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Effect of sprouting on nutritional value of *Panicium miliaceum* (proso millet)

Frank N. I. Morah, Usenobong P. Etukudo

ABSTRACT

Aims: To determine the effect of sprouting time on the nutritional value of proso millet. Methods: The millet was sprouted for 96 h. The millet at zero hour was oven dried and powdered to get the proso millet flour. The flour was analyzed for crude protein, crude fat, ash, fiber and available carbohydrate content. It was also analyzed for phytic acid, hydrogen cyanide, soluble oxalate and total oxalate. The entire procedure was repeated after 24 h, 48 h, 72 h and 96 h. Results: The present study shows that there is a decrease in fat and available carbohydrate with increase in sprouting time while ash, crude fiber and protein content increased. There was also decrease in the level of cyanide, phytic acid and oxalates with sprouting. With lowering in the level of phytate and oxalate during sprouting, protein and mineral elements become more biologically available. Decrease in cyanide level during sprouting also made the sprouted proso millet safer for human consumption. Conclusion: Sprouting improves the nutritional value of proso millet and makes it safer for human consumption. It also reduces its caloric value.

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INTRODUCTION

Millet is one of the oldest food-stuff known to mankind. It was used in biblical days to make unleavened bread (Ezekiel 4:9) and was grown as early as 2700 BC. It is a major source of food to both man and livestock. Millets are highly nutritious but lack gluten. They are 60% higher in crude protein, 40% richer in lysine and methionine and 30% richer in threonine than maize and barley [1]. Proso millet (*Panicum miliaceum*) belongs to the millet group. The other members of the millet group include kodo millet (*Paspalum scrobiculatum*), little millet (*Panicum sumatrense*), barnyard millet (*Echinochloa* species), pearl millet (*Pennisetum glaucum*), finger millet (*Eleusine coracana*) and foxtail millet (*Setarla itatica*) etc. [2]. It is well known that food processing generally improves the nutritional value of foods [3]. The sprouted millet is malted and used for making local alcoholic beverages like burukutu and pito in Nigeria

[4]. A lot of millet is consumed in Asia and Africa where it serves as both adult food and weaning food. Millet is consumed by adults as food. It is also used in preparation of weaning food, and can be brewed into burukutu and pito. The present study is aimed at evaluation of the effect of sprouting on the nutritional value and the level of anti-nutritional factors in it.

MATERIALS AND METHODS

Panicum miliaceum L. seeds were purchased from Bogobiri market, Calabar Municipality, Cross River State, Nigeria. It was authenticated by staff of the herbarium unit of the Botany Department, University of Calabar. The seeds were soaked in water for 5 min. The water was decanted and the seeds spread on a spreader and covered with large papers in the dark. Part of the sample was collected around 12 noon each day for a period of 96 h. The sample collected at zero time was taken as the control.

Moisture content was determined by the Association of Official Analytical Chemistry (AOAC) method [5]. The samples were dried to constant weight. The oven dried sample was powdered to give the proso millet flour which was used for the proximate and anti-nutrient analysis. The ash content was determined by igniting a known weight of the flour sample in a muffle furnace at 550°C for about 8 h. The nitrogen contents were determined by the micro-Kjeldhal method [5]. The crude protein was estimated by multiplying the nitrogen content by 6.25. Crude fat was determined by extraction with light petroleum in a Soxhlet extractor [5]. Available carbohydrate was calculated by difference method i.e., 100-(% fiber + % fat +%ash +% protein). The energy value was calculated by Atwater factor [(9x% fat) + (4x% available carbohydrate) + (4 x% protein)] kcal/100 g [6]. Total oxalate, soluble oxalate, cyanide and phytic acid were determined by AOAC methods [5] and Vaintraub and Lapteva method [7].

RESULTS

Table 1 gives variations of proximate composition and nutritional value of *Paniacum miliaceum* flour with increase in sprouting time. Fat and available carbohydrate contents decreased while fiber, ash and protein contents increased with sprouting time. Table 2 gives the variation of anti-nutritional factors with sprouting time. It shows that the level of all the anti-nutritional factors measured decreased with sprouting time.

DISCUSSION

The moisture content as expected increased with sprouting time. This is because of water intake by the seeds during sprouting. There is reduction in crude fat and available carbohydrate. This is because starch in the cotyledons is hydrolyzed to soluble sugars during sprouting. Both sugars and fat are utilized for biochemical activities of the germinating seeds [8, 9]. Since there is loss of fat and available carbohydrate during sprouting, there is overall decrease in total dry matter with concomitant increases in percentage protein, fiber and ash [10]. Similar increase in protein content of different types of beans has been reported [11–13].

Table 1: Variation of proximate composition with sprouting time of proso millet

Parameter	Control (0 h)	24 h	48 h	72 h	96 h
Moisture	21.8%	23.6%	26.0%	28.6%	37.2%
Crude lipid	5.5%	4.7%	4.6%	4.2%	3.1%
Crude protein	0.56%	0.63%	0.84%	0.88%	1.00%
Ash content	5.5%	6.0%	7.0%	8.4%	10.0%
Fiber content	4.5%	5.2%	4.6%	4.1%	4.8%
Available carbohydrate	83.94%	83.47%	82.96%	82.82%	81.1%
Energy (kcal/100 g)	362.8	358.4	357.8	356.0	345.8

Table 2: Variation of anti-nutrient level with sprouting time of proso millet

Anti-nutrient	Concentration of anti-nutrient				
	0 h	24 h	48 h	72 h	96 h
HCN	2.48 mg/100 g	3.02 mg/100 g	3.13 mg/100 g	2.92 mg/100 g	2.81 mg/100 g
Phytic acid	0.90 mg/100 g	0.07 mg/100 g	0.05 mg/100 g	0.045 mg/100 g	0.04 mg/100 g
Soluble oxalate	1.32 mg/100 g	1.21 mg/100 g	1.10 mg/100 g	0.092 mg/100 g	0.44 mg/100 g
Total oxalate	38.5 mg/100 g	27.5 mg/100 g	26.4 mg/100 g	24.42 mg/100 g	17.40 mg/100 g

Increase in protein content is also attributable to the activation of proteolytic enzymes present in the seeds as well as the hydrolysis of tannin-protein and enzyme-protein complexes which release more free amino acids and peptides for metabolism of the embryo and new protein synthesis. Ominawa and Asogu [11] suggested that increase in protein content can also be attributed to increase in enzyme activities resulting in net synthesis of enzymatic protein [6]. Protein in seed is also degraded and converted into soluble state during sprouting. The speed of utilization of the soluble amino acids becomes faster leading to increased protein contents [8]. Ash content of grains usually increased during sprouting and it is an index of mineral element concentration [10]. However, the ash content may decrease if the grains were regularly sprinkled with plenty of water during sprouting. This is attributable to leaching out of part of the mineral constituents. In the present study, there was no such sprinkling of a lot of water during the sprouting period. The moistened grains were rather covered in a dark humid environment to minimize loss of moisture during sprouting. This must have been responsible for the observed increase in ash content with sprouting time. The caloric value of the millet also became lowered from 362.8 kcal/100 g from zero time to 345.8 kcal/100 g after 96 h of sprouting.

The analyzed anti-nutritional factors such as hydrogen cyanide, phytic acid, soluble oxalate and total oxalate all decreased with an increase in sprouting time. Different processing methods reduce the level of anti-nutritional factors in food stuff [3, 14, 15]. Phytic acid forms insoluble complexes with divalent cations such Zn^{2+}, Fe^{2+}, Ca^{2+}, etc. and protein thus rendering them biologically inactive. Reduction of the concentration of phytic acid during sprouting leads to greater bioavailability of these mineral nutrients and proteins [16, 17]. Oxalates also interfere with assimilation of Ca^{2+} [17] and its decrease with sprouting time is also advantageous in terms of nutrition. Cyanide which is detected in proso millet initially increased but started decreasing after 48 h of sprouting. Cyanide disrupts biological oxidation at the mitochondria which is the power house of the cell and the site for cellular respiration [18].

CONCLUSION

Sprouting increases the level of protein and mineral elements in the proso millet. It also increases their bioavailability by lowering the concentration of phytic acid and soluble oxalate. It therefore increases the nutritional value of proso millet meals and also lowers its caloric value.

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Author Contributions

Frank N. I. Morah – Substantial contribution to the conception and design, Acquisition of data, Analysis and interpretation of data, Drafting of article, Revising it critically for important intellectual content, Final approval of version to be published

Usenobong P. Etukudo – Acquisition of data, Analysis and interpretation of data, Revising the article critically for important intellectual content, Final approval of the version to be published

Guarantor

The corresponding author is the guarantor of submission.

Conflict of Interest

Authors declare no conflict of interest.

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