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Effect of Germination on Cooking, Nutrient Composition and Organoleptic Qualities of African Yam Bean (*Sphenostylis stenocarpa*).

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Abstract
The study was carried out to determine the effect of germination on the nutritional and sensory qualities of African yam bean (AYB). The AYB seeds were germinated at 24, 48, 72 and 96 hrs. The ungerminated sample was used as control. Germinated and ungerminated samples were cooked separately and each sample was divided into three portions. Two third of each sample was served for sensory evaluation while one third of each sample was ground into paste and used for chemical analysis. Sensory evaluation was conducted using 40-man panelist. The result showed that AYB germinated for 96 hours (GN) had the shortest cooking time (115 minutes) and gave the best nutrient composition. Results for sensory evaluation showed that sample GN had the least acceptability in terms of colour, taste and flavor compared to other samples ($P<0.05$). Germination can be used to improve nutrient composition and reduce cooking time and beany flavor of the cooked AYB seeds.
Key words: African yam bean, germination, cooking, organoleptic, nutrient.

1. Introduction

African Yam Bean (AYB) is among the lesser known and underexploited legumes in South East Nigeria (Ene-Obong and Okoye 1992). Its use has however attracted research interest in recent times (Nwokolo 1987). According to Ezueh (1984) and Ofuya (1991), it has a high protein content of about 22%, while its carbohydrate and fat content are 62.6 and 2.5%, respectively. Inspite of its composition, AYB has a low consumption rate. This is mainly due to its long cooking time compared with that of cowpea (Nwokolo, 1996; Otah, 1999); possession of beany flavor and its constituents of anti-nutritional factors (Ebiokpor and Lloyd, 2005).

The quality of foodstuffs may be improved by processing. This may involve boiling, autoclaving and sprouting/germination. Germination is a natural process of all superior plants by which the seed comes out of its latency stage (Sangonis and Machado 2007). The process of germination has been developed in some countries as an alternative to defeat some of the disorders associated with untreated grains such as undesirable tastes and smell, as well as the presence of anti-nutritional factors (Sangonis and Machado 2007). Studies have shown that germination improves the nutritive value of cereals and legumes (Onwuka et al. 2009; Mohammed et al. 2011). Cooking on the other hand is usually carried out before the use of legumes in human diet. Cooking improves the protein quality by either destroying or inactivating heat labile anti-nutritional factors (Mubarak 2005).

This study will therefore determine the effect of germination on cooking, nutrient composition and organoleptic qualities of African yam bean. This would help in determining the most cost effective cooking and fuel saving time for developing countries in order to improve the nutritional value of this underutilized legume.

2. Materials and methods

2.1 Source of raw materials

The AYB seeds were purchased from Umuahia main market in Abia State, Nigeria. Identification of the seed was carried out at the Forestry Department of Michael Okpara University of Agriculture, Umudike, Abia state,Nigeria.

2.2 Methods

The seeds were sorted and unhealthy ones discarded. Four hundred (400) grammes of AYB seeds were weighed using a weighing scale. This was labeled into 5 samples as follows:
GU = Ungerminated
GT = Germinated for 24 hrs
GF = Germinated for 48 hrs
GS = Germinated for 72 hrs
GN = Germinated for 96 hrs
Germination was carried out for 4 days as described by Kulkani *et al.* (1991). The seeds were covered with wet jute bags under room temperature at the different germination hours. The seeds were washed twice a day. After the germination period, the seeds were re-weighed and thereafter washed in different bowls. The following weights were obtained:

Sample GT increased in weight by 75g
Sample GF increased in weight by 125g
Sample GS increased in weight by 225g
Sample GN increased in weight by 275g
No losses were encountered since only healthy seeds were selected.

2.3 Cooking of germinated seeds

The different samples of germinated seeds were cooked until the same degree of doneness as adjudged by the taste panelists was obtained using the sense organs of taste, smell and touch to determine when the seeds were properly cooked. The cooking times were recoded from the time boiling started till the time the grains were soft. This step is important in order to know the germination time that gave the shortest cooking time in order to save fuel. The recipe used for cooking the germinated AYB seeds was modified based on that developed by Enwere (1998). For cowpea preparation, the ingredients added to the cooked AYB include: palm oil (¼ cup), onion (25g), red pepper (5g), salt (10g) and bullion cube (5g). The palm oil was slightly heated, chopped onions were fried in it for half a minute. Other ingredients (red pepper, salt and bullion cube) were added, stirred and half a cup of water was poured into the mixture. This was left to boil for about 5 minutes after which the germinated cooked AYB samples were poured into the mixture. This was left to simmer for 10 minutes, brought down and left to cool (40^{o}C). The cooked samples were kept separately in a thermos flask to maintain the serving temperature of 40^{o}C.

2.4 Sensory evaluation

A 40 man panel randomly selected from members of staff and students of the Department of Human Nutrition and Dietetics were used for sensory evaluation. The panelists were separately seated and each was provided with a glass of clean tap water to rinse their mouth between the five evaluation sessions. The cooked ungerminated AYB (GU) was served as control. The 4 germinated cooked AYB were presented in 2 alphabet coded white plastic plates. These were evaluated for colour, taste, flavor and overall acceptability using a 9-point hedonic scale, where 0 represented the most desirable score (liked extremely) and 1 represented the least score (dislike extremely) as described by Iwe (2002).

2.5 Proximate analysis

Proximate analysis of the germinated and ungerminated cooked AYB samples were carried out in triplicates. Moisture, protein, ash, crude fibre, fat, vitamins and minerals were carried out using standard methods (AOAC 2000). Carbohydrate was determined by difference.

2.6 Statistical analysis

Data obtained from chemical analysis and sensory evaluation were subjected to ANOVA to determine significant differences (Steel and Torrie 1990). Duncan Multiple test was used to separate the means as described by Iwe (2002).

3. Results

Results on Table 1 shows differences in cooking time of the germinated and ungerminated AYB seeds. Sample GN had the shortest cooking time (115 minutes), while sample GU had the longest cooking time (195 minutes).

Results on Table 2 shows the proximate composition of cooked germinated and ungerminated AYB. The protein values ranged from 10.57±0.003 to 7.89±0.003% with sample GN having the highest and sample GU having the least value ($p<0.05$). Moisture ranged from 10.78±0.003 to 7.14±0.006%, fat was from 1.76±0.006 to 13.81±0.003%. The range for carbohydrate and crude fibre were 62.35±0.006 to 75.96±0.003% and 3.61±0.007 to 6.71±0.009%, respectively.

Table 3 represents vitamin and mineral content of processed AYB. Sample GF had significantly higher iron (5.71±0.003) compared with the other samples, while sample GU had the least value (1.14±0.00) ($p<0.05$). Sample GS had significantly more calcium (0.53±0.006) than others, while sample GU had the least calcium (0.33±0.003). Magnesium was higher (7.67±0.003%) in sample GN, while sample GF had the highest vitamin A content (0.007±0.00%).

Results of the sensory evaluation are presented in Table 4. The mean scores for colour were similar for samples GT, GF and GS, but differed from GN and GU. Sample GS however had the best score for colour with sample GN having the least acceptable colour. Mean scores for taste were similar for samples GT, GF and GS, but were different for sample GU and GN. Sample GS also had the highest mean score for taste. A similar trend was observed for flavor. Overall acceptability showed that sample GN had the least score, followed by sample GU, while scores for the others (GT, GF and GS) were similar.

4. Discussion

It has been reported that the greatest constraint in the utilization of AYB seed is it's hard to cook phenomenon (Osagie and Eka 1998). The need to find ways to make cooking of this legume easier led to the germination of the seeds before cooking. Kordylas (1990) noted that germination makes legumes easier to cook and tastier even

when raw. Sample GN had the shortest cooking time and saved fuel. This could be due to some biochemical and physiological reactions that takes place during germination. It has been reported that during the process of germination, the cells are liberated and the seeds absorb water and swell thus making them cook faster (Kordylas 1990). The ungerminated seed (GU) took almost twice as much time to cook as sample GN. This is because no treatment was given to sample GU prior to cooking.

It was observed that the protein value increased as the germination time increased. This could be attributed to the liberation of bound proteins during germination. Hsu *et al*. (1980) observed that protein content of legumes generally increase during germination as a result of biochemical changes induced by sprouting leading to an increase in free amino acids. Similar observations on increase in protein content during germination have been cited by other authors (Akpapunam and Achinewhu 1985; Giami 1993; Obatolu *et al*. 2001).

Fibre content was found to increase with decreasing germination time. This according to Jasen (1980) suggests that seed coats of legumes contribute significantly to their fibre content. The high moisture content of the samples could be attributed to the fact that the samples were washed at least two times a day in cold water and in the process absorbed water needed for germination. The higher moisture content of sample GN could have been the reason for the shortest cooking time observed. DelRosano and Flore (1981) reported that germination increases water and fat absorption capacities of mungbean. The increase in the fat content of the germinated AYB compared to the ungerminated may be attributed to the increase activity of lipolytic enzymes which produced more free fatty acids during sprouting. Eneche (2003) noted that germination increased the oil absorption capacity of AYB.

Carbohydrate values was observed to decrease as germination time increased. The ungerminated sample (GU) had significantly more carbohydrate than the other samples. The decrease in carbohydrate content as germination time increased corroborates findings of Inyang and Zakari (2008) and Yaboub *et al*. (2008).

Analysis of the sensory evaluation scores revealed that sample 172 had the best colour, taste and flavor compared to the other samples. It was observed that germination between 24-72 hours reduced the beany flavour which is one of the constraints to the utilization and consumption of AYB. The reduction in the beany flavor of the germinated cooked AYB suggests that some of the antinutrients responsible for the beany flavor were leached out while washing the seeds in water during the sprouting period. The ungerminated seeds (GU) were observed to have more beany flavor compared to the other samples. This thus suggests that germination could help reduce the beany flavour of AYB.

5. Conclusion and recommendation

The long cooking time and beany flavor of AYB has been the constraints to its utilization. This study has shown that there was a marked reduction in the cooking time of germinated AYB compared with the ungerminated samples (GU). There was also an increase in the sensory scores of germinated samples. Germination led to an increase in protein, fat, moisture and vitamin C content of the sprouted grains. Germination therefore seems to be a promising solution that can be used to reduce some of the constraints experienced with the utilization and consumption of AYB. Germination is therefore recommended in the processing of legumes because it is economical, reduces cooking time and improves nutrient value of the cooked seeds.

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Table 1: Differences in cooking time of germinated African yam bean seeds

Samples	Cooking time (minutes)
GU	195
GT	171
GF	158
GS	137
GN	115

GU= ungerminated, GT= germinated for 24 hrs, GF= germinated for 48 hrs, GS= germinated for 72 hrs, GN= germinated for 96 hrs.

Table 2: Proximate composition of germinated cooked African yam beam (wet weight basis)

Sample	Crude fibre %	Protein %	Moisture %	Fat %	Ash %	Carbohydrate %
GU	3.61±0.007^{e}	10.57±0.003^{a}	10.78±0.003^{e}	13.81±0.003^{a}	1.40±0.003^{d}	62.35±0.006^{e}
GT	4.10±0.003^{d}	9.47±0.003^{b}	10.53±0.003^{d}	3.14±0.012^{b}	2.41±0.007^{b}	68.67±0.003^{d}
GF	4.26±0.007^{c}	9.24±0.003^{c}	9.68±0.003^{c}	2.46±0.060^{a}	2.51±0.006^{a}	70.78±0.003^{c}
GS	6.01±0.009^{b}	9.15±0.003^{d}	7.65±0.006^{d}	2.19±0.006^{d}	1.30±0.000^{e}	72.80±0.003^{b}
GN	6.71±0.009^{a}	7.89±0.003^{e}	7.14±0.006^{e}	1.76±0.006^{e}	1.70±0.003^{c}	75.96±0.003^{a}

Mean values in the same column with different superscripts are significantly different (p<0.05). GU= ungerminated, GT= germinated for 24 hrs, GF= germinated for 48 hrs, GS= germinated for 72 hrs, GN= germinated for 96 hrs.

Table 3: Mineral and vitamin composition of germinated cooked African yam bean

Sample	Iron (mg)	Calcium (mg)	Magnesium (mg)	Vitamin C (mg)	Vitamin A (mg)
GU	2.85±0.000[b]	0.40±0.003[d]	7.67±0.003[a]	4.27±0.000[a]	0.02±0.000[a]
GT	2.51±0.003[c]	0.53±0.006[a]	1.67±0.003[c]	3.68±0.000[b]	0.07±0.000[c]
GF	5.71±0.003[a]	0.43±0.003[c]	1.67±0.003[c]	2.73±0.001[c]	0.007±0.000[e]
GS	1.31±0.000[d]	0.33±0.003[e]	7.67±0.003[a]	2.65±0.001[d]	0.05±0.000[b]
GN	1.14±0.000[e]	0.47±0.003[b]	3.67±0.003[b]	2.22±0.001[e]	0.005±0.000[d]

Mean values in the same column with different superscripts are significantly different ($p<0.05$). GU= ungerminated, GT= germinated for 24 hrs, GF= germinated for 48 hrs, GS= germinated for 72 hrs, GN= germinated for 96 hrs.

Table 4: Sensory evaluation scores of germinated cooked African yam bean

Sample	Colour	Taste	Flavour	Overall acceptability
GU	5.25±0.3[c]	4.92±0.2[b]	5.28±0.3[c]	4.68±0.3[c]
GT	7.25±0.3[a]	7.45±0.2[a]	6.78±0.3[a]	6.90±0.3[a]
GF	6.88±0.3[ab]	7.20±0.2[a]	6.48±0.3[a]	7.10±0.3[a]
GS	6.63±0.3[ab]	7.18±0.2[a]	6.63±0.3[a]	6.70±0.3[a]
GN	6.30±0.3[b]	5.58±0.3[b]	5.18±0.3[b]	5.58±0.3[b]

Mean values in the same column with different superscripts are significantly different ($p<0.05$). GU= ungerminated, GT= germinated for 24 hrs, GF= germinated for 48 hrs, GS= germinated for 72 hrs, GN= germinated for 96 hrs.