to be from the poultry industry, which is growing at a rate of 15-20% per annum (Kleih et al. 2000). But, apprehension about energy levels of sorghum-based feed rations among feed manufacturers and poultry producers is one of the major limiting factors for its use in the poultry industry.

Considering the expected increase in demand and to assess the feasibility of the use of sorghum grain based rations in poultry industry, ICRISAT along with Acharya NG Ranga Agricultural University (ANGRAU) conceptualized and implemented a project (funded by Department for International Development, UK) in collaboration with the non-governmental organizations, Federation of Farmers Associations (FFA), Andhra Pradesh Poultry Federation (APPF) and Janaki Feeds (a private sector partner). One of the project's goals is aimed at enhancing the use of rainy season sorghum in poultry feed rations in layer production as a potential alternative to maize and to create sustainable marketing linkages between sorghum growers and the poultry industry through innovative institutional systems. Performance of layers on rainy season sorghum grain-based feed rations was studied and the results are reported in this article.

Materials and Methods

Improved sorghum cultivars such as CSV 15, PSV 16, CSH 16 and S 35 were supplied in the rainy season of 2003 to 74 selected farmers in four villages of Mahabubnagar and Ranga Reddy districts of Andhra Pradesh, India. In each village, meetings were held with farmers where the objectives and methodology of the experiment were explained and participation was solicited on a voluntary basis. Efforts were also made to encourage female farmers to participate. Farmers were selected randomly with the help of FFA. Farmers selected to participate in these trials broadly possessed the following characteristics, as guided by Ray et al. (1989).

- They were willing to accept the innovations (such as high-yielding moderately mold resistant sorghum cultivars)
- They were traditional sorghum farmers using normal agronomic practices
- They were willing to be guided by research staff and to carry out operations as prescribed.
- They all agreed to cooperate without any financial incentives other than subsidized seed.

The project staff monitored the crop frequently and the farmers were advised appropriately on following recommended production practices. After harvest, the surplus grain was bulked at village level and supplied to Janaki Feeds (poultry feed manufacturer) and poultry feed rations were prepared using the sorghum in different proportions. The Poultry Feed Trials (PFTs) were conducted at Poultry Experimental Station, ANGRAU, Rajendranagar, Hyderabad. Maize-based diets were used as control in the PFTs.

Experimental diets. Sorghum was included part-by-part replacing maize at 0%, 50%, 100% and 100% + *3% Stylo* of control diet. Each diet was prepared both in mash and pellet forms, making for a total of 8 treatments. *Stylosanthes* leaf meal was included in place of deoiled rice bran as a source of dietary yellow pigment for egg yolk color. Feed and water was offered ad libitum during the experimental period.

Birds and housing. Five hundred, four day-old commercial chicks of egg type (White Leghorn) were classified into 42 groups based on body weight. All the groups were randomly allotted to six treatments i.e., 0%, 50% and 100% sorghum inclusion diets, each in both mash and pellet forms. Each of the dietary treatments was allotted to seven replicate groups during the growth period (day old to 18 weeks age) and four replicate groups during laying period (24-44 weeks age). Birds were housed in electrical battery brooders up to the age of 8 weeks, and then all the birds were shifted to grower cum layer cages up to 18 weeks age (At this stage, the experiment was disturbed due to mortality across all the treatments in experimental station. During this period, all the birds were given control diet. After six weeks the trials were continued). At the age of 24 weeks, 256 birds were allotted to 32 groups (8 birds/group) based on their egg production and housed individually. All the groups were randomly allotted to 8 treatments i.e., 0%, 50%, 100% and 100% + 3% *stylo* sorghum inclusion diets, each in both mash and pellet forms. A common layer vaccination schedule was followed.

Body weight and feed intake of birds were recorded at 2-week intervals during the growing period. Feed conversion ratio (FCR) was calculated as feed/body weights at 8 and 18 weeks of age. Mortality if any during growing period was also recorded. Layer trial data were collected for a total of 5 periods from 24 weeks to 44 weeks of age. Each period comprised of 4 weeks (28 days) duration. Data on egg production and mortality if any were recorded daily. Data on body weight and feed intake were recorded. To study egg quality traits, two eggs were taken on 3 consecutive days from each replicate at the end of each period. Eggs were weighed individually and internal egg quality parameters such as albumin index, yolk index, Haugh unit score, shell thickness and yolk color scores were recorded period-wise. Yolk color score was recorded by comparing the standard Roche Fan color scale. FCR was calculated at the end of each period and expressed as feed (kg)/ 12 eggs and feed (kg) /kg egg mass. Feed cost up to 8, 18 week age period and also feed cost per egg during each period of the laying stage was estimated.

Results and Discussion

There were no significant differences between the control and sorghum grain-based diets with respect to body weight, feed intake and feed conversion ratio (FCR) up to 8 weeks of age (Table 1). These results are in line with those of Madacsi et.al. (1988). However, at 18 weeks of age, there were significant differences in body weight and feed intake among the treatment groups. It was interesting to note that the body weight and feed intake of birds fed on control diet in mash form were high compared to that of other dietary treatments despite the nonsignificant differences in FCR among the treatments. All the birds achieved standard body weight of 1.2 kg by the end of 18 weeks irrespective of their diet treatment.

Table 1. Performance of egg type commercial chickens on different sorghum grain-based diets.

		8th week age				18th week age			
Treatment	Feed form	Feed intake (g)	Body weight (g)	FCR (feed/gain)	Feed cost up to 8th week (Rs)	Feed intake (g)*	Body weight (g)*	FCR (feed/gain)	Feed cost up to 18th week (Rs)
Sorghum @ 50%	Mash	1933	637	3.038	14.44	6100[a]		5.083	42.15
	Pellet	1911	652	2.935	14.75	6073[a]	1206[a]	5.037	43.48
Sorghum @100%	Mash	1897	637	2.978	13.88	6136[a]	1208[a]	5.083	41.54
	Pellet	1896	645	2.938	14.35	6176[ab]	1202[a]	5.138	43.35
Control	Mash	1901	621	3.061	14.47	6324[b]	1233[b]	5.130	44.58
	Pellet	1884	658	2.865	14.80	6129[a]	1202[a]	5.102	44.74
SEm±		41.1	16	0.091		76.9	9.4	0.071	

*Values followed by the same letter in the column are not significantly different at 5% level.

Table 2. Performance of commercial layer birds on sorghum grain-based diets.

Treatment	Feed form	Egg production Hen-day%	Feed intake (g)*	FCR/ 12 eggs (g)	FCR/kg egg mass (g)	Egg weight (g)*	Feed cost/egg (Rs)
Sorghum @ 50%	Mash	84.9	112.3[ab]	1.603	2.426	55.1[ab]	1.10
	Pellet	86.6	115.3[bcd]	1.598	2.396	55.5[bc]	1.04
Sorghum @ 100%	Mash	87.4	115.3[bcd]	1.586	2.434	54.2[a]	1.07
	Pellet	87.9	112.6[ab]	1.543	2.341	54.9[ab]	1.01
Sorghum @ 100% + *Stylo* 3%	Mash	85.3	111.1[a]	1.570	2.401	54.4[ab]	1.01
	Pellet	86.0	113.7[abc]	1.588	2.343	56.4[c]	0.99
Control	Mash	87.1	117.1[d]	1.614	2.481	54.1[a]	
	Pellet	86.7	116.5[cd]	1.615	2.377	56.6[c]	1.07
SEm±		0.92	1.61	0.040	0.068	0.57	1.04

*Values followed by the same letter in the column are not significantly different at 5% level.

Table 3. Egg quality parameters of birds fed on sorghum grain-based diets.

Treatment	Feed form	Haugh unit score	Albumen Index	Yolk index	Shell thickness (mm)	Yolk color score
Sorghum @50%	Mash	74	0.070	0.377	0.376	++
	Pellet	72	0.068	0.376	0.371	++
Sorghum@100%	Mash	73	0.073	0.379	0.369	+
	Pellet	74	0.070	0.368	0.355	+
Sorghum@100%+Stylo 3%	Mash	72	0.067	0.370	0.371	++
	Pellet	72	0.066	0.394	0.355	++
Control	Mash	75	0.072	0.383	0.361	++++
	Pellet	75	0.073	0.388	0.376	++++
SEm±		1.6	0.003	0.011	0.006	

Note: Cost of maize and sorghum was considered as Rs.6 kg^{-1} and Rs. 5.40 kg^{-1}, respectively.

Highest reduction in cost of feed was observed in diets on 100% replacement of maize with sorghum in both mash and pellet forms as well up to 8 weeks of age. Similar cost reduction was observed on sorghum-based diets up to 18 weeks of age.

The egg production performance of commercial layers (24-44 weeks) did not appear to be influenced by their diet treatments (Table 2). The results reported by Ambula et al. (2003) lend sufficient support to the present findings. Inclusion of *Stylosanthes* leaf meal at 3% in the diet comprising 100% sorghum in place of maize resulted in lower feed consumption by commercial layers compared to control diet. However, diet form did not have any influence on feed consumption. FCR was similar in all the experimental diets. Significant differences in egg weight among the treatments were observed with pellet diets resulting in higher egg weight compared to mash diets. The results are in congruence with the findings of Madacsi et.al. (1988). Feed cost per production of an egg was low in sorghum diets compared to control. Inclusion of 3% *Stylosanthes* leaf meal in sorghum diets further lowered the feed cost.

There is no reason to believe that inclusion of sorghum at any level in feed ration affects internal egg quality parameters (Table 3). However, the egg yolk color assessed by visual score method indicated a proportionate reduction due to inclusion of sorghum at different levels in diets. Though egg yolk color improved with the inclusion of *Stylosanthes* leaf meal at 3% level in 100% sorghum diet, the improvement was only 50%. Mortality throughout the experiment was within normal limits.

Conclusions

The experiments showed that maize can be replaced by sorghum in poultry feed rations without affecting body weight and egg production performance of layer birds. Considerable cost reduction was also achieved with sorghum-based diets, particularly in mash form. Quality traits of eggs produced by layer birds fed with sorghum-based diets were also comparable to that of maize-based diets except yolk colour. However, yolk colour was partially improved with addition of 3% *Stylosanthes* leaf meal at 100% inclusion level of sorghum with considerable positive cost effectiveness. These results provide sufficient evidence to dispel the apprehensions among poultry feed manufacturers and poultry producers about the use of sorghum grain as an alternative to maize in poultry feed rations. The encouraging results have been already disseminated to poultry feed manufacturers and poultry producers through stakeholder workshops.

Acknowledgments. This publication is an output of a research project funded by the Department for International Development (DFID) UK for the benefit of developing countries. The views expressed are not necessarily those of DFID, R8267, *Crop Post-Harvest Research Programme* (CPHP). Authors are grateful to Indian Grassland and Fodder Research Institute (IGFRI) for providing *stylo* leaf meal.

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Sweet Sorghum – A Potential Alternate Raw Material for Bio-ethanol and Bio-energy

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Introduction

Sweet sorghum [*Sorghum bicolor* (L.) Moench] is a special purpose sorghum with a sugar-rich stalk, almost like sugarcane. Besides having rapid growth, high sugar accumulation, and biomass production potential, sweet sorghum has wider adaptability (Reddy and Sanjana 2003). Given that water availability is poised to become a major constraint to agricultural production in coming years (Ryan and Spencer 2001), cultivation of sugarcane becomes difficult. Sweet sorghum would be a logical crop option in lieu of sugarcane in such situations. Sweet sorghum can be grown with less irrigation and rainfall and purchased inputs compared to sugarcane. The sugar content in the juice extracted from sweet sorghum varies from 16–23% Brix. It has a great potential for jaggery, syrup and most importantly fuel alcohol production (Ratnavathi et al. 2004a). The stillage after extraction of juice from sweet sorghum can be used for co-generation of power.

Need for alternate raw material

The Supreme Court of India informed the Government of India (GOI) to use Compressed Natural Gas (CNG) as an alternative to petrol and diesel for fuelling automobiles to reduce environmental pollution. However, considering the reduced output by the Oil and Natural Gas Corporation (ONGC), and thereby likely shortage of CNG in future (Anonymous 2001), the GOI has made it mandatory to blend petrol and diesel with ethanol (to reduce carbon monoxide emission in automobiles) initially up to 5% and gradually hiking it to 10% in the second phase. There are two objectives in this strategy, reducing both the environmental pollution and the fuel-import bill for the country. According to the Federation of Indian Chambers of Commerce and Industry (FICCI), India could save nearly 80 million L of petrol annually if petrol is blended with alcohol by 10%. Burning quality of alcohol-blended petrol is more eco-friendly than that of CNG (Arbatti 2001). These environment and cost considerations have triggered a debate on the availability of adequate raw material to meet the possible increased demand for ethanol production. Molasses (a by-product of sugarcane after the extraction of sugar), the traditional source of raw material for ethanol production, is unlikely to meet the actual demand in the long run (Ratnavathi et al. 2004b). The requirement of ethanol in India to blend with petrol (10%) is about 1000 million L, and for blending with diesel (5%) another 3000 million L per annum. Total ethanol requirement including other purposes is 5000 million L per annum. The possible ethanol production from available sugarcane molasses (8.2 million t) and other sources is 2000 million L per annum. This leaves a deficit of 3000 million L of ethanol per annum. Further, the molasses-based ethanol distilleries operate only for 180 days (during sugarcane crushing season) because of the limited availability of the molasses to run the distillery throughout the year as well as the problems associated with the spent wash to comply with pollution control standards [Personal communication from Patil, Vasanthadada Sugar Institute (VSI), Pune, India]. The existing distilleries therefore, operate at 50% efficiency and needs alternate raw material(s) to operate at their full efficiency (Anonymous 2004). The underutilization of the existing molasses-based ethanol distilleries and the deficit in ethanol requirement can be made good if sweet sorghum cultivation is promoted for ethanol production.

Comparative advantages of sweet sorghum

In recent years, there has been increased interest in the utilization of sweet sorghum for ethanol production in India as its growing period (about 4 months) and water requirement (8000 m^3 over two crops) (Soltani and Almodares 1994) are 4 times lower than those of sugarcane (12–16 months and 36,000 m^3 $crop^{-1}$, respectively). The cost of cultivation of sweet sorghum is three times lower than that of sugarcane (Dayakar Rao et al. 2004) (Table 1). Further, sweet sorghum is best suited for ethanol production because of its higher total reducing sugar content and poor sugar content compared to sugarcane juice (Huligol et al. 2004). The presence of reducing