Enhanced Utilization Of Sorghum And Pearl Millet Grains In Poultry Feeds – An Indian Perspective

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Abstract

Sorghum and pearl millet are two important dry land crops that provide grain and fodder. India is the largest pearl millet producer and second largest producer of sorghum in the world. The productivity of these crops has been low due to various reasons such as unavailability of quality inputs to the farmers, lack of access to improved technologies for crop production, unavailability of credit on time, grain moulds, poor market linkages etc are some of the issues associated with these crops. There is large potential for using sorghum and pearl millet as an alternate to maize in poultry feed. Improving the grain quality by sorghum farmers and understanding the nutritive value of sorghum and pearl millet by poultry producers and feed manufacturers is essential in the promotion of these crops for alternate uses. . Chemical composition, nutritive value and utilization of sorghum and pearl millet for poultry reviewed. The grain nutritive value is comparable and even better with some of the improved cultivars than maize. Recently developed cultivars are low in tannins and grain moulds. Technology for prevention of grain moulds through harvest of the crop at physiological maturity and drying the ear-heads with driers and scientific storage methods have been proved to be the best practices that are demonstrated to the farmers for high grain quality and better market price. New alternative markets are emerging for sorghum and pearl millet grain uses. Sorghum and pearl millet are in the initial stages of entering the commercial chain in both livestock and poultry feed, and in production of alcohol, starch and other products. Experiments have also showed that maize can be replaced by sorghum harvested in rainy season even up to 100 percent, and that the use of rainy season-produced sorghum in poultry feed rations is more cost effective if sorghum is priced at 15 to 20 per cent discount compared to maize

Key words: Sorghum; Pearl millet grains; Grain moulds; Tannins; Mycotoxins

Introduction

Sorghum (*Sorghum bicolor*) and pearl millet (*Pennisetum glaucum*) are the important food and fodder crops that sustain rural livelihoods in most of the Asian and African countries. World sorghum production is 59.7 mt out of which 74.2 per cent produce is from developing countries. Asia represents 19.9 per cent of world's sorghum production. Among the Asian countries India (7.46 mt), China (2.69 mt), Thailand (0.19 mt) are the major sorghum producing countries. With 6.99 mt, India stands first in the world's pearl millet production. Leading sorghum producing states in India are Maharashtra, Andhra Pradesh, and Karnataka while pearl millet is mainly in Rajasthan. Sorghum and pearl millet productivity per hectare from India (1.0 and 0.75 mt ha^{-1}) is low compared to China (2.8 and 1.43 mt ha^{-1}) (Rao *et al*.,2003). Low productivity, grain moulds, no support from government and poor market linkages are some of the important issues faced by Indian sorghum and pearl millet farmers.

The rainy season sorghum grain is vulnerable to grain moulds as it comes to harvest in the rainy season and alternative uses are mainly animal feed (0.57 to 0.86 mt), alcohol (0.09 to 0.10 mt) and starch (Rao *et al*., 2003). Good quality sorghum (post-rainy season grain) is expensive and often used for human consumption. Due to changes in food habits and also government subsidies on rice and wheat, sorghum grain for food purpose is declining.

High growth rate (15%) of Indian poultry industry demands large requirement of these cereals. Among the cereals, maize is the principal component (50%) of poultry feed. Maize availability is not in tune with the demand for industrial use particularly poultry feed. There is a shortfall of maize to the extent of 1 to 1.5 million tones for poultry feed formulations. Inadequate maize always demands other cereals such as sorghum and pearl

millet to lower the feed costs. Cost and quality of sorghum grain is important for sorghum growers, poultry producers and feed manufacturers. Projected utilization of sorghum for animal feed would go up to 3.7 million mt by 2010.

Sorghum and pearl millet are utilized globally in poultry feed but still Indian poultry producers have not realized the potential of these grains due to certain misconceptions mainly tannins and lack of awareness on the grain quality and nutritive value. DFID –CPHP (2003) and CFC-FAO-ICRISAT (2005) projects have given impetus on the sorghum and pearl millet utilization in poultry feeds in India. A review on use of these grains in poultry feeds is attempted in this paper.

Chemical composition and nutritive value of sorghum and pearl millet

Sorghum and pearl millet are energy ingredients with higher protein than maize. Nutritive value and utilization of these grains including recent sorghum cultivars in poultry feeds were reviewed by Rajashekher *et al* 2003 (Table 1 and 2). The reported variation in metabolizable energy, tannins could be due to cultivars, methodology and experimental errors. Although digestibility was slightly low, the amino acid content was higher than maize particularly tryptophan (Table 3). Most cereals contain non-starch polysaccharides (NSP). The latter cause increased digesta viscocity, impairs digestion or absorption in poultry. Cocht (2006) reported lesser NSP in sorghum than maize (4.8% *vs* 8.1%). Biotin (0.26 vs 0.06 ppm), niacin (41 vs 24 ppm), pantothenic acid (12.4 vs 4.0 ppm) vitamins and some of the trace minerals including selenium (0.2 vs 0.03 ppm), manganese (15 vs 7 ppm), copper (10 vs 3 ppm) were higher in sorghum than maize (NRC 1994). Selenium and biotin are nutritionally advantage for better health and disease resistance of birds.

Sorghum phenolic compounds (Tannins)

Sorghum is unique among major cereals because some cultivars produce polymeric phenols known as tannins. All sorghums contain phenols and most contain flavonoids and only few cultivars with a pigmented testa, B1_B2_ genes, produce condensed tannins (proanthocyanidins). Most cultivated sorghum do not contain condensed tannins even though non-tannin, phenolic compounds are occasionally reported as tannins. Tannins have antioxidant properties considered as neutraceuticals (Waniska, 2000). The tannins bind with protein and other nutrients and cause growth depression in birds. The color of the grain is not suggestive of tannins. The tannin can be estimated by simple bleaching test (Leeson and Summers, 2001) or by chemical analysis using certain standards like catechin (Waniska,2000). Tannin analysis much depends on the correct use of extraction protocols and tannin standards. The agronomic practices and plant breeding protocols have significantly reduced the tannin content. Sorghum cultivars reported by Tulasi *et al* (2004) contained very less tannins particularly condensed tannins (Table 2).

Sorghum grain moulds and grain weathering

Sorghum grain with open type panicle (ear-head) inhabits several fungi. Grain moulds including grain weathering is problematic in hot, humid environments. This reduces grain yield and quality which affect physical properties, processing, nutritional and market value (Glueck *et al*., 1978). Unfavorable weather conditions at the time of grain harvest may lead to grain discoloration or black color. Harvesting sorghum ear-heads at physiological maturity followed by drying prevented grain moulds and improved the grain quality during prolonged storage (CFC-FAO-ICRISAT, 2005).

Mycotoxins of sorghum and pearl millet

Common mycotoxins in sorghum are fumonisins, aflatoxins, T2 and ochratoxins. These toxigenic fungal strains grow when moisture content exceeds 12 per cent . Fumonisins and aflatoxins were very low in certain sorghum cultivars (Table 2). Sorghum and pearl millet are no different from maize or any other cereal as far as mycotoxin hazards are concerned but are relatively less susceptible to mycotoxins due to hard seed coat and phenolic compounds. Acotinic acid in sorghum is believed to be mycotoxin preventive agent (Hodges, 2000).

Sorghum poultry feed trials

The recent sorghum cultivars with low tannins and less susceptible to grain moulds were found superior in terms of their grain yield, grain quality and fodder acceptability by livestock (Smith, 2005). Poultry feed trials conducted at Poultry Science department, College of Veterinary Science, Hyderabad have explored and disseminated the knowledge on utilization of sorghum in poultry feed (Tulasi *et el.* 2004, Rajashekher *et al*. 2005). Sorghum can replace maize completely in poultry feeds. Rainy season sorghum with moderate grain moulds (up to a score of 3 out of 5) was as good as maize for feeding poultry. The sorghum fed broilers revealed comparable performance to that of maize in terms of FCR, growth rate and livability. Some of the sorghum cultivars like *CSV-15, PSV-16* have shown better broiler performance. Sorghum based pellet feed reduced feed cost by about Rs 0.30 kg^{-1} broiler over maize based diet. Egg production, egg weight and FCR were comparable on sorghum to that of maize. The cost of rearing pullets (up to 18 weeks age) reduced by Rs 3 $bird^{-1}$ on sorghum and similarly the feed cost also reduced by Rs.6 for every 100 eggs produced. Sorghum based diets deficient in pigments caused paler skin, shank and egg yolk but inclusion of S*tylosanthes* leaf meal at 3 per cent or marigold at 1 per cent appreciably improved the pigmentation.

Pearl millet utilization in poultry diets

Pearl millet grain in poultry feeds is an alternate to maize for broilers and layers. When pearl millet replaced maize part per part or isocalorically and isoproteinically the performance of chicks was either comparable or better than that on maize (Asha *et al*. 1986; Nagra *et al*. 1987; Reddy *et al* 1989; Purushothaman and Thirumalai 1995). Pearl millet was included at 32 per cent part by part for maize and at 60 per cent part per part or isocalorically and isoproteinically at the expense of maize. In all the cases, the performance of layers with pearl millet feed was comparable to that on maize, but for yolk color (Reddy and Reddy, 1970; Kumar *et al* 1991 and Srilatha, 1995).

Institutional arrangements for enhanced utilization of sorghum and pearl millet in poultry feed

Following success of sorghum poultry feed coalition (Smith, 2005 and Reddy *et al*., 2006), CFC/FAO/ICRISAT project was initiated in Asia (India, China and Thailand) to enhance sorghum and pearl millet utilization in poultry feed/industry by addressing crop productivity, grain quality, grain use in poultry feed, micro financing aspects for improving the market opportunities through institutional arrangements involving universities, farmer organizations, non-governmental institutions and private companies. The results are encouraging in two clusters of Andhra Pradesh and three clusters of Maharashtra states of India.

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Table 1 Chemical composition % and nutritive value of different cereals (as feed basis)

Parameter	Sorghum	Pearl millet	Maize
Dry matter %	87	89	89
ME_n (kcal / kg)	3288	2675	3350
Crude protein %	8.8	14	8.5
Fat %	2.9	4.3	3.8
Crude fiber %	2.3	3.0	2.2
Linoleic acid %	1.13	0.84	2.20
Calcium %	0.04	0.05	0.02
Total phosphorus	0.30	0.32	0.28
Non phytin phosphorus	0.09	0.12	0.08

Source: NRC (1994)

Table 2 Chemical composition and nutritive value of different sorghum cultivars (on dry basis)

Parameter	Jowar culitvars			
	CSV-15	**CSH-16**	**PSV-16**	**S-35**
Energy (ME Kcal/kg)	3422	3196	3402	3238
Crude protein,%	9.56	10.13	10.96	11.79
Ether extract,%	3.01	2.85	2.40	3.73
Crude fiber,%	3.20	2.48	2.81	4.02
Ash,%	1.13	1.29	1.37	1.53
Nitrogen free extract,%	83.10	83.25	82.46	78.93
Calcium,%	0.051	0.047	0.050	0.052
Phosphorus,%	0.226	0.270	0.260	0.304
Tannins %(catechin)	0.038	0.023	0.030	0.023
Aflatoxins (ppm)	0.0025	0.011	0.054	0.036
Fumonisin (ppm)	0.160	1.132	0.277	0.157

Tulasi *et al* (2004)

Table 3 Amino acid composition of sorghum and maize and their digestibility coefficients, %

Amino acid	**Pearl millet**[2]	**Maize**[1]	**Sorghum cultivars**[1]				**Digestibility coefficients**[1]	
			S-35	**PSV-16**	**CSV-15**	**CSH-16**	**Sorghum**	**Maize**
Met	0.25	0.18	0.17	0.17	0.15	0.16	88	91
Cys	0.24	0.19	0.19	0.16	0.17	0.18	80	88
Lys	0.45	0.27	0.22	0.20	0.20	0.20	78	82
Thr	0.48	0.32	0.33	0.30	0.27	0.29	80	84
Trp	0.08	0.07	0.12	0.11	0.09	0.10	85	80
Arg	0.74	0.44	0.40	0.36	0.33	0.34	78	90
Ile	0.37	0.31	0.40	0.36	0.31	0.35	88	89
Leu	1.14	1.07	1.31	1.19	0.79	1.16	93	93
Val	0.49	0.42	0.51	0.47	0.46	0.45	86	88
His	0.39	0.26	-	-	-	-	86	91
Crude protein	14	8.5	11.79	10.96	9.56	10.13	-	-

[1] Tulasi *et al* (2004) [2]NRC (1994)