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EFFECTS OF PROCESSING FOUR VARIETIES OF SORGHUM ON ANTI-NUTRITIONAL FACTORS

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ABSTRACT

A study was carried out to evaluate the effects of processing four varieties of *Sorghum bicolor* on anti-nutritional factors. The four varieties of sorghum used were Samsorg-14, Samsorg-40, Samsorg-17 and KSV-15 and they were subjected to two processing methods which were soaking 24hrs for 3 days and soaking 24hrs and fermentation for 72hrs. Significant levels of differences among treatment means were determined using the Tukey`s test (Steel *et al.*, 1997) to separate the means. The result showed that raw KSV-15 had the highest levels of phytic acid, tannin and saponin followed by Samsorg-14 and Samsorg-40 while the least anti- nutritional factor was observed with Samsorg-17.With soaking; Samsorg-14 had the highest level of anti-nutritional factors followed by KSV-15 and Samsorg-40, while Samsorg-17 had the least. Soaking 24hrs and fermentation of four varieties of sorghum grains caused significant ($P<0.05$) difference in the levels of phytic acid and tannin in Samsorg-17 and Samsorg-14 which had the least. The percentage reduction in most of the anti-nutritional factors was highest in fermented sorghum with KSV -15 having the highest percentage reduction followed by Samsorg-40 and Samsorg-17, while Samsorg-14 had the least. In conclusion fermentation as a processing method reduced tannins, saponins, phenols and oxalates more appreciably in four varieties of sorghum.

INTRODUCTION

Sorghum is an indigenous cereal crop of Africa and has the ability to tolerate drought, soil toxicities and temperature extremes effectively than other cereals. It is cultivated worldwide in warmer climate and can be grown on poor soil and in drier conditions than maize (Olomu, 2011).Sorghum grain is probably the next alternative to maize in poultry feed (Etuk *et al.*, 2012a).

Sorghum contains anti-nutritional factors, it has large amount of polyphenols and tannins (Salunkhe *et al.*, 1990). Animal nutritionists are interested in tannins because they bind protein, cellulose, hemicelluloses, pectin, phytate and mineral to form indigestible complexes (Van soest, 1994). In poultry, tannins are known to reduce feed intake, feed efficiency, growth rate, egg production, protein utilization and damaged the mucosal lining of the digestive tract (Hancock, 2000) it also reduced palatability and digestibility which had adverse effects on metabolism and toxicity (Kumar and D'Mello, 1995; Atteh, 2002; Ola *et al.*, 2005). Anti-nutritional factors interact with proteins and form insoluble complexes thereby decreasing bioavailability for proteins (Reena *et al.*, 2018).

Phytate is high in sorghum grains containing high tannin and this causes a decrease in the sodium pump by 80 % in the jejunum and ileum of the small intestines. Sorghum contains saponins, according to the reports by Jenkins and Atwal (1994) that saponins reduces the growth of chicks, feed efficiency and interfere with the absorption of dietary lipids, cholesterol, bile acids and vitamins A and E. Sorghum contains oxalates which affect calcium and magnesium

metabolism and react with proteins to form complexes which have an inhibitory effect in peptic digestion, oxalic acid binds calcium and forms calcium oxalate which is insoluble (Akande *et al.,* 2010).

Léder (2004) reported that germination, decortication and/or malting and fermentation enhanced the nutritional value of sorghum and millets by causing significant changes in chemical composition and elimination of anti-nutritional factors. Processing techniques such as soaking and germination reduced the extractable phenols (Parker and Waldron, 2005). This process produced enzymes that break down complexes to release free tannins and the free tannins leaches out. This study was therefore designed to evaluate the effects of processing four varieties of *Sorghum bicolor* (Samsorg-14, Samsorg-40, Samsorg-17 and KSV-15) in Kaduna state on the performance of broiler chickens.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Department of Animal Science Teaching and Research farm, Ahmadu Bello University, Zaria, Kaduna State. It is located within the Northern Guinea savannah zone of Nigeria on latitude $11^0$14`14"N and longitude $7^0$38' 65" E at an altitude of 610 m above sea level (Ovimap, 2014).

Sources of sorghum

The sorghum seeds used for this study were obtained from Samaru and Giwa in Kaduna State.

Anti-nutriti onal factors determination

The different anti-nutritional factors contained in the four different sorghum varieties were carried out in the Animal Science Biochemistry Laboratory, Ahmadu Bello University, Zaria and were determined as contained in Table 3 using the following procedures:

- Total Tannin in sorghum grains was determined as described by A.O.A.C (2005).
- The total oxalate of the sorghum samples was determined using the method of A.O.A.C., (1990).
- The saponin content of the sorghum samples was determined according to the method of Hudson and El-Difraw (1979).
- The phytate content of the sorghum samples was determined using the method of A.O.A.C. (1990).

Statistical Analysis

All data obtained from the study were subjected to analysis of variance (ANOVA) using general linear model procedure of SAS (2007). Significant levels of differences among treatment means were determined using the Turkey test (Steel *et al.,* 1997) to separate the means. The statistical model for all the four experiments were as follows:-

$$Xij = \mu + ti + eij$$

where Xij = any observation made in the experiment

μ = the population mean

ti = effectdue to treatment added or treatment effect

eij = ramdom error

RESULTS AND DISCUSSIONS

Effects of processing four varieties of *Sorghum bicolor* grains on the levels of anti – nutritional factors

The levels of anti-nutritional factors in the test ingredients and the effects of processing on the levels of anti-nutritional factors are presented in Table 2.The result showed that Samsorg-40, Samsorg-14, Samsorg-17 and KSV-15 were significantly ($P<0.05$) different in the levels of anti-nutritional factors when not processed.

The levels of anti-nutritional factors in four varieties of sorghum grains and the effects of processing showed that KSV-15 had the highest levels of phytic acid, tannin and saponin followed by Samsorg-14 and Samsorg-40.

Oxalate levels did not show any significant ($P>0.05$) difference in the four sorghum varieties. The least anti- nutritional factor was observed with Samsorg-17, the results agreed with the reports of Maidala *et al*. (2016) that kaura(yellow sorghum) had the least anti-nutritional factors compared to Fara fara (white sorghum) and Jandawa (red sorghum) moreover Jandawa is high in tannin content compared to other sorghum varieties. The result for phytic acid and oxalate did not agree with the reports of Maidala *et al*. (2016) that Jandawa grain had higher phytic acid and oxalate than Fara fara grains as the results in this study was similar.

With soaking, Samsorg-14 had the highest level of anti-nutritional factors followed by KSV-15 and Samsorg-40, with Samsorg-17 having the least. The reason might be that Samsorg-17 had soluble tannin and lower anti-nutritional factor that could easily be leached out unlike the other varieties which had condensed tannin and were difficult to be leached out.

Fermentation of four varieties of sorghum grains caused significant ($P<0.05$) difference in the levels of phytic acid with Samsorg-17 having the lowest significant level of phytic acid. The results agreed with the reports of Oyango *et al.* (2013) that fermentation was more effective in reducing anti-nutrients and should be carried out on grains with low levels of anti-nutrients

In addition fermentation was less effective in cereal grains high in tannin content such as red sorghum as they inhibit phytase activity and anti-nutrients were not effectively reduced (Sandberg, 1991). The results for phytic acid reduction in all the sorghum varieties studied agreed with the findings of (Towo *et al.,* 2006, Afify *et al.,* 2012 and Mahesh *et al.,* 2015) that fermentation had significant ($P<0.05$) impact on the phytic acid which strongly reduced the phytate content and enhanced water solubilization of some phytic acid salts and was more effective when whole grains were used, in addition germination during fermentation activated endogenous grain phytase which degraded phytate to phytins (Kayode *et al.,* 2007) and phytins were broken down by endogenous phytase enzymes, releasing their P, myo-inositol and then converted to inositol and the growing seedlings made use of the mineral content (Raboy, 1990). In addition natural fermentation induced phytate hydrolysis via the action of microbial phytase enzymes originating from the micro flora on the surface of cereal reducing the phytates (Hurrell, 2004). Egli *et al.*, (2002) reported that sorghum, maize and millet have low basal phytase activity but increased after processing.

The reduction in pH in fermented food produces organic acids such as lactic acid, citric and acetic acid favoured the activity of the enzyme phytase from lactic acid bacteria, dephosphorylating phytate effectively as reported by Abdelseed *et al.* (2011). Fermentation of the four sorghum varieties reduced tannin content, the result supported the findings of (Hassan and El-Tinay, 1995) that tannin content decreased during natural fermentation in sorghum and pearl millet Osman (2013) and maize as repoted by Abdel-Hady *et al.* (2005). Abdoulaye *et al.* (2011) and Ikram *et al.* (2013) reported that fermentation is one of the most economic and effective measure in reducing anti-nutritional factors such as tannin and phytates. Tannin in sorghum varieties are reduced by leaching of polyphenols due to increased enzymatic hydrolysis which occurs during soaking or fermentation process as reported by (Osman *et al.*, 2013 ; Falmata *et al.*, 2013).

. **Table 2: Anti-nutritional factors of different varieties of raw and processed *Sorghum bicolor***

Parameters	**Sorghum Varieties**				
Raw Sorghum	Samsorg-14	Samsorg-40	Samsorg-17	KSV-15	SEM
Phytic acid (mg/100ml)	0.74[c]	0.71[b]	0.66[a]	0.74[c]	0.005
Tannin (mg/100ml)	0.26[b]	0.25[b]	0.23[a]	0.33[c]	0.005
Saponin (mg/100ml)	0.48[b]	0.51[c]	0.42[a]	0.60[d]	0.004
Oxalate (mg/100ml)	0.26[b]	0.22[a]	0.22[a]	0.25[b]	0.004
Fermented Sorghum (%)	Samsorg-14	Samsorg-40	Samsorg-17	KSV-15	SEM
Phytic acid (mg/100ml)	0.22[a]	0.24[b]	0.21[a]	0.24[b]	0.017
Tannin (mg/100ml)	0.01[a]	0.02[b]	0.01[a]	0.01[a]	0.003
Saponin (mg/100ml)	0.07	0.08	0.08	0.08	0.003
Oxalate (mg/100ml)	0.06	0.06	0.06	0.06	0.003
Percentage reduction (%)	Samsorg-14	Samsorg-40	Samsorg-17	KSV-15	SEM
Phytic acid (%)	70.27[a]	66.20[d]	68.18[b]	67.57[c]	0.09
Tannin (%)	92.00[c]	96.15[a]	95.65[b]	96.97[a]	0.58
Saponin (%)	84.31[c]	85.42[b]	80.95[d]	86.67[a]	0.02
Oxalate (%)	72.73[b]	76.92[a]	72.73[b]	76.33[a]	0.44
Soaked Sorghum	Samsorg-14	Samsorg-40	Samsorg-17	KSV-15	SEM
Phytic acid (mg/100ml)	0.24[b]	0.22[a]	0.21[a]	0.22[a]	0.004
Tannin (mg/100ml)	0.24[b]	0.22[a]	0.22[a]	0.28[c]	0.004
Saponin (mg/100ml)	0.13[b]	0.12[a]	0.11[a]	0.12[a]	0.004
Oxalate (mg/100ml)	0.22[b]	0.20[b]	0.12[a]	0.13[a]	0.004
Percentage reduction (%)	Samsorg-14	Samsorg-40	Samsorg-17	KSV-15	SEM
Phytic acid (%)	67.56[d]	69.01[b]	68.18[c]	70.37[a]	0.07
Tannin (%)	7.63[c]	12.00[b]	4.35[d]	15.15[a]	0.87
Saponin (%)	72.92[c]	76.47[b]	73.81[c]	80.00[a]	0.87
Oxalate (%)	15.38[b]	9.10[c]	15.45[b]	48.00[a]	0.58

SEM = Standard error of means, [a,b,c,d] Means on the same row with different superscripts are significantly ($P<0.05$) different.

Fermentation reduces tannin via microbial activity as reported by (Svensson *et al.*, 2010; Schons *et al.*, 2011 and Afify *et al.*, 2012).

Percentage reduction in most of the anti-nutritional factors was highest in fermented KSV -15 followed by Samsorg-40 and Samsorg-17, while Samsorg-14 had the least. This result is similar to the report of Maidala *et al.* (2016) that Samsorg-14 had the least anti-nutritional reduction in terms of tannin and oxalate compared to Samsorg-17 and KSV-15 when subjected to malting a process similar to fermenting. The reason could be due that the sprouting time was not sufficient to degrade a greater percentage of tannin and oxalate (Ogbonna *et al.* 2012) which was present in Samsorg-14.

With soaking, Samsorg-14 had the highest level of anti-nutritional factors followed by KSV-15 and Samsorg-40, with Samsorg-17 having the least. The reason might be that Samsorg-17 had soluble tannin and lower anti-nutritional factor that could easily be leached out.

The results of tannin reduction agreed with the reports of (El-khalifa and El-Tinay, 1994; Hassan and El Tinay, 1995) and that the percentage reduction of tannin falls within the range of (60 – 70%) and (92%) respectively using different sorghum varieties when they were subjected to fermentation process.

The saponin content also reduced significantly ($P<0.05$) for all the varieties of sorghum used in this study, the results supported the findings of Rotimi (2011) that when finger millets were subjected to soaking or fermentation process the saponin content reduced greatly compared to the unprocessed millet.

The reduction of oxalate content during fermentation could be as a result of microbial activities that took place during fermentation process of 72 hours, this was reported by Lawal *et al.* (2015) that oxalates present in maize flours and sorghum grains were reduced by fermentation. In addition sprouting usually occur during fermentation and malting and reduced anti-nutritional factors present in cereals (Abdoulaye *et al.*, 2011 and Ogbonna *et al.*, 2012).

CONCLUSION AND RECOMMENDATION

It was concluded that processing methods such as soaking, soaking and fermentation reduced anti-nutritional factors in four varieties of sorghum. In conclusion fermentation as a processing method reduced tannins, saponins, phenols and oxalates more appreciably than soaking. Therefore, it is recommended that fermentation be used for processing sorghum to reduce anti-nutritional factors and enhance the nutrient availability for monogastric animals.

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