NUTRIENT CONTENT, SENSORY CHARACTERISTICS AND ORGANOLEPTIC ACCEPTABILITY OF SOYMILK AS FUNCTIONS OF PROCESSING TECHNIQUES

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Abstract
Soymilk is a water extract of whole soybeans. It is highly nutritious, and a cheap source of protein which has a unique role to play in addressing malnutrition in developing nations if adequately harnessed. However, like every other plant protein it has poor consumer acceptability due mainly to objectionable beany off-flavours. The effect of three processing techniques (hot extraction, cold extraction and steeping before hot extraction) on nutrient content, sensory characteristics and organoleptic acceptability of soymilk samples were evaluated using standard procedures. Results indicated that the nutrient content of the three soymilk samples (SMA, SMB and SMC) were significantly ($p \leq 0.05$) different. Sample SMC contained 13.82% and 17.07% more moisture; 3.36% and 8.87% more crude protein; 2.46% and 8.37% more crude fat; 2.30% and 8.76% more carbohydrates; 21.15% and 5.77% more total ash; 20.69% and 25.86% more crude fibre than samples SMA and SMB respectively. The mean values of the sensory characteristics were equally significantly ($p \leq 0.05$) different with the exception of appearance which showed no significant difference. Sample SMC was adjudged most preferable organoleptically, in terms of appearance, taste, aroma and acceptability followed by sample SMA while sample SMB received the least nod of organoleptic acceptability. The observed results suggested that steeping before hot extraction might be a better technique for processing soymilk in order to improve its wider acceptability.

Keywords: nutrient, sample, sensory characteristics, soymilk, technique.

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1. INTRODUCTION

Soybean (*Glycine max*) belongs to the family of Leguminoseae. It is about the most utilized legume as well as the most well researched and health-promoting food material in the world today (William and Akiko, 2000, Akubor et al. 2002). This can be attributed to its high nutrient content and low cost. Soybean is processed into a variety of food items, feed and industrial products which include soymilk, soy flour, soy meal, soy oil, soy infant formula, soy cultured products (soy ice-cream, soy yoghurt, tempeh, soy cheese), soy-based meat substitute, textured protein, soy dog foods, soap, cosmetics, biodiesel (Liu, 1997; Endres, 2001; Giampiatro et al. 2004; Merritt and Jenks, 2004; Hoogenkamp, 2005; Riaz, 2006; Anonymous, 2008).
Soymilk is a water extract of whole soybeans at a bean/water ratio of between 1:5 and 1:10. It is an off-white emulsion or suspension containing the water soluble proteins and most of the oils of the soybean. It doesn't contain lactose and therefore suitable for lactose-intolerant individuals (Nelson et al, 1971; Osundahunsi et al. 2007; Sanful, 2009; Anonymous, 2012).Unlike some other beans, soybean offers a *complete* protein profile and polyunsaturated fatty acids (Henkel, 2000; Lindsey, 2012). The Protein Digestibility Corrected Amino Acid Score (PDCAAS) which is the standard for measuring protein quality rated soy protein to be nutritionally equivalent to meat, eggs and casein with soy protein isolate having a biological value of 74, whole soybeans 96, soymilk 91 and eggs 97 (FAO/WHO, 1989). For this reason, soy products are good alternatives for vegetarians and vegans (Osundahunsi et al, 2007; Sanful, 2009; Anonymous, 2012).
Various processing techniques (Hauman, 1984; IITA, 1987; INTSOY, 1987) as well as associated numerous health benefits of soy products derived from its content of bioactive, functional and phytochemical ingredients such as natural phenols, phytic acid, polyunsaturated fatty acids (predominantly omega-6),

glyceollins, and others have been reported (Nelson et al. 1971; Yoon et al. 1983; Anderson et al. 1995; Kriz-Silverstein et al. 2003; Vucenik and Shamsuddin, 2003; Sudheer et al. 2004; Symolon et al. 2004; Sacks et al. 2006; Hogervost et al. 2008; Jenkins et al. 2010; Santo et al. 2010; Anonymous, 2011).

Soymilk, like other plant protein has poor consumer acceptability. However, the principal reasons for the poor acceptability of soy products are *beany* off-flavours and flatulence-inducing oligosaccharides namely starchyose and raffinose (Buono et al, 1990; Osundahunsi et al, 2007). This objectionable flavour is as a result of some ketones and aldehydes, particularly hexanals and heptanals, produced through endogenous lipoxydase-catalysed oxidation of soybean oil. These compounds are not contained in the whole soybean but are produced as soon the bean is wetted and ground. Research efforts have been deployed towards combating this off-flavour through both genetic and processing.

Legumes generally, including soybean contain potentially toxic and anti-nutritional factors such as saponins, phytohaemaglutinins, protease and amylase inhibitors, etc., which must be inactivated or destroyed by heat before usage (Giami and Bakebain, 1992; Soetan and Oyewole, 2009; Akande et al., 2010).

Considering its unique nutritional and health benefits, soy products, e.g. soymilk, have a utility role to play in addressing malnutrition in poor sub-regions of the world as an inexpensive substitute for animal products (INTSOY, 1987; Nsofor and Maduako, 1992; Nsofor and Osuji, 1997; Baghei et al, 2008; Akubor, 2003; Hoogenkamp, 2005).

The objective of this research, therefore, was to evaluate the extent to which various processing techniques would affect the nutrient content, sensory qualities and andorganoleptic acceptability of soymilk.

2. MATERIALS AND METHODS

A. Source of materials

One kilogramme of soybean seeds used in this study was purchased from a local market in Uyo. The seeds were identified and confirmed by the Department of Botany and Ecological Studies of the University of Uyo, Nigeria and were sorted by hand.

B. Reagents

All chemicals and reagents used in this study were of analytical grade. Standard processed water for beverage production was obtained from the Champion Breweries Ltd., Uyo.

C. Sample preparation

The whole soybean seeds were processed using modified methods of William and Akiko (2000) as shown in Figure 1: A, B and C. Three soymilk samples were produced:

a. Sample SMA – through hot extraction.
b. Sample SMB – through cold extraction.
c. Sample SMC – through steeping before hot extraction.

The pasteurized soymilk samples in tightly screwed plastic containers, without further treatments, were refrigerated at about 5^oC and used for subsequent analysis.

D. Proximate composition

The moisture content, crude protein, crude fat, carbohydrates, total ash and crude fibre were determined according to AOAC (2000) and AOAC (2005). The experiments were replicated three times and the mean values recorded.

E. Sensory evaluation

A sensory evaluation of the organoleptic attributes of the soymilk samples was carried out by the methods of Ihekoronye and Ngoddy (1985). A randomly numbered panel of eight untrained judges (all of whom were familiar with milk and used it regularly) rated and ranked the sensory characteristics of the samples on a nine-point hedonic scale for appearance, taste, aroma and acceptability.

F. Experimental design

The three samples were randomly analysed for six parameters each (treatments) and each treatment was replicated three times in a completely randomized design (CRD).

G. Statistical analysis

Mean values and standard deviation of results obtained were calculated. Significant differences among mean values of data were established through a one-way Analysis of variance (ANOVA) while the Student T-test was applied to compare their sensory properties. Significant differences were accepted at p≤0.05 (Iwe, 2002; Ubom, 2004).

Whole soybean
↓
Cleaning/Sorting
↓
Blanching
(Boiling in 0.5% $NaHCO_3$ solution for 10 minutes)
↓
Hand-dehulling
↓
Wet-milling
(Using an Electric Blender, Bean/water ratio, 1:5)
↓
Hot – filtration
(Through muslin cloth)
↓
Pasteurization
(70°C for 30 minutes)
↓
Cooling and Storage
(Refrigeration at 5°C)

A: Hot extraction processing technique.

Whole soybean
↓
Cleaning/Sorting
↓
Steeping
(12 hours)
↓
Hand-dehulling
↓
Wet-milling
(Using an Electric Blender, Bean/water ratio, 1:5)
↓
Cold – filtration
(Through muslin cloth)
↓
Pasteurization
(70°C for 20 minutes)
↓
Cooling and Storage
(Refrigeration at 5°C)

B: Cold extraction processing technique.

Whole soybean
↓
Cleaning/Sorting
↓
Steeping
(12 hours)
↓
Blanching
(Boiling in 0.5% $NaHCO_3$ solution for 10 minutes)
↓
Hand-dehulling
↓
Wet-milling
(Using an Electric Blender, Bean/water ratio, 1:5)
↓
Hot – filtration
(Through muslin cloth)
↓
Pasteurization
(70°C for 20 minutes)
↓
Cooling and Storage
(Refrigerated at 5°C)

C: Steeping before hot extraction processing technique

Fig. 1: Processing techniques for soymilk production (A, B and C)
Modified from William and Akiko, 2000.

3. RESULTS AND DISCUSSION

A. Proximate composition

The proximate composition of the soymilk samples is shown in Table 1. The nutrient composition of the three soymilk samples were significantly (p≤0.05) different. Sample SMC contained 13.82% and 17.07% more moisture; 3.36% and 8.87% more crude protein; 2.46% and 8.37% more crude fat; 2.30% and 8.76% more carbohydrates; 21.15% and 5.77% more total ash; 20.69% and 25.86% more crude fibre than samples SMA and SMB respectively.
The observed marginal increase in nutrient content of sample SMC over the others may have been a result of its processing conditions which incorporated steeping before blanching and hot filtration. These have increased the

water activity of the seeds and possibly improved the release of food reserves and their subsequent solubilisation for extract formation.

From previous reports, soymilk is a good source of proteins which are credited with significant lowering of body cholesterol levels (Nelson et al, 1971; Henkel, 2000; Farinde, 2008; Hogervorst et al, 2008; Anonymous, 2012).

The crude fat levels of the soymilk samples were considerably good. Soymilk lipids have been identified to be the healthy polyunsaturated types which reduce the risk of heart diseases and stroke with other associated health benefits. Soymilk contains no cholesterol (Henkel, 2000; Anonymous, 2012).

The carbohydrate content of the soymilk samples showed that soymilk could serve as a source of energy for the body. Its sugar profile does not include lactose which makes it suitable and ideal for lactose intolerant individuals (Anonymous, 2012; Nelson et al, 1971).

The total ash content of the samples was low with sample SMC having the highest value (Table 1). This may have resulted from the chelating effect of the anti-nutritive factors in the raw food materials. The heat inactivation of these anti-nutrients may not reasonably assure the release and availability of the mineral ions. The implication is that soymilk would need to be fortified with some minerals, especially calcium, considering their critical in intermediate metabolism.

The fibre content of the soymilk samples was consistent with reported results (Williams and Akiko, 2000). Dietary fibre is essential for effective gastro-intestinal functions during digestion. It could be effective in the treatment and prevention of many diseases including colon cancer, coronary heart diseases, obesity, diabetes, and gastrointestinal disorders (Anderson et al. 1994). High fibre content is one of the comparative advantages of soymilk, a product of plant origin, over animal milk.

Table 1: Proximate composition of soymilk samples*

Sample	Moisture (%)	Crude protein (%)	Crude fat (%)	Carbohydrates (%)	Total ash (%)	Crude fibre (%)
SMA	10.6 ± 0.58^c	40.3 ± 0.62^c	19.8 ± 0.42^c	21.2 ± 0.39^c	4.1 ± 0.94^c	4.6 ± 0.12^c
SMB	10.2 ± 0.38^b	38.0 ± 0.27^b	18.6 ± 0.29^b	19.8 ± 0.22^b	4.9 ± 0.80^b	4.3 ± 0.85^b
SMC	12.3 ± 0.25^a	41.7 ± 0.38^a	20.3 ± 0.77^a	21.7 ± 0.86^a	5.2 ± 0.76^a	5.8 ± 0.36^a

* Values are means of triplicate determinations ± S.D.

[abc] Means with different superscripts on the same column are significantly different at $P\leq0.05$.

B. Sensory evaluation

The mean values of the sensory characteristics were significantly ($p\leq0.05$) different except for appearance which showed no significant difference. Sample SMC was organoleptically rated above the other samples in terms of appearance, taste, aroma and acceptability followed by sample SMA while sample SMB attracted the least nod of acceptability (Figure 2). This may have resulted from a significant reduction in the *beany* off-flavour in samples SMA and SMC, possibly, due to the hot extraction techniques employed which may have complemented and improved the effect of blanching. The appearance of the three samples was similar and very difficult to distinguish inferring that the different processing techniques did not in any way induce a change in the appearance or colour of the soymilk samples. Since the samples were used in their original/natural state, i.e. without any flavour additive, it is believed that the panellists returned their real impressions about the samples.

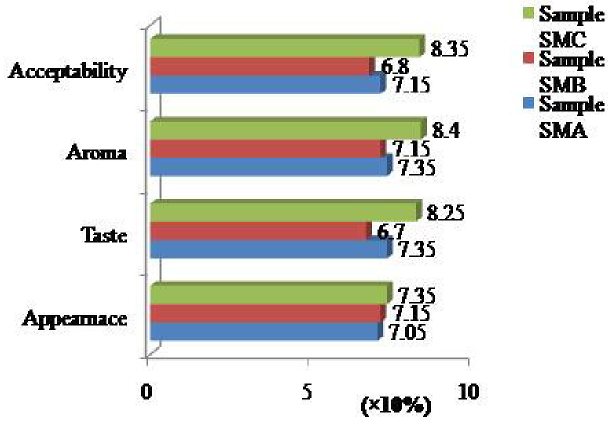

Fig. 2: Sensory evaluation of soymilk samples
Legend Description:
MA: Soymilk sample produced through hot extraction technique. SMB: Soymilk sample produced through cold extraction technique.
SMC: Soymilk sample produced through steeping before hot extraction technique

4. CONCLUSIONS

In this study, three processing techniques and their effect on nutrient content, sensory characteristics and organoleptic acceptability of soymilk samples produced were evaluated. Results showed that sample SMC from the technique of soaking before hot extraction had a significantly ($p \leq 0.05$) higher nutrient content than samples SMA and SMB produced from the cold and hot extraction techniques respectively. Also sample SMC was adjudged most preferable organoleptically by the panellists in the sensory evaluation assessment of the three soymilk samples in terms of appearance, taste, flavour and acceptability. The results suggested that steeping before hot extraction technique might be a better method of processing soymilk

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