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Effect of Replacement of Maize with Sorghum Brewer's Grains on Performance of Finishing Broilers

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Abstract:
The study was conducted to determine the effects of partially substituting maize with red sorghum brewer's grain on the performance of broiler chickens at finishing stage. The finishing diets contained 0%, 5%, 10% and 15% brewer's grain in place of maize. During week four, five and six 48 unsexed hybrid broilers were randomly allocated to 12 pens, four in each pen and allocated to the four diets.
The feed intake, average daily gain (ADG) and feed conversion ratio (FCR) were measured weekly. There was significant difference (P<0.01) in feed intake between birds fed on 0% (0.50kg) and those on 15% inclusion levels (0.54g). FCR showed significant difference (P<0.05) between birds fed on 0% (3.13) and those fed on higher levels (>4). ADG showed significant (P<0.01) difference in birds fed on 0% (42.4g) and those on higher inclusion levels (about 30g).
It is concluded that brewer's grain can partially replace maize up to 5% at finishing stage without affecting broiler growth.

Keywords: *Broiler finishing diets, intake, daily gain, feed conversion*

1. Introduction

Maize is one of the major energy sources for most poultry diets. However, one of the major problems of incorporating maize in livestock diets in countries like Zimbabwe is the competition that exists between livestock and humans in the consumption of the cereal. Also the escalating costs of stockfeeds means that maize-based diets will continue to be scarce. The effects of drought mean that the amount of maize allocated to the stockfeed industry will continue to decline. Therefore, a suitable alternative to maize in poultry diets is critically required in Zimbabwe.

Sorghum is one cereal crop which can be used as a substitute for maize (Dogget, 1988). The crop is drought resistant, requiring 20 % less rainfall compared to maize (Okoh, Obilana, Njoku & Aduku, 1982). It is an excellent energy source in certain parts of the world where it forms the main source of energy in the diets of humans. It contains marginally more protein but less oil than maize and has no pigmenting xanthophylls (Okoh, *et.al,* 1982). However, sorghum has some anti-nutritional factors which are harmful to poultry if consumed. These include tannins, and other polyphenols: phytates, cyanogens and glycosides.

It has been established that traditional processing methods such as fermentation can enhance sorghum utilisation in monogastric animals (Shayo *et al.,* 2001). The bulk of the sorghum grown is the brown varieties which tend to have many agronomic advantages and therefore favoured by farmers. Red Swazi is a crossbred variety with early-to-medium maturity and moderately resistant to drought. The grain colour is red and offers moderate resistance to bird damage (Mangan, 1988; (Okoh, *et.al,* 1982). Most of the crop is grown on a contractual basis with the breweries for production of opaque beer. Fermentation increases the content of B vitamins, so the fermented products are a good source of these vitamins (Mayhew & Penny, 1988; Brand *et al,* 1992). Brewers' grain or 'draft' is a valuable sorghum by-product from the malting and brewing industry which consists of insoluble residue left after removal of the wort. It is high in phosphorus but low in other minerals. It is a safe and palatable feed and is relatively a cheap source of energy and protein (Corbett *et al*, 1966).

The effect of partially substituting maize in poultry feeds with sorghum brewer's grains has not been widely evaluated in Zimbabwe. Therefore an attempt was made to study the effect of partially replacing maize in poultry diets with sorghum brewer's grains on the feed intake, average daily gain and feed conversion ratio of broiler finisher birds.

2. Materials and Methods

2.1. Diets

A reference maize-based diet (MD) was prepared using a commercial broiler concentrate by mixing 1 part commercial concentrate to 2 parts milled maize as is the common practice in Zimbabwe. In the experimental diets, the maize in the MD was partially replaced by sun-dried sorghum brewers' grain (SBG) obtained from Kadoma National Breweries at the levels of 0%, 5%, 10% and 15%. The ingredients and the composite diets were all analysed in triplicate for dry matter, crude protein (CP), fat (ether extract), crude fibre (CF), ash, calcium (Ca), phosphorus (P) and gross energy content (MJ/kg) (AOAC, 1990). The composition of the diets is shown in Table 1 while the chemical composition of the diets is shown in Table 2.

Diet	Concentrate	Maize	Brewers' grain
0% SBG	330	670	0
5% SBG	330	620	50
10% SBG	330	570	100
15% SBG	330	520	150

Table 1: Composition (g/kg) of the cereal-based broiler finisher diets

Diet	Nutrient content							
	DM	CP	Fat	CF	Ash	Ca	P	ME(MJ/Kg)
0% SBG	900	192	41	27	53	10	7	12.5
5% SBG	899	194	40	33	55	10	7	12.5
10% SBG	899	196	38	38	57	10	7	12.3
15% SBG	899	197	37	45	58	10	7	12.2

Table 2: Nutrient composition of the diets (g/kg)

2.2. Husbandry

One hundred day-old chicks (Ross Breeders, Harare) were reared in a deep litter pen. The fowl run was thoroughly cleaned and disinfected before the chicks were housed. Warmth was provided by infrared lamp and the temperature regulation was based on chick behaviour. The chicks remained in the brooder for 21 days. Fresh clean water was supplied *ad libitum*. Standard management practices were followed throughout the experiment.

During the fourth week forty-eight (48) chickens were randomly selected from the flock when they weighed about 812g and allocated to the four diets in a completely randomised design with three replicates (12 pens, 4 in each pen). The birds were fed on the experimental diets for the next three weeks.

2.3. Measurements

Weekly replicate (group) bodyweights, feed consumption and feed conversion ratio was calculated for each group of birds.

Statistical analysis

The data were subjected to one-way analysis of variance (Snedecor and Cochran, 1989) and the differences between treatment means were compared by Duncan's multiple range test at the 5% probability level using the General Linear Model (GLM) of the Statistical Analysis System (SAS, 2000).

3. Results

The effects of the different diets on the performance of finisher broilers are shown in Table 3. Total voluntary feed intake of chickens fed on the normal diet (0% SBG) was 0.50 kg, significantly ($P < 0.05$) different from the other three inclusion levels. The average daily gain of the birds decreased with increasing levels of sorghum brewer's grain. The feed conversion ratio showed an increasing trend as the amount of sorghum brewer's grain increased in the diet.

Treatment diet	Voluntary feed intake (kg)	Average daily gain (g)	Feed conversion ratio
0% SBG	0.50^{a}	42.44^{a}	3.13^{a}
5% SBG	0.54^{b}	35.99^{b}	4.08^{b}
10% SBG	0.55^{b}	29.77^{c}	4.80^{b}
15% SBG	0.56^{b}	29.70^{c}	4.70^{b}
	s.e 0.002	s.e 2.4	s.e 0.3

Table 3: Mean voluntary feed intake, average daily gain and feed conversion ratio of chickens given different diets.

^{a,b,c}Means with different superscripts in a column differ significantly ($P<0.05$)

Total feed consumed by chickens consistently showed an increasing trend as the amount of sorghum brewers' grains increased. No significant ($P <0.05$) difference was observed between the feed consumption on the 10% SBG and 15% SBG diet during the finishing period. The feed conversion ratio of the broilers increased with time. Including sorghum brewers grains improved the feed conversion

ratio compared to the maize reference diet. The weight gain of the broilers decreased with increasing amounts of sorghum brewers' grains as illustrated graphically (Figure 1).

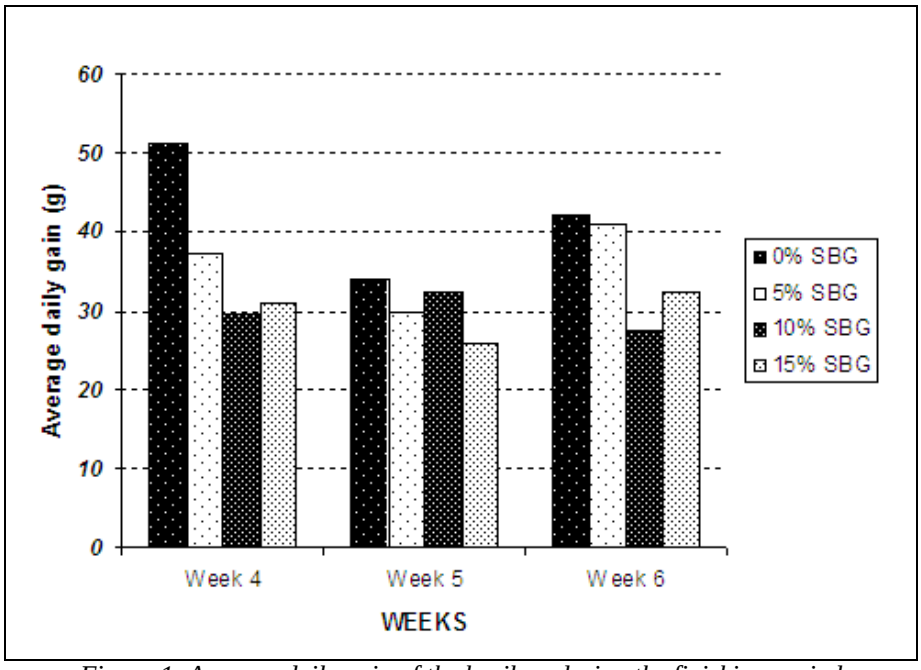

Figure 1: Average daily gain of the broilers during the finishing period

4. Discussion

The primary objectives for most fermentation of high protein foods are to modify the flavour or texture characteristics of the starting food ingredients. These changes generally are produced by fermentations that are limited. The effect of tannins may also be quite negligible or indeed they may enhance intake (Mueller-Harvey and McAllan, 1992).

The birds consumed more food as their growth progressed with red sorghum brewer's grain inclusion levels of 5%, 10% and 15%. This could have been facilitated by increased appetite from the fermented products. However, this is in disagreement with Bullard, York, and Kilburn, (1981) who reported that there is low intake of brewery by-products attributed to the astringent taste created by the tannins which eventually reduces palatability of the diet. Mahmood, Smithard, & Sarwar, (1997) and Armstrong *et al*., (1974) have reported depressed feed intake with high tannin intake although Nyannor et al (2007) reported no differences in feed intake in sorghum diets. The red sorghum used in this experiment has been reported to contain high tannin levels compared to white varieties (Scott *et al*., 1982). Tannins are known to bind to nutrients and enzymes of digestion thus reducing the release of nutrients (Fleury 2004), and consequently reducing efficiency of utilization of feed.

In layer diets sorghum and millets have been reported to produce comparable results in feed intake and food conversion efficiency (Kulube and Mhlanga, 1988). Dhliwayo (2011) also found similar results as in this instance.

In this study it has been noted that feed conversion ratio increased with increase in inclusion levels of red sorghum brewers' grain and feed conversion efficiency decreased respectively. This could be attributed to the effect of high crude fibre content in the red sorghum brewers' grain. The crude fibre content of the diets increased with SBG inclusion levels. This showed that the birds consumed more feed from the red sorghum brewers' grain inclusion levels as their growth progressed but this was not converted to weight gain. Crude fibre limits the release of energy and other nutrients (Teguia and Beynen (2005) hence more feed was consumed. Hetland and Svihus (2001) also reported increased feed consumption with increasing dietary fibre.

Live weight gains showed significant difference in average daily gain between maize and red sorghum brewer's grain diets. This is in agreement with reports by Moreland, Topps and Michie (1975) in which broilers fed on sorghum based diets performed poorly. Jimenez-Moreno *et al* (2010) also found that broilers on standard diets performed better than those fed on diets with higher fibre content. The same findings, however contradict results by Reddy & Reddy (1970) and Rama Rao *et al.* (1995) where insignificant differences in live mass in broiler fed with maize and sorghum based diets were reported.

In this study there has been superior growth recorded in maize diets at finishing phase rendering maize more superior to red sorghum brewer's grain in feeding broilers. This could be attributed to the nutrient profile of the test diets used. The chemical composition of red sorghum brewer's grain diet used in study show that at 0% inclusion level the diet had a 19.2% CP while 5%, 10% and 15% inclusion levels had 19.4%, 19.6% and 19.7% respectively. Crude protein is very critical for growth in all farm animals. The optimum protein for broiler feeds is about 19-20% for broiler finisher (Hulse *et al*., 1980; Beck, 1993). In poultry nutrition, the amino acid profile of a diet is more critical that the total (crude) protein level, and dietary lysine is particularly important in growing animals. There is possibility that during fermentation the total amount of any particular amino acid may increase or decrease or that the availability may change significantly. For most foods the limiting amino acids are lysine or sulphur amino acids (Dozier *et al*, 2011).

In addition, the diet energy levels were not quantified in this study, but it is common knowledge that an upset of the protein- energy balance in livestock diets results in poor growth. The effect of feeding diets of higher energy levels to chickens is to increase broiler performance in terms of both live weight gains and feed conversion rate (Pesti and Smith, 1984).
Another possible reason for low weights when using red sorghum breweries grain could also be due to high crude fibre (Sanchez, Lazaro, and Mateos, 2010). Poultry cannot digest CF, however, a certain amount is necessary in poultry feeds because it acts as a medium for bacteria to live on in the caecum and it makes the feed bulky but relatively low in body building nutrients and it also activates the intestines and more peristaltic movements occur (Kekeocha,1984).

5. Conclusion

Results of this study showed that partially substituting maize with red sorghum brewer's grain by up to 5% inclusion levels does affect the broiler growth. Feed conversion ratio is affected by partially substituting maize with 5%, 10% and 15% inclusion levels. However, feed intake is not affected by partially substituting the maize with red sorghum brewer's grain for up to 15% inclusion level. Since feed is the largest single item of cost in broiler production, it follows that the rate at which feed is converted into poultry meat is an important measure of efficiency.

6. Recommendations

Future studies should explore the possibility of partially substituting maize with white sorghum grain brewer's grain beyond 15%, because poultry farmers are in great need of a replacement of maize in poultry diets. Since comparable chemical composition of red sorghum brewer's grain highlight usefulness of its use, there is need to repeat the experiment using brewer's grain from white sorghum which has low tannins. The economic benefits of replacing maize with sorghum could also be quantified.

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