NUTRITIVE EVALUATION OF FOUR SORGUM CULTIVARS GROWN IN BOTSWANA

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ABSTRACT

Botswana produces more sorghum compared to maize because of the climatic conditions that are prevalent in the country. However, most poultry feeds are manufactured based on maize even though there is high competition between the poultry industry and humans for maize. The increasing poultry feed prices have led to the collapse of most poultry projects especially, small-scale projects. A study was conducted to evaluate the amount of tannins in the sorghum varieties available in Botswana with possible inclusion in poultry diets. The poultry industry in Botswana is at its infant stage and most of the inputs are imported from neighboring countries. The tannin contents of the Phofu, Sephala, Mmabaitse and Segaolane sorghum cultivars were not significantly different (P>0.05) from each other 0.14, 0.15, 0.08 and 0.06% respectively. The crude protein contents of the four sorghum cultivars were 11.5, 10.8, 11.7 and 11.9% respectively and were also not significantly different. A similar trend was found for Phosphorus content (0.47, 0.31, 032 and 0.56%) respectively. The crude fibre content of the sorghum cultivars, (4.89, 7.40 and 6.87%) respectively, was not significantly different (P>0.05) and so was the crude fat content (4.48, 5.23, 4.27 and 8.81). Digestibility of the four sorghum cultivars was also not P>0.05 significantly different (95.47, 89.70, 89.54 and 94.16%) respectively. Energy in this was study was not measured because of lack of the equipment to do energy analysis. It was concluded that sorghum varieties grown in Botswana are not significantly different (P>0.05) in terms of tannin content and are of low tannin content. Similarly, there are no significant differences (P>0.05) between the sorghum cultivars grown in Botswana for the most important nutrients, i.e., crude protein, phosphorus, crude fibre, crude fat and digestibility. This study shows that sorghum cultivars grown in Botswana might be included in poultry feeds formulations without any deleterious effects.

Keywords: Botswana, sorghum varieties, tannin content, poultry, important nutrients.

INTRODUCTION

In Botswana, there are two systems of poultry farming namely village or traditional and commercial poultry production. It is estimated that village chickens account for about 3.5 million of the national flock (Moreki, 2000). Despite the developments in the diversification of the rural economy, indigenous chickens were never considered as a commodity that could improve the lives of rural people particularly women. This is because indigenous chickens are low producing and have slow growth rates, which would not sustain any intensive

production.

Commercial poultry production in Botswana on the other hand is based on exotic poultry strains. The commercial broiler production system is characterized by flocks ranging from 200 to 4 500 birds per shed depending on the scale of production. The layer production systems range from 500 to about 10 000 birds per shed (Badubi *et al*., 2004).

Production data on broilers is generally lacking in Botswana and there has been poor performance in production parameters. The poor performance observed in small-scale broiler production systems is due partly to insufficient feed supply because of the ever-increasing feed prices in Botswana and also the quality of the feed, which has never been tested against the standards (Badubi *et al*., 2004). Increasing use of maize (*Zea mays*) grain in animal feeding also competes with human feeding (Faquinello *et al*., 2004). Maize is the major source of energy used in poultry diets that is difficult to obtain and use in least cost diets in Botswana due to unstable grain supply as a result of low and erratic rainfall.

One of the optional substitute ingredients to maize grain is sorghum (*Sorghum bicolor*). Sorghum (*Sorghum bicolor*) is an important cereal, ranking fifth in world production and is used for both human and animal consumption throughout the world (Gualtieri and Rapaccini, 1990). Sorghum grain is lower in energy content compared to maize, but similar in other chemical composition and high in protein and essential amino acids, which include among others lysine, methionine, arginine, phenylalanine and tryptophan (National Research Council, 1994). However, the presence of phenolic compounds in sorghum grains limits their use in animal nutrition.

Phenolic compounds are divided into acidic phenolics, flavanoids and tannins, and they limit large-scale use of sorghum (as a livestock feed) (Garcia *et al*., 2004). When birds are fed sorghum-based diets; the presence of tannins reduces productivity in terms of inferior feed conversion, mainly due to the decrease in the use of the protein and a reduction in the activity of digestive enzymes (Haslam, 1981). As a result, nitrogen and use of the amino acids are reduced due to the reduction in protein digestibility (Elkin *et al*., 1995). Utilization of carbohydrates, vitamins and minerals are also reduced by the presence of tannin in sorghum grains (Chang and Fuller, 1993). This is possible as a result of complex compounds formation through reaction between tannins and either carbohydrates or proteins (Mahmood and Smithard, 1993). However, to be utilised efficiently, sorghum grain diets should be supplemented with protein and/or to provide adequate quantities of all essential amino acids, especially lysine, threonine, tryptophan, isoleucine and methionine which are first limiting (Maner, 2006).

It has been reported that the level of tannin in sorghum grains varies from 1.3 to 3.6% in high tannin sorghum and from 0.1 to 0.7% in low tannin sorghum (Myer *et al*., 1986). In Botswana there is limited information on the tannin content of sorghum grain, hence a study was conducted specifically to evaluate the tannin and nutritive value of different sorghum cultivars grown in Botswana as a potential ingredient for inclusion in broiler diets.

MATERIALS AND METHODS

The four sorghum varieties namely Phofu, Mmabaitse, Segaolane and Sephala sorghum were sampled from the Seed Multiplication Unit (SMU) storage facilities after harvest in Sebele-Gaborone located at latitude 24^0 34' 'S and longitude 25^0 57' 'N and altitude of 994 m above sea level. The mean annual rainfall for the area is 500 mm. Monthly average minimum and maximum temperatures are 12.8^0 C and 28.6^0 C respectively. The soil type is classified as moderately deep to very deep, imperfectly to moderately well drained, dark brown to red, clay loams to clays (Badubi *et al*., 2004).

Chemical analysis of sorghum samples

Sorghum samples were analysed for dry matter, crude protein, crude fibre, crude fat, phosphorus, *in vitro* digestibility and tannin using the procedure of A.O.A.C (1990). Total phosphorus and nitrogen were determined following Kjeldahl digestion by UV spectrophotometer (Twine and Williams, 1971; Technicon, 1973). Crude fibre was determined using the Ankom Fibre Analyser, while fat was determined through the fat extraction (SOXTEC) method. Tannin content of the sorghum samples was determined by vanillin/HCI method (A.O.A.C., 1990). The method is based on acid catalysed formation of an abduct of vanillin with tannins which absorbs at 500 nm. The method is specific for leucoanthocyanins and catechins. The standards for tannin content that were used ranged from 1 to 5 at (0.4; 0.8; 1.2; 1.6 and 2.0 ppm) for 1 to 5 respectively.

The *in-vitro* digestibility is carried out after the rumen fluid is collected from a cannulated animal and the rumen fluid and the weighed samples are mixed after sieving. The mixture is buffered using solutions A and B. Solution A consists of Potassium dihydrogen orthophosphate, magnesium sulphate and calcium chloride including urea while Solution B consists of Sodium carbonate and sodium sulphate. These are dissolved in water and the two solutions mixed and then the pH adjusted to 6.68 and then mixed with 400 ml of rumen fluid in a jar and placed in an incubator for 48 hrs at 39.5^o C (A.O.A.C., 1990).

Statistical analysis

The data was subjected to analysis of variance by the General Linear Models procedure of the Statistical Analysis System (SAS, 1997). Differences were considered significant at $P<0.05$ and significant differences between means were determined using the Least Significance Difference (Steel and Torrie, 1980).

RESULTS

Nutritive value of sorghum varieties in Botswana

The nutritive value of four most common sorghum cultivars grown in Botswana was determined and the dry matter, crude protein (CP), phosphorus (P), crude fibre (CF), crude fat (Cfat), digestibility and Tannin of the different cultivars are given in Table 1.

Table 1. Percentage mean of nutritive value of the most common sorghum cultivars *grown in Botswana*

Nutrient	**Phofu**	**Sephala**	**Mmabaitse**	**Segaolane**
Dry Matter	91.42 (1.41)a	91.07 (1.41)a	90.95 (1.41)a	91.05 (1.41)a
Crude Protein	11.5 (0.84)a	10.8 (0.84)a	11.7 (0.84)a	11.9 (0.84)a
Phosphorus	0.47 (0.14)a	0.31 (0.14)a	0.32 (0.14)a	0.56 (0.14)a
Crude Fibre	4.89 (2.49)a	7.40 (2.49)a	6.87 (2.49)a	ND
Crude Fat	4.48 (2.75)a	5.23 (2.25)a	4.27 (2.25)a	8.81 (2.25)a
Digestibility	95.47 (5.33)a	89.7 (5.32)a	89.54 (5.32)a	94.16 (5.3)a
Tannin	0.14 (0.07)a	0.15 (0.07)a	0.08 (0.07)a	0.06 (0.07)a

***** Numbers in brackets are SEM. Means with the same letter are not significantly different (P>0.05). ND = Not determined

There was no significant (P>0.05) difference between the sorghum cultivars for dry matter, crude protein, phosphorus, crude fibre and crude fat content. Further the four cultivars did not show any significant difference for digestibility and tannin content (Table 1).

DISCUSSION

The primary aim of the study was to evaluate the nutritive composition of different sorghum cultivars in Botswana. The sorghum varieties that were evaluated showed that on average they have similar content of crude protein. However, the chemical composition of sorghum is quite variable whereby in most widely grown commercial hybrids protein content may range from 10 to 13%, depending on the cultivar and on the soil and climatic conditions (Gualtieri and Rapaccini, 1990). Looking at this statement it might be deduced that the commonly grown sorghum varieties in Botswana are hybrids or improved lines (Louis *et al*., 1997). In ruminant nutrition, sorghum is viewed primarily as a source of carbohydrates while in non-ruminants, sorghum is viewed mainly as an energy source; however, the quality and quantity of the protein is more important than for ruminants (Louis *et al*., 1997). The sorghum varieties evaluated also showed that they were similar in terms of other nutrients. In comparison to maize, sorghum has similar average contents of crude fibre, crude ether extract, ash and phosphorus, but twice as much as calcium (Gualtieri and Rapaccini, 1990). It therefore means that sorghum could be used in poultry feeds without any detrimental effects on poultry performance (Garcia *et al*., 2004). The digestibility of the four cultivars that were evaluated was also not significantly different from each other and they were highly digestible. This probably means that when these sorghum cultivars are used in poultry the performance of the birds would not be seriously affected (Louis *et al*., 1997).

The tannin content of the different sorghum varieties was also not significantly different. Sorghums high in tannins are important in monogastric nutrition because tannins will depress growth and feed conversion in broiler birds leading to poor performance (Connor *et al*., 1969). However,

Rostagno *et al*. (1973) stated that modern varieties are low in tannin and this was also observed by Hancock *et al*. (1990) who saw improvements in rates and efficiencies of gain, relative to maize, when normal sorghum lines were selected with higher *in vitro* digestibility. According to Myer *et al*. (1986), the level of tannin in sorghum grains varies from 1.3 to 3.6% in high tannin sorghum and from 0.1 to 0.7% in low tannin sorghum. Therefore, it could be concluded that the sorghum varieties evaluated are low in tannin content and if included in poultry feeds formulations they would not pose detriments to the performance of broiler chicks.

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CONCLUSION

The results clearly show that the evaluated sorghum varieties grown in Botswana may be included in poultry feeds with fewer effects on growth and feed conversion efficiency. This is because these cultivars are lower in tannin content which acts as anti-nutritional factor with effects varying widely according to their composition and extent of polymerisation. Further, sorghum is reported to be similar to maize in other nutrients and energy and its protein is more important.

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