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Utilisation of Malted Sorghum Sprouts in the Diet of Pullet Chicks

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ABSTRACT

One hundred and sixty eight (168) one-week-old pullet chicks of Nera® strain were used in a feeding trial to evaluate the effect of malted sorghum sprouts (MSP) in diets of pullet chicks. The trial lasted for 10 weeks. There were three experimental diets containing 0, 150gkg^{-1} or 300gkg^{-1} levels of MSP. Each diet was fed to four replicate groups of 14 pullet chicks. The results showed that feed intake reduced ($P<0.05$) gradually as the level of MSP inclusion in the diet increased. MSP inclusion in diets also led to reduced final weight ($P<0.05$). Crude protein and fibre digestibility decreased significantly ($P<0.05$) with increase in dietary level of inclusion of MSP. The converse was the case for ash digestibility. Birds fed 300 gkg^{-1} MSP had high ($P<0.05$) level of packed cell volume and total serum protein, which was quite unexpected if the final weight and weight gain of the birds are taken into consideration. There was, however, an indication of impairment of protein utilisation when MSP was included as the birds in this group recorded significantly higher serum creatinine. It was concluded that there are some factors inherent in MSP, probably tannin and HCN that impair the utilisation of MSP based diets by pullet chick. It is apparent from the foregoing of inclusion of MSP even at 150g kg^{-1} depressed feed intake and growth. It is, therefore, not advisable to use MSP at a level up to 150g kg^{-1} especially for starting pullets.

Keywords: Starting pullet, malted sorghum sprouts, utilisation

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INTRODUCTION

A major problem facing the poultry industry across the globe is that of escalating cost of conventional feeding stuff. This phenomenon is occasioned by competition between man

and livestock. Profit maximisation cannot be attained unless the birds are fed well formulated diets and at reasonable price. This occurrence had stimulated interest in finding alternative feedstuff that is cheap, readily available and with comparable nutritional qualities with the well known conventional feedstuff. Such alternatives have the potential of reducing feed cost, thereby making poultry enterprise more profitable.

Sorghum spp (Guinea corn) has replaced barley as a raw material in confectionery and brewing industries in many tropical countries (Banjoko, 1990). Malting of sorghum essentially involves soaking and steeping, which is followed by germination of the seed during which amylase enzyme is released. Malt is extracted from the germinated sorghum seeds and the residue consists of sorghum shoots and roots that are referred to as malted sorghum sprouts (MSP) (Aletor *et al.,* 1998). MSP is produced in commercial quantities in Nigeria and an estimated 200,000 metric tonnes of malted and un-malted extracts are produced annually by only one food industry with a sizeable cereal processing plant in Nigeria while the disposal is becoming a problem for the industry (Ikediobi, 1989). MSP has no use at present but efforts for its incorporation into animal feed has been advocated. In fact, feed waste, the disposal of which is becoming a problem for the industry, can be dried, bagged and stored within a short time period.

MSP has potential for use as feedstuff. Ologun *et al.* (1998) showed that up to 40% of sorghum rootlet or malted sorghum sprouts may be fed to rats. Fajemidagba (2000) reported that MSP compared favourably with brewer's dried grain when both were included in practical broiler rations up to 20% level. Oduguwa *et al.* (2001) studied the nutritive value of MSP using rats, and they concluded that the nutritive value was lower compared to soyabean meal reference diet. Morrison (1984) opined that not more than 10 to 15% malt sprouts should be included in concentrate mixture for dairy cows. There is a dearth of information on the utilisation of MSP in the diets of egg type chickens. This study was, therefore, designed to evaluate the effect of feeding MSP in the diet of starter pullets on performance, nutrient utilisation and on some serum metabolites with the intention of assessing the adequacy of MSP as a feed resource for pullet chicks.

MATERIALS AND METHODS

Location

This study was carried out at the poultry unit of the Teaching and Research Farm of the College of Animal Science and Livestock Production, University of Agriculture, Abeokuta, South Western Nigeria.

Diets

A control diet (with NRC, 1994 requirements) containing no MSP was formulated. Two other diets were formulated to contain 150 g kg^{-1}(12.08 MJ kg^{-1} ME, 212.8 kg^{-1} CP) and 300 gkg^{-1}(11.55 MJ kg^{-1}, 219.8 kg^{-1} CP) MSP. The test ingredient was

sourced from a Nigerian brewery located in southwest Nigeria. The gross composition of experimental diet is shown in Table 1.

TABLE 1
Gross composition of experimental diets (g kg^{-1})

Ingredients	Levels of MSP		
	0	150	300
Maize	530.0	380.0	230.0
Soybean meal	180.3	180.3	180.3
Fish meal	40.0	40.0	40.0
Groundnut cake	120.0	120.0	120.0
Brewers dried grain	68.2	68.2	68.2
Lysine	2.5	2.5	2.5
Methionine	3.5	3.5	3.5
Bone meal	30.0	30.0	30.0
Oyster shell	20.0	20.0	20.0
Premix (S)[x]	3.0	3.0	3.0
Salt	2.5	2.5	2.5
MSP	0.0	150.0	300.0
Total	**1000.0**	**1000.0**	**1000.0**
Determined analysis			
Metabolizable Energy ($MJkg^{-1}$)	13.00	12.08	11.55
Crude protein (gkg^{-1})	210.0	212.8	219.8
Crude fibre (gkg^{-1})	36.5	53.5	59.4

[x]The vitamin and mineral premix contained per kg of diet: retinyl acetate,5.12 mg; cholecalciferol, 10 mg; dl-a-tocopherol acetate, 30 mg; menadione, 4 mg; folicacid,1.20 mg; choline, 80,000 mg ; d-pantothenic acid, 19.0 mg; riboflavin, 8.0 mg; niacin, 70 mg ; thiamin, 5 mg; d-biotin, 0.1 mg; pyridoxine, 0.9 mg; ethoxiquin, 28 mg; manganese, 200 mg; zinc, 150 mg; iron, 153 mg; copper, 17.64 mg; iodine, 4 mg; selenium, 0.1 mg.

Experimental Design and Management of Pullet Chicks

A total of 168 one-week-old pullet chicks of Nera black® strain were used for the study. They were divided into three treatment groups of 56 birds each. Each treatment was further divided into four replicates of 14 birds. All the birds were fed a commercial diet for the first seven days before they were distributed into the experimental groups. The pullet chicks were raised in a conventional poultry house with concrete floor containing dry wood shavings as litter material. The birds remained in the deep litter pens throughout the experimental period. Each replicate of 14 birds was housed in a compartment (1.5 x 2M) properly demarcated with wood and chicken wire mesh. Feed and water were supplied *ad libitum*. Litter was changed every two weeks to disallow growth of pathogens. All vaccination and medication procedures were strictly adhered to. The experiment lasted 10 weeks.

Digestibility Trial

Metabolic trial was carried out when the birds were 10 weeks old. Two birds from each replicate of the treatments were selected. The birds were housed individually in specially designed metabolic cages, equipped with separate facility for feeding, watering and excreta collection. Three day total excreta collection followed a three-day acclimatisation period. The excreta collected were weighed and representative samples were taken in well labelled aluminium foil and dried in the oven at 65^0C for 72 hours. The dried excreta samples were milled and analysed for their proximate constituents along with the feed samples using AOAC (1990) methods. Apparent digestibilities of the proximate constituents were then calculated.

Plasma and Serum Biochemistry

Blood samples were collected from three birds selected from each replicate and analysed for some plasma and serum profile. Blood sample was taken by careful puncture of the brachial vein. A pinch (about 5 µg) of Ethylene diamine tetracetate (EDTA) was added to the 2.5 ml blood samples for plasma analysis, which was carried out within three hours of blood collection. Samples for serum analysis were decanted after centrifugation at 3000 rpm for 10 minutes. The packed cell volume (PCV), mean cell volume (MCV), white blood cells (WBC) and red blood cells (RBC) were determined using Wintrobe's microhaematocrit and improved Newbauer haemocytometer as described by Baker and Silverton (1985). Total serum protein was determined according to the methods of Colowich and Koplan (1955) while serum albumin was determined using bromocresol purple method of Varley *et al.* (1980). Serum creatinine was determined using the principles of Jaffe reaction as described by Bousness and Taussky (1945) while serum uric acid was determined using the kit-Quinica clinica spam (Wootton, 1964).

Data Collection

The performance of the birds was monitored on a weekly basis via feed intake, body weight gain and feed-to-gain ratio.

Chemical Analysis

Feed and excreta samples were analysed for their proximate constituents (Dry matter, crude protein, ether extract, crude fibre, ash, nitrogen free extract) according to AOAC (1990) methods. Gross energy in feed and excreta output were determined using adiabatic bomb calorimeter and data used to evaluated the metabolisable energy. The test ingredient (MSP) was analysed for its cyanide content using the method described by Zitnanak (1973). The cyanide content was determined by Ogawaski cyanide ion-electrode CN-1256B.

Statistical Analysis

The design of the experiment was a completely randomised design and all data collected were analysed using Analysis of Variance techniques (Steel & Torrie, 1980). Significant differences between means were separated using Duncan's multiple range test (Gomez & Gomez, 1985). A 5% confidence level was set to test statistical significance.

RESULTS AND DISCUSSION

Proximate Composition of Malted Sorghum Sprouts

The proximate composition of MSP is presented in Table 2. The dry matter value of 842.3 g kg^{-1} was recorded in this study. Crude protein (CP) value of 224.3 g kg^{-1} agrees with earlier reports of Aning *et al.* (1998) and Fafiolu *et al.* (2006) while Akinola (2002), reported CP values of 226 and 243 g kg^{-1} respectively. A lower crude fibre (CF) of 46.7 g kg^{-1} was reported in this study, which is different from 83.0 g kg^{-1} reported by Oduguwa *et al.* (2001). The generally low crude fibre of MSP may be due to the fact that hardening or lignification of the rootlets and shoots has not taken place before growth termination

during malting process at the 5th day of germination. However, Oduguwa *et al.* (2007) reported a relatively high content of neutral detergent fibre in MSP (224 g/kg). This is an indication that non-starch polysaccharides (NSP) may also play a role in limiting the nutritive value of this product.

TABLE 2
Chemical composition of MSP

Component	g kg^{-1}
Dry matter	842.
Crude protein	224.3
Crude fibre	46.7
Ash content	63.0
Ether extract	24.2
Nitrogen free extract	641.8
Ca	1.9
P	3.5
HCN (mg/kg)	1.5

A higher ether extract value of 39.8 g kg^{-1} was obtained by Akinola (2002) for alkaline-treated MSP. Aning *et al.* (1998) also reported 33.0 g kg^{-1} while 22.4 g kg^{-1} was reported in this study. The ether extract values were also understandably generally low because one does not expect tender rootlets and shoots of germinating sorghum seeds to have much oil or any appreciable lipid content for that matter. The ash content of 63.0 g kg^{-1} obtained here differed from the 16.0 g kg^{-1} reported by Aning *et al.* (1998). This difference is, however, high, and may be connected with the type of sorghum used for the MSP. The MSP used in this study was from white sorghum. However, it has earlier been reported that polyphenol levels are high in sorghum with brown pericarp and no testa and very low in unpigmented grains (Nyachoti *et al.*, 1997). The polypehnol in brown pericarp sorghum may have a binding effect on minerals. This, probably, may be the reason for low ash content in Aning *et al*'s (1998) report. Slight contamination with dust and sand particles, which increases the silica content, may also be a possibility for the relatively high ash content observed in this study. The findings, however, agrees with the report of Akinola (2002), who reported ash content of 70.0, 60.0 and 95.0 g kg^{-1} for untreated fermented and alkaline treated MSP.

Oduguwa *et al.* (2007) reported the calcium (Ca) content of MSP was 1.78 g kg^{-1}; the value of 1.9 g kg^{-1} recorded in this present study corroborates this result although an earlier study by Oduguwa *et al.* (2001) reported Ca values in MSP was as low as 0.5 g kg^{-1}. The study revealed that a value of 3.5g kg^{-1} was recorded for phosphorus and 1.5 mg kg^{-1} hydrogen cyanide (HCN) was detected in MSP. This is noteworthy and confirms earlier reports in the literature (RMRDC, 1990) that MSP contains a substance called Dhurin, which is a cyanogenic glucoside that yields HCN on hydrolysis.

Performance and Nutrient Utilisation of Pullet Fed MSP Based Diets (1-10 weeks)

Table 3 shows the performance and nutrient utilisation of pullet chicks (1-10 weeks) fed MSP based diets. Inclusion of MSP depressed ($P<0.05$) feed intake. MSP has a bitter taste, which could be traced to its content of tannin (RMRDC 1990). This may

explain why feed consumption of the birds gradually decreased ($P<0.05$) as the level of MSP in the diet increased. Morrison (1984) had earlier reported that MSP was somewhat bitter and unpalatable. The reduction in feed intake could also have been due to the gritty nature of the resulting diet. The results showed that birds fed the control diet without MSP were heavier ($P<0.05$). The higher final weight observed for the control group over those fed MSP-based diets may be as a result of low intake of MSP diets due to the influence of some anti-nutritional factors (ANFs), which are known to be present in MSP such as tannin and dhurin (HCN) (RMRDC 1990; Aning *et al.*, 1998; Fafiolu *et al.*, 2006; Oduguwa *et al.*, 2007). Abbas and Musharaf (2008) carried out a study in which sorghum seeds were germinated for 3, 5 and 7 days and the effects of germination periods on nutrient contents was determined. The result showed that by the seventh day of germination, tannin increased by 100%. Oduguwa *et al.* (2007) reported that the total tannin content of MSP was 140 g kg^{-1}, out of which only 0.3 g/kg was extractible. Tannins have been described as a group of substances with the ability to bind proteins in aqueous solution. Their multiple phenolic hydroxyl groups lead to the formation of complexes primarily with proteins and to a lesser extent metal ions, amino acids and polysaccharides (Mansoori & Acamovic, 1995, 1996; Makkar, 2001). The implication of this is very important as the availability of a large portion of the protein, and to a lesser extent amino acids and useful metal elements in MSP, would have been compromised because they are in bound form and hence, not easily accessible to enzymatic action. Another effect of tannin in the digestive tract of the birds is that it increases appreciably endogenous losses, a process that is very expensive (Oduguwa *et al.*, 2007). Mucin is a high-molecular weight glycoprotein that covers the entire luminal surface of the gastro intestinal tract (GIT), protecting the underlying epithelium, and it also comprises a significant proportion of the endogenous protein found in the digesta (Lien *et al.*, 2001). Diets high in indigestible materials e.g. NSPs tend to induce structural, morphological and cytokinetic changes in the GIT related to a capacity for high mucin secretion (Jacobs, 1986; Morel *et al.*, 2005). Feeding relatively high content of dietary tannins, a component that is indigestible and highly irritant, may also irritate the gut wall and increase the excretion of gastrointestinal mucin, a physiological waste; HCN is also a well known anti-nutritional factor (ANF) that is toxic and affects protein metabolism in farm animals. (Church & Pond, 1988). The presence of HCN in sprouted sorghum was reported by Ikediobi *et al.*, (1988); they observed that 99% of the cyanide is concentrated in the roots and shoots. The workers explained that some local food and beverages produced from sprouted sorghum grains contained negligible or undetectable levels of cyanide. This apparently is because of prior mechanical elimination of roots and shoots, coupled with heat or water treatment during processing, which they opined, was adequate for detoxifying sorghum-based food and beverage products. Taylor (1983),

TABLE 3
Performance, nutrient utilisation, plasma and serum chemistry of pullets fed MSP based diets

Parameters	Levels of MSP				
	0	150	300	SEM	p-value
Average initial weight(g)	58.8	56.9	56.0	0.41	0.201
Average final weight (g)	898.6[a]	785.2[b]	788.8[b]	22.40	0.00
Average daily feed intake (g)	56.4[a]	52.1[ab]	50.7[b]	2.47	0.033
Average daily weight gain (g)	12.1	10.4`1	10.3	6.55	0.100
Feed to gain ratio	4.7	5.0	4.9	0.39	0.303
Nutrient utilisation					
Dry matter digestibility	0.8213	0.7934	0.8137	1.53	0.110
Crude protein digestibility	0.7157[a]	0.6512[b]	0.6013[c]	0.37	0.028
Crude fibre digestibility	0.7341[a]	0.3704[b]	0.3620[c]	5.90	0.039
Ether extract digestibility	0.9801	0.9725	0.9793	0.23	0.248
Ash digestibility	0.6062[c]	0.6535[b]	0.6994[a]	3.24	0.122
Plasma and Serum metabolites					
Packed cell volume (%)	30.5[b]	32.0[ab]	33.2[a]	0.43	0.021
Mean cell volume (%)	10.2	11.0	11.2	0.27	0.319
White blood cell (mm^3)	4765.0[b]	5225.0[b]	5940.0[a]	1663	0.001
Red blood cell (gm/100ml)	47.0[a]	12.5[c]	14.5[b]	0.72	0.135
Serum total protein (gm/dl)	5.1[b]	5.6[b]	6.8[a]	0.29	0.021
Serum albumin (gm/dl)	2.5	3.0	2.9	0.11	0.228
Serum uric acid (gm/dl)	0.06	0.06	0.97	0.06	0.143
Serum creatinine (gm/dl)	0.48[b]	0.48[b]	0.90[a]	0.06	0.000

working independently, had earlier observed that there was mobilisation of HCN to the root and shoot of sorghum seedling during malting process. Thus, the presence of these ANFs coupled with the effect of NSPs definitely would have affected the growth of birds that received MSP diets (Fafiolu, *et al.*, 2006; Oduguwa *et al.*, 2007). The reduction in feed intake by birds on MSP diets may also be a contributory factor to the slow growth. No difference ($P>0.05$) was obtained in the feed-to-gain ratio and average daily weight gains of the experimental birds.

Nutrient Utilisation

Significant differences ($P<0.05$) were recorded for the digestibility of crude protein, fibre and ash. Crude protein digestibility showed a decrease as the level of MSP increased in diets. This observation confirms the report of Oduguwa *et al.* (2007). Crude protein digestibility was generally low in birds on MSP diets. This observation may not be unconnected with the presence of tannin in diets. Tannins, complex polyphenolic compounds, are known to bind proteins and cations in reactions involving them; hence, the reduction in its digestibility.

Crude fibre (CF) digestibility of the group that received 0 g kg^{-1} (MSP free diet) was significantly higher ($P<0.05$) than that in the other two diets. Holman (1989) reported that fibre present in a feedstuff was opposed to degradation by digestive enzymes secreted by certain organs of the chicks. The diet with 0 g/kg MSP had lower CF levels than the other two diets. The high fibre content of the two diets coupled with the chickens' natural inability to digest fibre may have produced a confounding effect in the birds, leading to very low CF digestibility values compared to those of the control group. The high fibre diets could also have decreased the mean transit time of the digesta (Milton & Demment, 1988) leading to lower digestion of the nutrient components including the fibre itself. Ash digestibility increased significantly ($P<0.05$) as the level of MSP increased in the diets. The elevated values may be as a result of the presence of substantial amounts of minerals in the test ingredient. The dry matter and ether extract digestibility were not significantly ($P>0.05$) affected by dietary treatments.

Plasma and Serum Chemistry of Birds Fed MSP-Based Diets

The haematological parameters of birds fed MSP-based diets are presented in Table 3. The analysis showed that packed cell volume, white blood cell, serum total protein and serum creatinine varied significantly ($P<0.05$) with dietary treatments. The mean cell volume, red blood cell, serum albumin and uric acid were not statistically ($P>0.05$) affected by the level of MSP. Birds fed 300 g kg^{-1} MSP had higher levels of packed cell volume and total serum protein. This is quite unexpected if the final weight and the weight gain observed are put into consideration.

The levels of creatinine in the serum of the group of birds fed 300 g kg^{-1} MSP diet were significantly higher ($P<0.05$) than those of other treatments. High level of creatinine in the blood is an indication of impairment of protein utilisation (Eggum, 1970; Adewusi & Bradbury, 1993). It follows, therefore, that the birds on 300 g kg^{-1} MSP were not able to incorporate the protein in the feed into their tissues despite the high levels in the blood. Perhaps protein was mobilised from other tissues other than from feed to meet the energy requirement of the birds. The same trend was also observed for the serum uric acid although the difference was not significant ($P>0.05$). This indicates physiological protein wastage by the birds.

The above observations point to the fact that some factors in the MSP were the cause of impairment in feed utilisation. Ikediobi (1989) had earlier reported that MSP contained an appreciable level of HCN. Taylor (1983) observed that there was mobilisation of HCN to the root and shoot of sorghum seedlings during the malting process. Tannin has also been indicted as an antinutritional factor that is present in sorghum products and co-products (R.M.R.D.C, 1990, Oduguwa *et al.*, 2001; Oduguwa *et al.*, 2007). The successful removal or alleviation of the effect of these anti-nutritional factors including the fibre will go a long way towards enhancing the utilisation of MSP by monogastric livestock species.

CONCLUSION

The result of this present study showed that the final body weight and body weight gained were best in birds fed 0 g kg^{-1}. It is apparent from the foregoing that inclusion of MSP even at 150 g kg^{-1} depressed feed intake and growth. It is, therefore, not advisable to use MSP at a level of up to 150 g kg^{-1} especially for starting pullets. Lower levels of inclusion could be tested to ascertain the level that these young birds can tolerate in their diet.

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