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Nutrient digestibility and carcass characteristics of broiler chickens fed different cultivars of sorghum replacing maize in the semi-arid zone of Nigeria

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Abstract

The effect of replacing maize with different varieties of sorghum grains on nutrient digestibility and carcass components of finisher broiler chickens was investigated in a 5-week feeding trial. Two hundred and forty (240) broiler chickens were randomly assigned to 6 experimental diets in a completely randomized design. The control diet was maize based while one of the 5 local sorghum varieties (Ajagama, Bulwalana, Chakalare, Kafimoro and Tumbuna) were compared it in each of the other diets. Dry matter (DM), crude fibre (CF) and nitrogen free extract (NFE) digestibility for all sorghum varieties were similar ($P \geq 0.05$) to maize, however, crude protein (CP) digestibility was depressed ($P \leq 0.05$) for the Tumbuna variety. Except for dressing percentage which was similar for all the treatments, Tumbuna showed significantly lower ($P \leq 0.05$) values for carcass and organ components. It was concluded that maize can be replaced by Ajagama, Bulwalana, Chakalare and Kafimoro varieties of sorghum in broiler finisher diets.

Key words: Broilers Chickens, Sorghum, Maize, Digestibility, Carcass Measurements

Introduction

In the search for cheaper alternatives to maize in poultry diets, several cereals are being explored. Sorghum (*Sorghum bicolor*) a grain widely grown in many parts of the world (FAO, 2005) has the potential to replace maize (Olomu, 1995; Hancock, 2000).

Sorghum has been shown to have similar nutritional characteristics to maize (Smith, 2001; Travis et al., 2006; Torki, and Farahmand, 2007). Several reports have also indicated that sorghum can completely replace maize in the diets of broilers without adverse effects on performance (Gualtieri and Rapaccini, 1990; Jacob et al., 1996; Issa et al., 2007; Medugu et al., 2010).

There are several varieties of sorghum grown in the semi-arid region of Nigeria (Olabanji et al., 2001) and information on their effect on poultry performance need to be established. This study was designed to evaluate the effects of feeding different sorghum cultivars on nutrient digestibility and carcass characteristics of broiler chickens in a semi-arid environment.

Materials and Methods

Two hundred and forty (240) day-old mixed sex broiler chicks were obtained from a commercial hatchery and used for the study. They were brooded together for 4 weeks during which they were fed a commercial starter mash. At the end of brooding, the birds were weighed and divided into 6 treatment groups of similar weight with 4 replicates of 10 birds each. The birds were reared on floor pens in an open sided poultry house with wood shavings as litter material for the 5 weeks experimental period.

Six (6) experimental finisher diets based on maize in the control which was completely replaced in the other diets by five (5) commonly found sorghum cultivars within and around Maiduguri were formulated (Table 1). The cultivars used were Ajagama (cream), Bulwalana (white), Chakalare (white), Kafimoro (cream) and Tumbuna (brown). The diets and water were offered *ad libitum* through out the experimental period.

At the end of the 4th week of the experiment, one bird from each replicate was transferred to individual metabolism cages measuring 38.5 × 19.5 × 35 cm (length x breadth x height) for digestibility trial. The birds were allowed 3 days adjustment period in the cages followed by 5 days of faecal sample collection. Samples were air-dried and cleaned to remove feathers and other contaminants. Faeces collected from each bird for the 5 days were homogenized and taken to the laboratory for proximate analysis.

Table 1: Ingredient and analysed proximate composition of the experimental diets

Ingredients	Diets					
	Maize	Ajagama	Bulwalana	Chakalare	Kafimoro	Tumbuna
Maize	56	-	-	-	-	-
Sorghum varieties	-	56	56	56	56	56
Wheat bran	12	12	12	12	12	12
Whole Soyabean	24	24	24	24	24	24
Fish meal	5	5	5	5	5	5
Bone meal	2	2	2	2	2	2
Premix	0.5	0.5	0.5	0.5	0.5	0.5
					0.2	0.2
Methionine	0.3	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100	100
Proximate Analysis						
Dry matter (DM)	90.40	90.30	88.60	91.10	89.60	90.20
Crude protein (CP)	20.28	20.56	19.69	20.06	19.49	20.00
Crude fibre (CF)	4.50	4.50	5.50	4.00	4.00	5.00
Ether extract (EE)	3.50	4.00	7.00	4.00	5.00	6.00
Total ash	4.50	4.00	3.50	3.50	5.00	4.50
[+]Nitrogen-free extract (NFE)	67.22	66.94	64.31	68.44	66.51	64.5
[*]ME (Kcal/Kg)	3301.7	3361.09	3378.54	3365.84	3367.24	3365.75
[+]Tannin content (%)	-	0.62	0.5	0.67	0.51	0.80

[*]Metabolizable energy calculated according to the formula of Pauzenga (1985) as ME= 37 × %CP + 81 × %EE +35.5 × %NFE; + Calculated

Table 2: Analyzed tannin content of the sorghum varieties

Varieties	Colour	Tannin level (%)
Ajagama	Cream	1.24
Bulwalana	White	0.99
Chakalare	White	1.33
Kafimoro	Cream	1.01
Tumbuna	Brown	1.59

At 62 days of age, 4 birds from each treatment (1 bird per replicate) were fasted overnight, weighed the next morning and then killed by cervical dislocation for carcass measurements and organ weights. Slaughtered birds were scalded in hot water (50^{o}C) for about 1 minute and then plucked and dressed. Dressing percentage was as the ratio of the dressed weight to the weight of the bird before slaughter multiplied by 100. The weight of carcass cut-up parts and organs were also expressed as percentages of the live weight.

Proximate composition of experimental diets and faecal samples were determined according to the methods of AOAC (1990). The sorghum varieties were analyzed for tannin content using the hydrochloric acid, methanol, and phenol vanillin procedure described by Price *et al*. (1978). All data collected were subjected to analysis of variance (ANOVA) in a completely randomized design (Steel and Torrie, 1980) and where significant difference were observed, means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

The proximate composition of the experimental diets is shown in Table 1. The diets met the requirements of finishing broilers in the tropics (Olomu, 1995). It also shows similarities between the nutrient composition of maize and the different cultivars of sorghum which supports the reports of FAO, 1995, Travis et al. (2006) and Torki (2007) that sorghum has similar nutrient composition to maize.

The tannin contents of the sorghum grains (Table 2) were within the range of 0.2-2% reported by Rotagno et al. (1973) for sorghum grain. Tumbuna (a brown sorghum) had the highest tannin content while the lowest was recorded in Bulwana (white grain). This is in agreement with the observation of Issa et al. (2007) that coloured sorghum grains contain more tannin than white ones.

Results of the digestibility trial (Table 3) showed that except for CF and NFE, the digestibility of crude protein, ether extract and ash were significantly ($P \leq 0.05$) affected by dietary treatment. The crude protein digestibility for the different sorghum cultivars except Tumbuna was similar to that of maize. The depressed digestibility in the Tumbuna cultivar may be due to its higher tannin content (1.59mg/g) compared to the other cultivars. This agrees with the observations of Mitaru (1984, 1985) and Kyarisiima et al. (2004) that high tannin sorghums adversely affect protein digestibility in broiler chickens. Ravindran et al.

Table 3: Nutrient digestibility of broiler chickens fed maize or different sorghum cultivars as replacement for maize.

	Diets						
Ingredients	Maize	Ajagama	Bulwalana	Chakalare	Kafimoro	Tumbuna	SEM
DM	89.56	88.48	87.67	88.89	87.88	87.34	1.0^{NS}
CP	92.77^{ab}	90.34^{b}	95.87^{a}	88.89^{bc}	88.75^{bc}	87.06^{c}	1.34*
CF	67.46	65.62	67.33	67.88	68.70	67.23	3.90^{NS}
EE	87.83^{ab}	88.19^{ab}	92.42^{a}	88.52^{ab}	92.95^{a}	83.65^{b}	4.32*
Total ash	90.55^{a}	80.26^{c}	85.52^{abc}	82.52^{bc}	89.08^{ab}	73.78^{d}	3.52*
NFE	87.57	84.61	85.60	88.60	83.85	85.60	1.15^{NS}

DM- Dry Matter, CP – Crude Protein, CF – Crude Fibre, EE – Ether Extract, NFE – Nitrogen Free Extract
$^{A-c}$means within the same rows bearing different superscripts differ significantly ($P \leq 0.05$); SEM – standard error of means; NS – Not significant.]

Table 4: Carcass measurements of broiler chickens fed different sorghum varieties as replacement for maize.

	Diets						
Parameters	Maize	Ajagama	Bulwalana	Chakalare	Kafimoro	Tumbuna	SEM
No. of birds	8	8	8	8	8	8	NA
Slaughter weight (g)	2533.30^{a}	2066.70^{ab}	2316.70^{ab}	2050.00^{ab}	2250.00^{ab}	1800.00^{b}	0.17*
Dressed weight (g)	1966.70^{a}	1466.70^{ab}	1666.70^{ab}	1483.30^{ab}	1633.30^{ab}	1233.30^{b}	0.18*
Dressing %	72.53	66.76	68.38	69.38	70.11	65.47	2.71^{NS}
Cut-up parts as percentage of slaughter weight							
Wings	8.22^{a}	8.03^{a}	8.45^{a}	8.28^{a}	8.03a	5.49^{b}	0.46*
Thighs	10.46^{a}	9.94^{a}	10.58^{a}	10.56^{a}	11.33^{a}	8.41^{b}	1.12*
Drumsticks	9.49^{a}	10.31^{a}	10.52^{a}	10.13^{a}	10.17^{a}	6.84^{b}	0.57*
Breast	15.81^{ab}	15.18^{ab}	16.52^{a}	16.58^{a}	16.23^{a}	10.46^{b}	1.18*
Thorax	5.48^{a}	5.25^{a}	5.03^{a}	5.59^{a}	5.23^{a}	3.41^{b}	0.32*
Back	9.25^{a}	8.46^{a}	8.30^{a}	8.61^{a}	8.54^{a}	5.67^{b}	0.51*
Organs weight as Percentage of slaughter weight							
Full crop	0.80^{b}	1.44^{a}	0.74^{b}	1.06^{a}	0.93^{b}	0.66^{b}	0.12*
Liver	1.70^{ab}	1.91^{a}	1.58^{b}	1.66^{a}	1.85^{a}	1.43^{b}	0.07*
Gizzard	2.28^{ab}	2.43^{a}	2.08^{ab}	2.67^{a}	2.34^{a}	1.75^{b}	0.13*
Heart	0.49^{a}	0.49^{a}	0.45^{a}	0.50^{a}	0.41^{a}	0.29^{b}	0.03*
Ceaca	0.62^{a}	0.57^{b}	0.48^{b}	0.53^{b}	0.70^{a}	0.51^{b}	0.03*
Abdominal fat	1.56^{a}	1.08^{b}	1.56^{a}	1.78^{a}	1.87^{a}	1.33^{b}	0.12*

$^{a-c}$Means within the same rows bearing different superscripts differ significantly. ($P \leq 0.05$); SEM– standard error of means; NA- Not analysed; NS –Not significant

(2006) reported that an increase of 0.1% tannin can induce a decrease of 10% in digestibility of most amino acids. The digestibility of ether extract and ash were also lower in the Tumbuna variety compared to all the other treatments. In a trial, Nyannor et al. (2007), reported similar nutrient digestibility between maize and sorghum when it was fed to broiler chicks.

Table 4 summarizes data on carcass measurements and organ weights. Slaughter weights and dressed weights were depressed ($P \leq 0.05$) in the group fed the Tumbuna sorghum compared to those fed maize based diets although there were not different from those fed the other sorghum cultivars. Similarly, there were no differences ($P \geq 0.05$) between maize and the other sorghum cultivars with respect to slaughter and dressed weights. Dressing percentage was however, not affected ($P \geq 0.05$) by the dietary treatments. Values for cut-up parts and organs weight showed similarities between the sorghum cultivars and maize except for the Tumbuna cultivar which consistently showed lower ($P<0.05$) weights than maize. The lower carcass values obtained on the Tumbuna sorghum was attributed to the reduced nutrient digestibility on this diet as a result of its higher tannin content. The depressing effect of tannin on nutrient utilization has also been reported by Mohammed and Ali (1988). The similarities observed between maize and the other sorghum cultivars for carcass traits in this experiment are in line with the reports of Issa et al. (2007) and Medugu et al. (2010) who observed no differences ($P \geq 0.05$) in carcass yield of broilers fed sorghum compared with maize. Similar pattern of carcass traits has also been reported in

Japanese quail fed diets based on sorghum and yellow corn (Ragab et al., 2002).

It was concluded that the local sorghum cultivars (Ajagama, Bulwalana, Chakalare and Kafimoro) can replace maize in the diets of broiler chickens without compromising nutrient digestibility and carcass traits.

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