Sorghum *injera* quality improvement through processing and development of cultivar selection criteria

by

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Declaration

I hereby declare that the thesis herewith submitted for the degree of PhD (Food Science) at University of Pretoria is my work and has not previously been submitted by me for a degree at any other university or institution of higher education.

Dedication

This thesis is dedicated to the memory of my senior sister w/o Asegedetch Belehu, who passed away while I was studying for my doctorial degree in South Africa, with love.

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ABSTRACT

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Injera is a fermented, leavened, flat and round pancake-like Ethiopian traditional bread made from cereals such as tef and sorghum, with tef preferred for the best quality *injera*. Because sorghum is less expensive in Ethiopia, there is great interest in improving the quality of sorghum *injera* through processing and cultivar selection.

The effects of the processing methods of decortication and compositing whole sorghum flour with tef on the *injera* making quality of high-tannin and non-tannin red sorghums were studied. Abrasive decortication was found to be more effective than hand pounding because acceptable *injera* was obtained with lower milling loss and higher tannin removal. Composting of whole sorghum flour with tef flour improved *injera* quality as the proportion of tef increased. Tef probably acted mainly as tannin diluent, overcoming the inhibitory effects of tannins on fermenting microorganisms. Compositing with tef is a more useful method than decortication since grain losses are avoided.

Twelve Ethiopian sorghum cultivars grown for two seasons at Melkassa Agricultural Research Center were characterized in terms of their physico-chemical properties and used to make *injera* under standard conditions, and compared with white tef of good *injera* making quality. *Injera* quality was evaluated by descriptive sensory analysis of fresh *injera* and instrumental texture analysis of fresh and stored *injera* over a storage period of 48 hr.

Principal component analysis of sensory data associated fresh *injera* from sorghum cultivars AW (red, floury endosperm), 3443-2-op (white, intermediate endosperm), 76TI #23 (white, intermediate endosperm), and PGRC/E #69349 (white, relatively vitreous endosperm) with the positive *injera* texture attributes of softness, rollability and fluffiness. Across the two seasons, texture analysis showed *injera* prepared from AW and CR:35:5 (both with floury endosperm), required the least force to bend after 48 hr of storage. Thus, from the standpoint of *injera* making quality it appears that floury to intermediate endosperm sorghums are most suitable.

Sorghum flours were found to be distinctively different from tef flour. Lower water solubility index, higher water absorption index, higher hot paste, setback and cold paste viscosities with a soft gel texture are features of sorghum flours.

On the basis of linear regression correlations between physico-chemical properties and sensory data, it appears that the sorghum grain physical properties of endosperm texture, test weight, hardness, water solubility and water absorption indices affect the sensory textural attributes of *injera*. These relationships enabled the development of indirect and direct selection criteria for use in the Ethiopian Sorghum Improvement Program (ESIP) for selection of sorghum cultivars of good *injera* making quality. Grain endosperm texture (visual rating) of 3-5 (intermediate to floury), flour water solubility index of ≥2.5 g/100 g and water absorption index of ≤1.5 g/g are proposed as selection criteria at the early generation (nursery) breeding stage. Milling extraction rate (TADD) of 56.0-79.0%, test weight of 71.0-75.0 kg/hl, *injera* softness score of ≥6.7, stickiness score of ≤2.0, fluffiness score of ≥6.8, rollability score of ≥7.2 grittiness score of ≤2.7, for maximum force required to bend *injera* after 24 hr of storage ≤0.27 N and after 48 hr of storage ≤0.33 N are proposed as selection criteria for the advanced breeding stage. However, testing a larger number of sorghum lines, about 15-20 cultivars across 2-3 locations, from multilocation trials such as the Pre-National Variety Trial of the ESIP will be required to fine-tune these proposed selection criteria.

TABLE OF CONTENTS

List of tables

List of figures