African Journal of Biotechnology Vol. 5 (22), pp. 2329-2333, 16 November 2006
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2006 Academic Journals

Full Length Research Paper

Effects of some processing methods on the toxic components of African breadfruit (*Treculia africana*)

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Accepted 25 September, 2006

A variety of breadfruit (*Var africana*) was evaluated for the presence of some anti-nutrients. It was found to contain some hydrogen cyanide (26.45 mg/kg), tannin (184.10 mg/g), starchyose (1.8%) and rafffinose (1.01%). Different methods of processing such as fermentation, boiling, autoclaving and germination was found to have effect on the anti-nutritional factors. Fermentation for 48 h reduced hydrogen cyanide activity to 0.01 mg/kg, tannin to 6.42 mg/g, haemagglutinin to 6.80 Hu/g, phytate to 0.80 mg/g, starchyose and raffinose to 0.32% and 0.01%, respectively. Boiling for 120 min reduced hydrogen cyanide activity to 4.40 mg/kg, tannin to 6.2 mg/g, haemagglutinin to 3.6 Hu/g, phytate to 0.56 mg/g, starchyose and raffinose to 0.44% and 0.02%, resppectively, while autoclaving for 60 min markedly reduced HCN to 3.40 mg/kg, tannin to 4.42 mg/g, haemagglutininin to undetectable, phytate to 0.42 mg/g, starchyose in traces and raffinose to undetectable. Finally, germination for 120 h reduced the HCN to 4.68 mg/kg, tannin to 18.16 mg/g, haemagglutininin to 10.0 Hu/g, phytate to 0.78 mg/g, starchyose to 0.24% and raffinose to 0.01%. From this research work, any of the processes could be employed in detoxifying the anti-nutritional factors in breadfruit. However, autoclaving was found to be best in the elimination of haemagglutinin, starchyose and raffinose while fermentation was effective in the reduction of hydrogen cyanide.

Key words: African breadfruit, anti-nutrients, fermentation, germination.

INTRODUCTION

African breadfruit (*T. africana*) from the family *moraceace* is an important food crop in Nigeria. The extracted seeds have been found to be highly nutritious when adequately processed (Ejiofor, 1998; Okafor, 1988). Breadfruits just like some other legumes have been known to contain some anti-nutrients which interfere with digestive processes and prevent efficient utilization of their proteins. Some of these are protease inhibitors, haemagglutinin, Lectins, saponins, and flatulence factors (Liener, 1976). The presence of these anti-nutritional factors limits the use of these crops. However, they could be eliminated or reduced by some processes such as soaking, dehulling, germination fermentation (Khokhars and Chuuham, 1986).

The utilization of breadfruit, being a cheap protein source, would be greatly enhanced if the most effective method of elimination of its toxic components is discovered. This work is therefore aimed at identifying the various anti-nutritional factors inherent in breadfruit and the best processing method for maximum elimination of the anti-nutritional factors.

MATERIALS AND METHODS

The breadfruit variety (*V.africana*) used, was bought from a local farmer at Obolo Afor in Nsukka, Enugu State in Nigeria. The seeds were extracted form the pulpy fruit heads in a flowing water with sand, sponge and basket until the slimness of the husk was reduced considerably.

Sample preparation

The breadfruit seed were divided into two portions. One portion was

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Table 1. The effect of fermentation on the weight, pH and antinutritional factors in breadfruit.

Treatment	Period (h)	Weight loss (%)	pH	HCN (mg/kg)	Tan (mg/g)	Haem (Hu/g)	Phyt (mg/g)	Sta (%)	Raff (%)
Raw seed	0	-		26.45	184.10	126.48	2.16	1.8	1.01
fermentation	6	23.31	6.4	18.80	78.10	74.36	1.04	1.08	0.14
	12	26.58	6.2	6.40	36.08	50.14	1.02	0.96	0.08
	18	35.58	6.0	2.30	22.14	30.90	0.90	0.54	0.06
	24	35.58	6.0	1.10	12.00	14.80	0.80	0.44	0.04
	48	35.58	5.8	0.01	6.42	6.80	0.80	0.32	0.01

Tan = Tannin, Haem = haemgglutinnin, Phyt = phytate, Sta = starchyose, and Raff = raffinose.

set for germination while the other portion was conditioned for 5 min in a 100°C boiling water and dehulled. The dehulled portion was then divided and subjected to various processes such as boiling, autoclaving and fermentation.

Germination

20 g of samples were weighed in triplicates and left to germinate for 96, 108 and 120 h. The weight loss was determined and the germinated samples were dried, dehulled and milled into flour to be analyzed.

Boiling

About 81.5 g of sample were weighed in triplicate to the various boiling periods. The boiling was done in water at 100°C for 30, 60, 90 and 120 min. The seeds were then oven-dried at 60°C. The dried seeds were milled and pass through 60 mesh size sieve.

Autoclaving

About 81.5 g of sample were weighed in triplicate for the various autoclaving period of time. The raw breadfruit seeds were autoclaved at a pressure of 15 1lb (120°C) for 15, 30, 45 and 60 min. The autoclaved seeds were oven dried at (60°C) milled into flour.

Fermentation

About 65.2 g of sample were weighed in triplicate for the various fermentation periods. The seeds were then left to ferment for 6, 12, 18, 24 and 48 h. The pH was monitored during fermentation. The fermented seeds were oven-dried and milled into flour.

Chemical analyses

The hydrogen cyanide determination was done by the method described by Balagopalan et al. (1988). Tannic was determined by the method of Pearson (1976), phytic acid was determined using the method of Balagopalan et al. (1988), starchyose and raffinose determination using the method described by Balagopalan et al. (1988), and haemagglutinin was determined by the method described by Armtfield et al. (1985).

RESULTS AND DISCUSSION

The results of the effect of fermentation on the levels of some anti-nutritional factors are presented in Table 1. The level of hydrogen cyanide (HCN) in the raw seed was found to be 26.45 mg/g. This value is higher than that of cowpea (20 mg/kg) (Oke et al., 1990) and lowers than that of *Mucuna cochinuiensis* (40 mg/kg) as reported by Ukachukwu and Obioha (1997). During fermentation process, there is an increase in the weight loss as the period of fermentation progresses, showing the dissolution of some of the soluble molecules in water. Also the pH shown in Table 1 goes towards acidity as the time increases form 6 to 48 h of fermentation showing the presence of HCN. The level of HCN was drastically reduced to a non-significant value of (0.01 mg/kg) when compared to other processes like boiling, autoclaving, as shown in Table 1. This result agrees with the known fact that detoxification of HCN being a water-soluble compound is enhanced by fermentation. Cooke and Maduagwu (1978) observed that cyanide content of cassava chips was highly removed during fermentation.

The tannin content in raw breadfruit (184.10 mg/g) was very high when compared to other leguminous plants like *Brachystegia eurycomo* seed, which is 5.15 mg/g (Amah et al., 2001). The tannin content of breadfruit at 6 h of fermentation is 78.10 mg/g. This reduces drastically to (6.42 mg/g) after 48 h of fermentation which shows the significant reduction in the levels of tannin present. This agrees with the fact that tannins are polyphenols and polyphenolic compounds which are soluble in water, are mostly located in the seed coat and therefore their reduction during fermentation may be attributed to leaching out of the phenol.

The haemagglutinin content of raw breadfruit reduced from 126.48 Hu/g to 6.8 Hu/g as in Table 1. The haemagglutinin content was found to be higher to other legumenous plants such as *Mucuna cochinchinensis* (42.67 Hu/g) and raw *Mucuna utilis* (15.27 HU/g) (Udensi et al., 2003). Generally, fermentation has a significant effect on the haemagglutinin content.

The phytate content of raw breadfruit was found to be 2.16 mg/g as presented on Table 1. The value is lower than 888 mg/g for moth bean and 51.3 mg/g for *Prospis chilensis* reported by Khokhars and Chuuham (1986) and Vijayakumari et al. (1996), respectively. The low level of phytic acid in breadfruit suggests that the nutritive value of the raw seed will be comparatively less impaired. Generally a progressive increase in fermentation time significantly reduce phytate thereby improving the availa-

Table 2. The effect of boiling on the levels of some antinutritional factors in breadfruit.

Treatment	Period (Min)	weight loss (%)	HCN (mg/kg)	Tan (mg/100g)	Haem (mg/100g)	Phyt (mg/100g)	Sta (%)	Raff (%)
Raw seeds	0	-	26.45	26.45	126.48	2.16	2.16	1.01
Boiling	30	28.22	21.5	21.5	84.0	1.08	1.08	0.10
	60	20.86	10.10	10.10	46.40	0.90	0.90	0.08
	90	31.29	6.80	6.80	10.18	0.54	0.54	0.04
	120	28.83	4.40	4.40	3.60	0.44	0.44	0.02

Tan = Tannin, Haem = haemgglutinnin, Phyt = phytate, Sta = starchyose, and Raff = raffinose.

bility of mineral such as calcium and phosphorous. This is in line with what happened in the production of fermented pro-ducts such as tempeh in which phytate is being hydro-lysed by the action of phytase produced by microor-ganism during fermentation.

The oligosaccharides content in raw breadfruit flour are also presented on the table. This was found to be lower compared to the oil seeds such as soyabean and pum-pkin seeds. According to Enwere (1998) oligosac-cha-rides are known to be more concentrated in the hulls of legume seeds and at lower concentration in cotyle-dons. As fermentation proceeds the activity of starchyose and raffinose are reduce remarkably.

The data in Table 2 shows the effect of boiling on the levels of some anti-nutritional factor in breadfruit. These factors remarkably reduced as the boiling/cooking time increases. From the Table, the initial value of HCN (26.45 mg/g) was reduced to 21.5 mg/g after 30 min of boiling which indicates reduction of the HCN content. As boiling time proceeds from 30–120 min, it was reduced to 4.4 mg/kg. Boiling could therefore be employed for total des-truction of the toxins without destroying the nutrient value of the food.

The value of raw tannin, which was originally 184.10 mg/g was found to be drastically reduced to 89.0 mg/g after boiling for 30 min. Generally, progressive increase in boiling time significantly reduced tannin content to a non significant level. This was reduced from 26.45 mg/g to 4.40 mg/g respectively. Tannins, which are polyphe-nols, and polyphenolic compound are water soluble in nature (Kumar et al., 1979). They are mostly located in the seed coat (Singh, 1988) and therefore the reduction of tannins during boiling may be attributed to leaching out of the phenol into the cooking medium under the influ-ence of the concentration gradient (Uzugara et al., 1990). Boiling for 120 min significantly reduced haemagglutinin concentration of raw breadfruit to 3.6 Hu/g as shown in Table 2 above. However, Enwere (1998) noted that tradi-tional method of household cook-ing and industrial auto-claving or retorting are capable of detoxifying haemagglu-tinin using wet heat, although they are somewhat resis-tant to dry heat.

According to Boulter (1982) phytate lead to hard to cook phenomen in pulses, which increased the cooking time of legume grains. However, the apparent decrease in phytic acid during cooking can be attributed to the formation of inso-luble complexes between phyates and other compo-nents, such as phytate protein and phytate-mineral comp-lexes (Vijayakumari et al., 1996).

The increase in the durations of boiling caused a significant reduction in the content of starchyose and raffinose and presented in Table 2. However, the decre-se in levels of oligosaccharides due to cooking might be attributed to heat hydrolysis of the oligosaccharides with the formation of simple disaccharides and monosaccha-rides or other compounds (Onigbinde and Akijele, 1983).

Autoclaving which is known as pressure cooking has a significant effect on the reduction/elimination of the anti-nutritional factors observed in breadfruit, as shown in Table 3. Generally, there is an increase in % weight loss as the autoclaving time increases form 15 – 60 min showing that some of heat liable molecules, have been destroyed thereby reducing the weight. Autoclaving for 15 min does not show any significant effect but as it proceeds to 60 min of autoclaving, most toxins reduced to undetectable level. Autoclaving could be regarded as the most effective method in the elimination of haema-gglutinin and the oligosaccharide, though some heat liable substance are destroyed which could result to decrease in palatability and nutritive value of the processed breadfruit.

Germination is known as one of the methods used in the elimination of various anti-nutritional factors present in food is a natural process in which dormant but viable seeds are induced to start growing into seedlings. Weight loss was noticed as the hours of germination increased (Table 4). This may be because of the action of enzymes present in the seeds. The enzymes convert the stored foods such as insoluble carbohydrates and proteins to soluble components (Enwere, 1998). The increased rate of reduction of the anti-nutritional factors depends on the period of germination. For example, germination of brea-dfruit seed, for 5 days, reduced the haemagglutinin

In Table 2, the level of phytate during boiling was found to reduce from 2.16 mg/g to 0.44 mg/g. haemagglutinin content reduced from 126.48 mg/100g to 3.60 mg/100g. This agrees with a fact that there could be up to 100% reduction in haemagglutinin content of bean seeds during a four day germination period (Chen et al., 1977). However, this elimination of hemagglutinating activity is

Table 3. The effect of autoclaving of the levels of antinutritional factors in breadfruit.

Treatment	Period (Min)	weight loss (%)	HCN (Mg/kg)	Tan (Mg/kg)	Haem Hu/kg	Phyt. Mg/g	Sta (%)	Raff (%)
Raw seeds	0	-	26.45	184.10	126.48	2.16	1.8	1.8
Autoclaving	15	26.13	20.64	68.24	68.62	1.02	0.10	0.10
	30	28.58	8.40	30.01	36.14	0.84	0.06	0.06
	45	31.04	5.60	12.18	12.61	0.84	0.02	0.02
	60	38.40	3.40	4.42	0.00	0.42	0.00	0.00

Tan = Tannin, Haem = haemgglutinnin, Phyt = phytate, Sta = starchyose, and Raff = raffinose.

Table 4. The effect of germination/sprouting on the levels of anti-nutritional factors in breadfruit.

Treatment	Period (h)	weight loss (%)	HCN (Mg/kg)	Tan (Mg/kg)	Haem (Hu/kg)	Phyt (Mg/kg)	Starchyose (%)	Raffinose (%)
Raw seeds	0	-	26.45	184.10	126.48	2.16	1.8	1.01
Germination	96	10.00	16.18	64.45	62.45	0.98	0.98	0.08
Sprouting	108	10.00	8.90	36.02	30.80	0.82	0.48	0.04
	120	10.00	4.68	18.16	10.04	0.78	0.24	0.01

Tan = Tannin, Haem = haemgglutinnin, Phyt = phytate.

Table 5. Reduction (%) of some anti-nutritional factors in breadfruit after processing.

Anti-nutritional factors	Fermentation (48 h)	Boiling (120 min)	Autoclaving (60 min)	Germination (120 h)
HCN (mg/kg)	99.96	83.36	87.15	82.31
Tannin (mg/g)	96.51	99.63	97.60	90.14
Haemgglutinnin (Hu/g)	94.62	97.15	100.00	92.06
Phytate (mg/g)	62.96	74.07	80.56	63.89
Starchyose (%)	82.22	75.56	100.00	86.67
Raffinose (%)	99.01	98.02	100.00	99.00

probably due to proteolysis of lectins during germination. Phytate is also reduced to a significant value of 0.78 mg/g when compared to the raw breadfruit seed 3.16 mg/g. This is observed during the germination of soy-beans, where there is an increase in phytase activity, which is accompanied by a corresponding decrease in phytate content (Sattar et al., 1990).

Table 5 presents the reduction of some anti-nutritional factors in breadfruit after processing. Generally, there is a decrease in the levels of all the investigated anti-nutritional factors as different processing techniques are applied. Hydrogen cyanide, which is easily soluble in water, was reduced by 99.96% during fermentation. Autoclaving reduced haemagglutinin, starchyose and raffinose to undetectable level.

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