

**Malted and fermented sorghum as ingredients in composite bread**

by

Leda Florinda Hugo

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I declare that the thesis herewith submitted for the degree of PhD Food Science at the University of Pretoria, has not previously been submitted by me for a degree at any other university or institution of higher education.



## Dedication

This dissertation is dedicated to my parents **Herminio Hugo** and **Arrucina Faquirá** for their unconditional love and encouragement.

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## Malted and Fermented Sorghum as Ingredient in Composite Breads

by

Leda Florinda Hugo

Promoter: Professor J.R.N. Taylor

Co-promoter: Professor L.W. Rooney

Department: Food Science, University of Pretoria, Pretoria 0002

Degree: PhD Food Science

### ABSTRACT

The possibility of using the simple technologies of malting and fermentation to modify endogenously the sorghum grain components, to alleviate the grittiness, dryness and high crumb firmness caused by the inclusion of sorghum flour in composite bread, was investigated. The most suitable grain and the optimal malting time for sorghum for bread-making, were selected by malting five sorghum cultivars, up to 8 days, and evaluating them for the highest protein modification and lowest dry matter losses. On that basis, a 6-days malt of Local White, a relatively high protein sorghum (10.7%), was selected.

Sorghum malt flour potentially suitable for bread-making was produced by boiling the selected malt, rather than drying it at high temperatures, stewing or steaming. Boiling was most effective in inactivating the amylases and in increasing the pasting viscosity of sorghum malt. The bread made with boiled malt flour (30%) had an improved crumb

structure and water-holding capacity, a softer crumb and increased resistance to staling, compared to bread made with sorghum grain flour (30%).

Bread-making with reconstituted flours from flour and bran fractions of whole sorghum grain and whole boiled sorghum malt indicated that the bread improving effect of malting and boiling was due to dextrinization and gelatinization of starch, and to the increase of total and water-soluble pentosans, and crude fiber. Dextrinization and gelatinization of starch decreased the gelatinization temperature and the rate of starch retrogradation, thus decreasing the crumb firmness and firming rate of sorghum and wheat composite bread. However, high levels of gelatinized starch decreased dough strength and bread volume. The increase of total pentosans and crude fiber of sorghum malts, caused by germinating grains roots and shoots growth, and the increase of water-soluble pentosans, due to hydrolysis of the non-starch polysaccharides during malting, significantly increased flour and dough water-holding capacity. Thus, crumb structure was improved and crumb firmness and crumb-firming rate decreased.

Treatment of sorghum flour with endo-(1-4)- $\beta$ -xylanase to determine whether endoxylanases could solubilize sorghum pentosans, increased the water-soluble pentosans slightly, indicating the potential of endoxylanases to improve the bread-making quality of sorghum flour. However, heating the endoxylanase treated flour to inactivate the enzyme, so as to determine its specific effect, gelatinized the starch and decreased the bread volume.

A natural lactic acid fermentation of sorghum flour, followed by drying at 60°C, decreased the pH of sorghum flour from 6.2 to 3.4 and slightly increased the gelatinized starch and the pasting viscosity of sorghum flour. Apparently, the low pH caused higher loaf volume and improved crumb structure and softness by suppressing the amylases and by increasing the viscosity of dough, and hence increasing its gas-holding capacity. Adding wet fermented sorghum flour directly to wheat flour (sourdough process), as an alternative to drying, further increased the volume and decreased the crumb firmness. Fermentation and drying also improved the protein digestibility of sorghum composite bread.

Consumer panel members liked the bread made with boiled sorghum malt flour most, apparently because it was softer, more moist and had a fine malt flavor. They liked the bread made with fermented and dried sorghum flour less, apparently because it had a pronounced sour taste.

Malting and fermentation can be successfully used to produce acceptable sorghum and wheat composite bread. Fermentation is probably the most suitable technology for poor developing countries because it is simple and effective. Steaming the malt and adding the endoxylanases directly when mixing the dough, to eliminate the flour drying step and to reduce starch gelatinization, should be looked at further.

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