Production of African breadfruit (*Treculia africana*) and soybean (*Glycine max*) seed based food formulations, 2: Effects of germination and fermentation on microbiological and physical properties

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Abstract. The effects of germination (G) and naturally fermented (F) on the bacterial flora, viscosities and moisture sorption isotherms of soybean (S) and African breadfruit (B) seed based food products were investigated. *Bacillus, Enterobacter, Enterobacteriaceae, Proteus, Serratia* and *Staphylococcus* species dominated in the nonfermented products. *Lactobacillus, Leuconostoc, Pediococcus* and yeast species dominated in the fermented products whose gruels also inhibited growth of coagulase positive *Staphylococcus aureus* in challenge tests. Germination and fermentation resulted in significant (*p* < 0.05) decreases in cooked paste viscosities which is advantageous in increasing nutrient density. The monolayer moisture contents (g H₂O/g solid) and surface areas for monolayer adsorption (m²/g solid) derived from BET model were 0.0422 and 148.1 (GFSB); 0.0428 and 150.4 (NGFSB); 0.0436 and 153.3 (NGNFSB); 0.0531 and 186.6 (GNFSB), respectively.

Key words: Fermentation, Germination, Microbial safety, Sorption isotherm, Soy-breadfruit, Viscosity

Introduction

African breadfruit based porridges popularly called ‘aho-ukwa’ in the Igbo language are commonly used as weaning foods and snacks, especially by children in the eastern region of Nigeria. An earlier study [1] showed that when breadfruit is combined with soybeans, food formulations of improved nutritive value, which could be used as weaning foods, can be produced. When ground cereals and legumes are cooked with water into a porridge or gruel, two problems arise. Such products have a high viscosity caused by
gelatinization of starch. Therefore, a porridge of acceptable viscosity would have a low density of nutrients and energy. The neutral pH (6.0–6.5) of such porridges make them a good substrate for growth of spoilage and pathogenic microorganisms.

Germination and fermentation are among the simple, easily adaptable technologies for reduction of bulkiness (high viscosity) and increasing shelf-life of cereal and legume based food formulations [2, 3]. High counts of indicator (e.g. *Escherichia coli*) and spoilage (e.g. *Bacillus cereus*) microorganisms were found in stored, nonfermented traditional Gambian weaning foods [4] while severe contamination of Kenyan children’s food with *Enterobacteriaceae* and *Staphylococcus aureus* was reported by van Steenbergen et al. [5]. Challenge tests using *Salmonella typhimurium* and *Staphylococcus aureus* revealed growth in porridges from nonfermented concentrates while the inoculated bacteria died in the fermented porridges [3]. There is no information on the microbiology and physical properties of African breadfruit and soybean based formulated food products, especially as affected by germination and fermentation. Knowledge of moisture sorption isotherms is needed for shelf-life predictions and determination of critical moisture contents and water activity (aw) for acceptability of products that deteriorate mainly by moisture gain, such as flours. Moisture sorption isotherms are also important in drying, packaging and storage of food products and in problems that involve moisture transfer like ingredient mixing [6]. The objectives of this study were to investigate (a) the effects of germination and fermentation on the microflora, (b) microbial safety, (c) viscosity and moisture sorption isotherms of African breadfruit and soybean based food products.

**Materials and methods**

*Product formulation.* About 3 kg each of soybean (*Glycine max*) and African breadfruit (*Treculia africana*) seeds were purchased from local markets in Okigwe, Nigeria. Four products consisting of germinated-fermented soy-breadfruit (GFSB), germinated-nonfermented soy-breadfruit (GNFSB), non-germinated-fermented soy-breadfruit (NGFSB) and nongerminated-nonfermented soy-breadfruit (NGNFSB) were produced from the soybean and breadfruit seeds as described earlier [1]. Essentially, the soybean and breadfruit seeds were steeped for 12 hours in water which was changed every 4 hours. Sprouting was achieved by layering the seeds on moistened jute bags placed in a wooden malting box for 54 and 96 hours for soybeans and breadfruits, respectively. The sprouted seeds and the nongerminated controls were dried to 10% moisture in an electric oven at 100 °C and milled.