

**Development of soy fortified sorghum and bread wheat
biscuits as a supplementary food to combat Protein Energy
Malnutrition in young children**

By

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DECLARATION

I hereby declare that the thesis submitted at the University of Pretoria for the award of PhD degree is my work and has not been submitted by me for a degree at any other university or institution of higher learning.

Charlotte Atsango Serrem



DEDICATION

This thesis is dedicated to my loving husband Dr. Cornelius Kibet Serrem for understanding and sharing my dreams, believing in my ability to achieve them and for the support and sacrifice to enable me achieve them.

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ABSTRACT

Development of soy fortified sorghum and bread wheat biscuits as a supplementary food to combat Protein Energy Malnutrition in young children

By

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Protein Energy Malnutrition (PEM) due to under nutrition is a major public health problem among children in Africa and other developing countries. Sorghum and bread wheat, which are important dietary staples in the semi-arid tropics of Africa, are suitable vehicles for delivering proteins to alleviate PEM. Formulation of foods from these low-lysine staples fortified with legumes is a sustainable approach to improve the protein nutritional quality of foods for young children. Biscuits offer a valuable vehicle for fortification as they are nutrient dense, ready-to-eat, have a long shelf-life and are popular. Therefore, this study investigated the effect of complementing sorghum and bread wheat with defatted soy flour on the nutritional and sensory quality and consumer acceptability of biscuits.

Biscuits were formulated and developed by compositing sorghum and bread wheat flours with defatted soy flour at different ratios. To establish the nutritional characteristics of biscuits, proximate composition, lysine and reactive lysine contents and in vitro protein digestibility were determined. Protein Efficiency Ratio (PER), Food Efficiency Ratio (FER) True Digestibility and Biological Value (BV) of sorghum biscuits were determined using Sprague Dowley weanling male rats. The sensory characteristics of biscuits were evaluated using a descriptive panel and instrumental texture analysis. Acceptability was evaluated using eight to nine year old school children.

Compared to the 100% cereal biscuits, sorghum-soy and bread wheat-soy composite biscuits in a 1:1 ratio had at least double the protein, mineral and crude fibre contents. The lysine contents of biscuits increased by 500-700%. For the sorghum-soy biscuits, in vitro protein digestibility increased by 170% and Protein Digestibility Corrected Amino Acid Score (PDCAAS) was 8 times higher. Two such biscuits of 28 g each could provide 50% of the recommended daily protein intake for 3 to 10 year olds. In the animal study, PER and FER for sorghum-soy biscuits were equivalent to the reference casein. True Digestibility was high for all diets, 85 to 95% and BV of sorghum biscuits was higher than sorghum-soy diet by 20%.

Principal Component Analysis (PCA) revealed that 61% and a further 33% of the variation in sensory properties was due to the type of cereal and concentration of soy in biscuits, respectively. Maximum stress increased by 39% and 34% in sorghum-soy and bread wheat-soy biscuits, respectively at 1:1 ratio. Spread factor of biscuits increased by 7 to 32%. Biscuits were darker in colour (reduced L* value) by 14 to 56% and hardness increased by 84% in sorghum biscuits. Positive hedonic scores by 8 to 9 year old school children for fortified biscuits were sustained above 80% through 8 consumption occasions. This data shows that fortifying with defatted soy flour imparts positive sensory characteristics associated with biscuits to sorghum and bread wheat biscuits and the acceptance of such biscuits may be sustained over an extended period of time.

This study indicates that soy fortified sorghum and bread wheat biscuits have high nutrient density, protein quality, positive sensory properties and high acceptability if consumed over an extended period. Hence, the biscuits have great potential as protein-rich supplementary foods to alleviate PEM among children and to provide an income to small holder farmers in rural African communities through purchase of grain for the Home Grown School Feeding Programme.

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