Sorghum dry-milling processes and their influence on meal and porridge quality

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DECLARATION

I declare that the dissertation 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.

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ABSTRACT

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Sorghum bicolor (L.) Moench is an important staple cereal in Africa, where it ranks second after maize. Despite its importance, the sorghum food industry remains non vibrant, constrained in part by inadequate milling technology. Presently, Prairie Research Laboratory (PRL) type abrasive dehullers and hammer mills, which apparently produce meals of inconsistent quality and low output, are generally used for industrial milling of sorghum. Efforts to improve sorghum milling require an in-depth understanding of how milling process and grain type affect the sensory characteristics of the final food products. Such knowledge is currently lacking. Therefore, this study investigated the effects of milling process and sorghum type on the quality of sorghum meal and porridge.

Twelve sorghum types with diverse physico-chemical properties were milled by roller milling (RM), abrasive decortication-hammer milling (ADHM) and hand pounding (HP), and the effects on meal extraction and meal quality were evaluated. Porridges were prepared using standardised Botswana recipe, and their sensory profiles were characterised using Descriptive Sensory Analysis. Additionally, factors that affect the texture of sorghum porridge were investigated, and suggestions for improving the sorghum milling process are given.

Both the sorghum type and the milling process affected the quality of the meal and the sensory characteristics of the porridge, but the milling process was found to have more effects on these characteristics than the sorghum type, because of the diverse milling principles of the milling processes. RM gave far better extraction rate and had

substantially higher throughput than HP and ADHM. However, meals obtained with RM had slightly more ash and were a little darker, and gave porridges which were correspondingly darker in colour, had slightly more branny aroma, more astringency and bitter taste, than meals obtained with the other two milling processes, indicating higher bran contamination of the meals, presumably caused by fragmentation of the pericarp. Clearly, even with tempering the pericarp was still friable, and hence, requires indepth sorghum tempering studies. Grain hardness proved to be important for milling, as it correlated positively with extraction rate with ADHM and HP, but not with RM. Hard grains generally gave coarser and better refined meals, and produced porridges that were firmer, compared to soft grains. Weathered and pigmented pericarp sorghums produced dark and specky meals, and gave porridges with apparently undesirable sensory qualities, because of staining caused by the pericarp pigments, showing that these characteristics affect the quality of sorghum foods negatively. When used with hard and light coloured sorghums, ADHM gave more appealing meal and porridge qualities (light coloured, firm texture and enhanced cereal aroma), indicating that dry abrasive decortication is advantageous for production of sorghum products with superior sensory qualities.

Firmness varied considerably among the porridges, caused by differences in the meal particle sizes, which was predominantly a consequence of the milling process. An increased proportion of coarse endosperm particles, as was the case with HP meals, caused increased porridge firmness. The coarse particles absorbed water slowly, thus restricting swelling of the starch granules, such that a high proportion of non-ruptured gelatinised starch granules that reinforce the porridge matrix resulted. The sorghum type also influenced porridge firmness, whereby the corneous sorghum types with high protein content produced firmer porridges, owing to presence of the hard and less water-permeable protein-starch matrix in the endosperm meal particles.

Because abrasive decortication gave meals and porridges with superior sensory qualities, while roller milling prduced high throughputs, a roller milling system that is preceded by a dry abrasive decortication process is recommended as a versatile milling process for industrial processing of diverse sorghum products that have superior sensory qualities.

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