Effects of Fermentation on the Nutritional Quality of African Locust Bean and Soybean

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Abstract: ***The effects of fermentation on the nutritional quality of African locust bean and Soybean were investigated. The oil-seeds were fermented to produce condiments. The substrates were subjected to natural (spontaneous) fermentation. The physiochemical properties, proximate and mineral composition of both unfermented and fermented samples were determined. Fermentation led to increase in the pH, moisture content, protein and fat content of the two oil-seeds but led to a decrease in their Titratable acidity; however, the carbohydrate and crude fibre contents were lower in the fermented products. There was no particular trend for the value of ash of the fermented products. The effect of fermentation on the mineral content (sodium, calcium, zinc, potassium, magnesium, manganese, copper and iron) varied significantly among the fermented products.***

Keywords: African locust bean, Soybean, fermentation, micronutrients, macronutrients.

1. Introduction

Fermentation is the chemical transformation of organic substrate into simpler compounds by the action of enzymes which are produced by microorganisms such as moulds, yeasts and bacteria (Shurtleff and Akiko, 2007). Some physical characteristics of legumes are modified by fermentation to increase the level of some nutrients and bioavailability (WHO, 1998) and impact some microbial properties (Mensah *et al.*, 1990). Fermentation of oil seeds result in increased nutritional value and wholesomeness over the starting material and this may lead to changes in vitamins and micro- nutrients levels. Fermentation reduces toxicity, improve palatability and impact desirable flavor in foods. Fermentation has also led to the development of some essential micronutrients which are needed during the periods of rapid growth such as infancy, adolescence and late pregnancy (Odumodu, 2007).

To improve the nutritional quality and organoleptic acceptability of these foods processing has to be employed. Fermentation of protein oil seeds help to argument the protein and micronutrients of staple foods. This research aims at studying the effects of fermentation on nutritional quality of African locust bean and Soybean.

2. Materials and Methods

Sources of Materials

African locust beans and soy beans were purchased from Kings Market, Ado-Ekiti.

Processing of African locust beans to produce 'iru'

The method described by Ikenebomeh and Kok (1984), on the production of 'iru' from *Parkia biglobosa* seeds was adopted. Two hundred grams (200g) of the dried African locust bean seeds were soaked in water for 15 minutes and boiled under pressure for two hours (2h). The cooked seeds were dehulled and washed thoroughly to remove the testa. The cotyledons were boiled for the second time under pressure for 45mins and was drained, then fermented in an incubator at 35^{o}C for 36h. The fermented products and control were analyzed for physico-chemical properties, proximate and mineral compositions.

Processing of soy beans to produce 'soy – iru'

The method of Fabiyi (2006) was adopted in producing 'soy – iru'. Two hundred grams (200g) of soy bean seeds were sorted, washed and boiled for 2h. The boiled seeds were dehulled to remove the seed coat, washed and boiled again for 1h. The water was drained and the beans were inoculated with *Bacillus subtilis* (strain 8A) and fermented at 30^{o}C for 72h to produce soy-iru.

- **PH determination:** The pH of each homogenate was determined with a Pye Unicam pH meter (Model PW9409). Five grams (5g) of each sample was homogenized and mixed with 100ml of distilled water. Determination was done in triplicates.
- **Total titratable acidity determination:** The suspension from the pH determination was filtered and 20ml of the filtrate was titrated against 0.1M NaOH using 1 drop of phenolphthalein as indicator (Joslyn, 1970).
- **Moisture content determination:** The method of AOAC 2000 was adopted in the determination of moisture content.
- **Microbiological analysis:** The microbial analysis carried out include isolation of microorganisms from the samples, determination of total viable counts (microbial load) using direct microscopic observation of the isolates (Olutiola *et al.*, 1991).

Proximate Analysis

The protein, ash, crude fibre, and fat contents of the samples were determined by Assosiation of Officials Analytical Chemists (AOAC, 2000). The carbohydrate content of each sample was determined by difference i.e. 100 – (% moisture content + % protein + % lipid + crude fibre + Ash content). (Joslyn, 1970; AOAC, 2000).

Mineral Analysis

The mineral components of the seeds were analysed by dry-ashing method. One gram (1.0g) of the samples was ashed at 550^{o}C in a furnace. The ash obtained was dissolved in 10ml of 10% hydrochloric acid, filtered and made up to standard volume with deionized water. The elements (Ca, Zn, Fe,Mg, Mn, K, Cu and Na) were determined using the atomic absorbtion spectrophometer (Buck model 200-A).

3. Results

Table 1 shows the microbial load of the fermented and unfermented samples. Fermentation led to increase in the microbial load of the fermented products. The microbial load of the fermented product increased from 7.40-7.81 and 7.45-7.75 for African locust bean and soy bean respectively. The pH of the unfermented African locust beans and soy bean were lower than the pH of their fermented samples as shown in table 1. However, there were inverse correlations between the pH and TTA values of the fermented and unfermented samples. Thus, it was observed that the unfermented African locust beans and soy bean were more acidic than their fermented products. The percentage moisture of the unfermented and fermented products are also presented in 1. The moisture contents of the fermented products significantly from 32.3% - 58% and 46.7% to 59.3% for African locust beans and soy bean respectively.

Table 1: Microbial Load of Fermented and Unfermented Seeds

Samples	Microbial load (log_{10}CFU/ml)	pH	TTA	Moisture contents (%)
UAL	7.40	6.73	11.33	32.3
FAL	7.81	7.73	6.00	58.0
USB	7.45	6.19	12.30	46.7
FSB	7.75	6.63	8.167	59.3

Key: UAL = Unfermented African locust bean, FAL = Fermented African locust bean, USB = Unfermented soybean, FSB=fermented soybean.

Table 4 shows the proximate composition of the fermented and unfermented samples. It was observe that fermentation had significant effect on the proximate composition of the fermented products. The percentage protein of African locust beans (AL) and Soy beans (SB) increased during fermentation from 29.47% - 37.41% and 43.34% - 45.53% respectively. The percentage fat of African locust beans (AL) and Soy beans (SB) as well increased during fermentation from 20.31% - 29.08% and 19.86% - 24.55% respectively. However, there were significant decreases in percentage content of ash, carbohydrate and crude fibre of the fermented samples.

The mineral contents of the fermented and unfermented samples are presented in Table 3. There was a significant reduction in the mean value of calcium, iron and magnesium of fermented samples while the concentration of zinc, manganese and sodium varied considerably.

Table 2: Proximate composition of the fermented and their unfermented products

Samples	*Protein*	*Ash*	*Fat*	*Carbohydrate*	*Crude Fibre*
UAL	29.47 ± 1.00^{h}	2.85 ± 0.02^{e}	20.31 ± 0.05^{g}	$30.87\pm.75^{h}$	9.42 ± 0.36^{a}
FAL	37.41 ± 0.34^{e}	2.56 ± 0.32^{e}	$29.08\pm.25^{e}$	$21.53\pm.52^{i}$	6.49 ± 0.25^{d}
USB	43.34 ± 0.85^{b}	4.37 ± 0.13^{b}	$19.86\pm.18^{g}$	$20.58\pm.95^{i}$	5.63 ± 0.40^{e}
FSB	45.53 ± 2.06^{a}	4.21 ± 0.19^{bc}	$24.55\pm.39^{f}$	9.86 ± 0.68^{k}	4.54 ± 0.21^{g}

Values are the mean and stanadard deviation of three replicates expressed on dry weight basis.
Key: UAL = unfermented African locust bean, FAL= fermented African locust bean, USB = unfermented soybean, FSB= fermented soybean,

Table 3: Mineral composition of the fermented and unfermented samples

Samples	Calcium	Zinc	Iron	Magnesium	Manganese	Potassium	Copper	Sodium
UAL	$6.83^{d}\pm0.06$	$1.03^{b}\pm0.06$	$3.90^{d}\pm0.10$	$1.13^{i}\pm0.06$	$2.23^{b}\pm0.06$	2.00^{b}	$4.23^{d}\pm0.06$	4.32^{c}
FAL	$5.95^{f}\pm0.06$	$1.10^{b}\pm0.10$	$3.47^{f}\pm0.06$	$1.09^{j}\pm0.01$	$2.47^{a}\pm0.06$	2.00^{b}	$4.47^{c}\pm0.06$	$4.16^{c}\pm0.09$
USB	$8.60^{b}\pm0.17$	$0.83^{c}\pm0.06$	$4.63^{c}\pm0.06$	$5.19^{a}\pm0.01$	$1.63^{c}\pm0.06$	1.00^{d}	$4.02^{e}\pm0.03$	$1.23^{h}\pm0.01$
FSB	$6.40^{ef}\pm0.36$	$0.67^{d}\pm0.06$	$2.63^{i}\pm0.06$	$4.69^{c}\pm0.01$	$0.27^{g}\pm0.06$	$1.87^{b}\pm0.12$	$0.04^{g}\pm0.01$	$0.51^{i}\pm0.00$

Values are in mg/100g and each value is average of three replicates expressed on dry weight basis.
Key: UAL = unfermented African locust bean, FAL= fermented African locust bean, USB = unfermented soybean, FSB= fermented soybean

4. Discussion

The increase in pH that led to decrease in acidity of the fermented products can be attributed to the proteolysis and the release of ammonia through deaminase activity (Odunfa and Oyeyiola, 1995). This result is similar to the report of Omafuvbe *et al.*, 2000 on the fermentation of legumes for the production of 'iru'. There was an inverse correlation between the pH and titratable acidity of the samples, that is, an increase in pH led to a decrease in the TTA of the samples.

The increase in the moisture content of the fermented products may be due to the addition of water during cooking and washing of the cotyledon. It may also be due to the activity of the fermenting organisms on the substrate. This result is in agreement with the result of Omafuvbe *et al.*, 2004 while caring out similar research on African locust bean and melon.

The higher percentage of protein in the fermented product may be due to reduction of carbohydrate content of the unfermented samples. This is in agreement with the result of Ene- Obong and Obizoba, 1996. The decrease in ash content of the seeds with fermentation may be due to lost in ash because of leaching of the solute inorganic salt into the processing water during the boiling of the samples. Osman, 2007, reported similar result in Dolichus laboratory on bean seed.

The increase in fat content of the fermented products with may be attributed to the increase activities of lipolytic enzymes, which hydrolyze fat to glycerol and fatty acid. Similar observation were reported by Obizoba and Atii, 1991. The reduction the total carbohydrate content of fermented product could be as a result of the utilization of some of the sugars by fermenting organisms for growth and metabolic activities. This result conforms to the report of Achinewhu and Isichei, 1990 during the fermentation of oil seeds.

The reduction in the values of potassium (K) in some of the fermented product may be because of its leaching into the water during boiling or it may be due to its utilization by fermenting organisms. However, the increase in K may be attributed to the release of free K from the organic compound that binds the element thereby making it unavailable. Increase in sodium content of some fermented products may be due to the release of this compound from its complex state which made it unavailable in fermented seeds. The magnesium Mg and the calcium Ca also decreased because of leaching during processing or because of the utilization of the compound by the fermenting organisms. Similar results were also observed for the Zn and Fe.

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