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Anti-Nutrient Composition of Starch Isolated from Red and White Sorghum Cultivars Subjected to Different Steeping Times.

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Abstract

Sorghum (Sorghum bicolor) is a staple food that provides a major source of calories to large segments of the population living in semi-arid tropics of Africa and Asia. Steeping is an age-long process among all the available food processing techniques known to improve nutritional qualities, palatability and consumer appeal of sorghum. The effects of steeping periods on the anti-nutrient composition of starches from two varieties of sorghum (red and white) were investigated. Sorghum grains steeped for 6, 12, 18 and 24 h with water were processed into starch and sample from unsteeped sorghum served as control. The starch samples were analysed for anti-nutrients components using standard analytical procedure. Anti-nutrients investigated varied with cultivars and increased steeping time. Hydrogen cyanide observed was in the range of (1.34 to 1.86 mg/kg), tannin (1.30 to 4.82 mg/g), saponin (6.10 to 13.05 mg/g), oxalate (0.43 to 0.90

mg/g), phytate (2.15 to 9.06 mg/g), cardiac glycoside (9.30 to 13.35 mg/g), terpenoid (13.50 to 18.99 mg/g) and alkaloid (34.10 to 50.31%). The objective is to determine the anti-nutrients composition of starch from red and white sorghum. There was no significant difference between starches from the two cultivars of sorghum (red and white) in most of the parameters investigated. However, the red cultivar recorded higher values in some of the anti-nutrients investigated. The anti-nutrient levels significantly reduce with increase in steeping time thereby improving the bioavailability of mineral and other nutrients present in sorghum. Mixture of two varieties (red and white) could find applications in food formulations.

Keywords: anti-nutrients; starch; steeping; sorghum

Introduction

Sorghum is the fifth most important cereal crop in theworld after rice, wheat, maize, and barley, and the most-grown cereal in Sub-Saharan Africa, after maize[20,28]. Sorghum remains one of the most versatile cereal crops on the continent, serving as a staple andmain meal for millions of people (Schober and Bean,2008). It is an important source of calories, a variety of nutrients, and beneficial food components [20]. It isgenerally high in carbohydrates, low quantity, and quality protein, and is limiting in lysine, threonine, methionine, and tryptophan [7]. Sorghum grains varyfrom white to dark brown depending on the phenolic pigments present. The seed coat contains anabundant number of polyphenolic compounds which combine with other flavonoids (anthocyanins, anthocyanidins, e.t.c.) to give it various colors [11]. The germ fraction of sorghum is rich in minerals (ash), protein, and lipids as well as B-group vitamins: thiamine, niacin, and riboflavin (Melaku *et al.*, 2005). The endosperm consists mainly of starch granules, storage proteins, and cell wall materials (Melaku *et al*., 2005).

Starch is the most abundant carbohydrate reserve inplants and it is deposited in plant parts in the form of small granules or cells ranging from 1 up to 100 µm [30]. Starch is commonly processed by wet milling, the seed or tuber is milled, followed by the separationof the main constituents such as starch, protein, and fiber [26,27]. Starch granules are composed of amixture of two polymers: an essentially linearpolysaccharide called amylose and a highly branched polysaccharide called amylopectin. Depending on theplant, starch generally contains 20 to 25% amylose and 75 to 80% amylopectin by weight. Despite an impressive array of nutrients in sorghum grains, sorghum-based foods have continued to be nutritionally deficient and organoleptically inferior dueto the presence of anti-nutritional factors such as tannin, saponin, phytic acid, polyphenol, and trypsin inhibitors which bind these food ingredients into complexes making them unavailable for human nutrition [8].

Anti-nutritional factors are primarily associated with compounds or substances of natural or syntheticorigin, which interfere with the absorption of nutrients,and act to reduce nutrient intake, digestion, and utilization and may produce another adverse effect [10]. Anti-nutrients are found in their highest concentrations in grains, beans, legumes, and nuts, but can also be found in leaves, roots, and fruits of certain varieties of plants [15]. The presence of anti- nutritional factors limits the digestibility of proteins and carbohydrates by inhibiting respective proteolytic andamylolytic enzymes [8]. Anti-nutritional factors equallydetermine the bioavailability of divalent mineral elements which play key roles as enzyme stabilizers,transport co-factors in metabolic pathways, and otherkey physiological functions [9].

Steeping or soaking is an important unit operation that facilitates the processing of sorghum whereby the cereals or the legumes are kept in water for a specific period (Zubair and Osundahunsi, 2016). There is a need for adequate steeping of sorghum for the development of value-added products from grains likea highly nutritious and easy-to-digest whole-grain food with robust flavor [34]. Steeping of sorghum hasbeen reported to significantly reduce the anti-nutrient content of sorghum thereby, leading to an improvement in protein digestibility and other proteinquality characteristics including the percentage ofprotein, nitrogen solubility index, and content of the limiting amino acid lysine [6]. Kazanas and Fields (1981) reported an improvement in the in-vitro digestibility of protein and starch during the soaking of sorghum while Chavan *et al.* (1988)) indicated an improvement in the composition and content of essential amino acids and an increased absorption of minerals such as zinc, iron, potassium, magnesium and calcium respectively in sorghum. Soaking of sorghum leads to a modification of inherent metabolites and constituents, activation of enzymes, decrease in pH levels, increased metabolic activities,

Results And Discussion

Anti-nutrient content of starch from red and white and microbial actions with detoxification and degradation of contaminants [1]. Knowledge of anti-nutrient in sorghum during processing is required so that the potential of sorghum can be evaluated and also the need to develop a processing method or adequate steeping time that will remove completely or reduce these undesirable components to improve the nutritional quality of cereals. Hence, the need to investigate the effect of different steeping times on the anti-nutrient content of sorghum starch. The objective of this study is, therefore, to determine the effect of different steeping times on the anti-nutrient component of starch from two varieties of sorghum (red and white).

Materials And Methods

Sorghum grains (red and white) were purchased fromthe Ojo-Oba market in Akure, Ondo State, Nigeria. Allchemicals used were of analytical grade.

Sample preparation

Sorghum grains were cleaned manually and sorted toremove the husks, stems, and damaged and discolored seeds which were achieved by winnowing,hand-picking, and washing with tap water. The method of Singh *et al*. (2010) was used for starch production. About 250 g of sorghum grains werewashed with tap water, steeped for 6, 12, 18, and 24h, and thereafter wet milled; while the control samplewas milled without steeping. The slurry was filtered through a 100 µm mesh screen and the filtrate was allowed to sediment overnight, decanted, and slurriedtwice before final decantation. The starch cake was oven dried at 50 °C for 6 h, milled after drying, and sieved through a 0.25 µm mesh screen to get the sorghum starch.

Sample analyses

Alkaloid, terpenoid, and Cardiac glycoside content were determined using the method described by Uchenna and Otu (2019). Saponin content, tannin content, cyanide content, total oxalate, and phytate contents were determined using the method of described by Aiwonegbe *et al*. (2018).

Statistical analysis

All experiments were carried out in triplicate. Mean and standard deviation was calculated for each treatment. Data obtained were subjected to analysis of variance (ANOVA) and the means were separatedby the lowest standard deviation test (SPSS version 16) and the significant level was accepted at 5%.

sorghum cultivar is presented in Table 1. Hydrogen cyanide content was in the range of 1.34 mg/kg to 1.86 mg/kg, tannin content was in the range of 1.30 mg/g to 4.82 mg/g, saponin content was in the rangeof 6.10 mg/g to 13.05 mg/g, oxalate content was in the range of 0.43 mg/g to 0.90 mg/g, phytate contentwas in the range of 2.15 mg/g to 9.06 mg/g, alkaloid content was in the range of 34.10% to 50.31%, terpenoid content was in the range of 13.50 mg/g to 18.99 mg/g and cardiac glycoside ranged between 9.30 mg/g to 13.35 mg/g. All anti-nutrients investigated showed a significant decrease ($p \leq 0.05$) with an increase in steeping time. This finding is in linewith the observation of [12]. reported that grains showa notable decrease in anti-nutritional content when subjected to steeping and this has been considered an effective way to reduce the risk of mineral deficiency among populations, especially in developing countries where unrefined cereals are highly consumed. The reduction of the anti-nutrient as a result of the steeping could be attributed to the leaching of the anti-nutrients in the steeping water considering a change in the color of the steep water.In addition to leaching, increased enzymatic hydrolysis could have facilitated the reduction of the anti-nutrients [12]. The result obtained in this research for tannin was in line with the observation of Melaku *et al*. (2005) who reported that white-colored sorghum contains less tannin than red-coloredsorghum. Reduction in tannin content could be due tothe leaching out of polyphenols into steeping water under the influence of concentration because tanninsare polyphenols and polyphenolic compounds that are readily soluble in water and mostly located in the seed coat (Opeyemi *et al*., 2016). [13] reported that steeping significantly reduces the tannin content in some food grains such as finger millet. Phytate may have been significantly affected by the endogenous enzyme like phytase activated during steeping. Phytase degrades phytate into inorganic phosphorous and inositol and its intermediate forms [14]. Phytate is the principal storage form of phosphorous and is particularly abundant in cereals and legumes. The reduction in phytate content occasioned by an increase in steeping time is inagreement with the findings of Valverde *et al*, (1994) who reported that the steeping of lentils greatly reduced the phytate content.

The oxalate content range of 0.43mg/g to 0.90mg/g recorded in this research was within the range of

Variety	Steeping time (h)	Hydrogen cyanide (mg/kg)	Tannin (mg/g)	Saponin (mg/g)	Oxalate (mg/g)	Phytate (mg/g)	Alkaloids (%)	Terpenoid (mg/g)	Cardiac glycosides (mg/g)
	0	1.86±0.01^{a}	4.82±0.01^{a}	13.05±0.06^{a}	0.90±0.01^{a}	9.06±0.01^{a}	50.31±0.06^{a}	18.99±0.01^{a}	13.35±0.21^{a}
	6	1.83±0.01^{ab}	2.72±0.02^{c}	12.44±0.62^{bc}	0.85±0.01^{a}	8.94±0.08^{ab}	49.25±0.35^{ab}	17.75±0.35^{b}	12.21±0.01^{b}
Red	12	1.66±0.01^{c}	2.21±0.04^{d}	8.73±0.01^{d}	0.71±0.01^{b}	6.20±0.28^{c}	38.04±0.05^{c}	16.14±0.11^{c}	10.95±0.07^{c}
	18	1.48±0.01^{d}	1.82±0.01^{e}	6.57±0.01^{e}	0.56±0.01^{cd}	3.30±0.00^{d}	35.81±1.21^{d}	14.04±0.04^{d}	10.20±0.28d^{e}
	24	1.34±0.01^{e}	1.69±0.01^{e}	6.15±0.07^{e}	0.44±0.06^{e}	2.40±0.28^{e}	34.25±0.35^{e}	13.70±0.14^{d}	9.50±0.42^{f}
	0	1.83±0.01^{ab}	3.50±0.14^{b}	12.90±0.14^{ab}	0.88±0.03^{a}	9.02±0.02^{ab}	49.00±0.00^{b}	18.70±0.14^{a}	13.15±0.07^{a}
	6	1.82±0.02^{b}	2.10±0.14^{d}	12.30±0.42^{c}	0.76±0.01^{b}	8.70±0.14^{b}	48.30±0.42^{b}	17.60±0.57^{b}	12.05±0.07^{b}
White	12	1.64±0.01^{c}	1.70±0.14^{e}	8.50±0.14^{d}	0.61±0.01^{c}	6.10±0.14^{c}	38.20±0.28^{c}	16.00±0.01^{c}	10.70±0.14^{cd}
	18	1.47±0.01^{d}	1.40±0.14^{f}	6.30±0.14^{e}	0.54±0.01^{d}	3.32±0.03^{d}	36.50±0.71^{d}	13.95±0.07^{d}	10.10±0.14^{e}
	24	1.34±0.01^{e}	1.30±0.14^{f}	6.10±014^{e}	0.43±0.04^{e}	2.15±0.07^{e}	34.10±0.14^{e}	13.50±0.14^{d}	9.30±0.42^{f}

Table 1**:** Anti-nutrient content of starch from red and white sorghum cultivar subjected to different steeping time

Conclusion

A significant reduction was observed in the level of the anti-nutrient composition with an increase in steeping time thereby improving the bioavailability of minerals. There was no significant difference between starches from the two cultivars of sorghum (red and white) in most of the parameters investigated. However, the difference observed insome results could be attributed to the isolation method. A mixture of two varieties (red and white) could find better applications in food formulations.

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Nutrition 342348: pg 61-63

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