ABSTRACT

Cassava (*Manihot esculenta* Crantz) is an important source of carbohydrate for humans and animals, producing high energy of 610 kJ/100 g fresh root weight. However, it is very poor in protein (1 % fresh root weight) and contains cyanogenic glucosides which are related to various health disorders that occur in populations where cassava is the staple food. Cassava products that are not adequately processed have been linked to diseases like *konzo*, caused by cyanide poisoning, as was the case in Nampula Province, Mozambique.

Samples of cassava flour were collected in 4 different districts in Nampula Province, Mozambique and the cassava processing methods were recorded. Cassava processing techniques used in Nampula Province consist of peeling, chipping or grating, sun-drying or fermenting followed by sun-drying, and finally pounding into flour. There was a large variation in the average cyanogenic potentials of flours from the different districts, ranging from 26 $\pm$ 20 to 90 $\pm$ 60 mg HCN/kg. The average total cyanogenic content for the unfermented samples (64 ± 60 mg HCN/kg) was significantly greater than that of the fermented samples (34 ± 30 mg HCN/kg).

Biochemical and microbial changes occurring during the heap fermentation of cassava roots were determined and predominant micro-organisms were isolated and identified. The total crude protein and cyanogenic potential were determined in dried fermented and unfermented cassava flour. The moulds, *Rhizopus stolonifer* and *Neurospora sitophila* were the dominant microbes involved in the heap fermentation of cassava followed by lactic acid bacteria, *Leuconostoc pseudomesenteroides*, *Leuconostoc mesenteroides*, *Enterococcus faecium* and *Weissella cibaria*. The pH values of the cassava roots decreased from 6.1 $\pm$ 0.01 to 5.6 $\pm$ 0.6 during heap fermentation.

Heap fermentation of cassava resulted in a decrease in the total cyanogenic potential levels. The average total cyanogenic level in unfermented cassava flour was 158 mg HCN/kg, while in fermented cassava flour, a value of 17 mg HCN/kg was recorded. The average cyanogenic potential of fresh cassava roots was 259 $\pm$ 9 mg HCN/kg. Protein concentration in the cassava flour slightly increased from 1.3% to 1.8% w/w dry matter during fermentation.

Laboratory simulation of the heap fermentation of cassava roots using isolated moulds was carried out to determine the growth and change in texture of the cassava roots. *Neurospora sitophila* grew faster than *Rhizopus stolonifer* on cassava roots under controlled conditions. *Rhizopus stolonifer* softened the cassava roots more than the *Neurospora sitophila*. Slicing the cassava roots increased the rate of mould growth and the softness of the roots during the fermentation.

Studies were carried out to increase the protein content of cassava flour by the co-fermentation of cassava roots with cowpea (*Vigna unguiculata*) using selected moulds. Co-fermentation of cassava roots with cowpea flour, at a proportion of 92:8 (cassava:cowpea), resulted in faster growth of moulds, rapid softening of cassava roots and an increase in the protein content of the flour. The final protein content in cowpea supplemented cassava flour was 7.93 $\pm$ 0.98 % dry weight basis, similar to the maize grain. The flour produced from cassava roots co-fermented with cowpea produced a paste (*karakata*) of lower viscosity and higher sensory acceptability compared to that prepared using flour from cassava roots fermented without cowpea.

Heap fermentation of cassava roots reduced the cyanogenic potential of the roots but did not achieve the FAO/WHO recommended safe limit of 10 mg HCN/kg when bitter varieties were used. Supplementation of cassava roots with cowpea produced a flour with lower cyanogen content, higher protein content and lower viscosity compared to flour produced from unsupplemented cassava roots.

ACKNOWLEDGEMENTS

I would like to express my personal thanks to:

My supervisor, Dr. Jane Bvochora, for her valuable scientific discussions, encouragement and support to take the research to the end.

My previous supervisors, Professor Remigio Zvauya and Dr. Anthony Mutukumira for their constructive contribution to the research project.

Dr José da Cruz Francisco of Eduardo Mondlane University, Mozambique, for introducing me to field of cassava research.

Dr. John David Owens of the School of Food Bioscience, The University of Reading, for the numerous ideas, constructive discussions, for allowing me to work in his laboratory, assistance and support in the area of lactic acid bacteria and mould identification and laboratory simulation of cassava roots fermentation using isolated moulds.

Professor Louis Mutombene Pelembe of Eduardo Mondlane University, Mozambique for assistance in sensory evaluation of cassava flour prepared from the laboratory.

Dr Maria Isabel Andrade of South Africa Root crop network (SARNET)-Mozambique, eng Anabela Zacarias of Instituto Nacional de Investigação Agronómica, eng Paulo Mabote and Abudo Jone of World Vision-Mozambique for providing material, transport and assistance in fieldwork.

Dr J. Howard Bradbury of Australian National University for his assistance and support in the area of cyanogen determination.

Professor Daniel Tevera of University of Zimbabwe, Mrs Tevera and Mrs Margaret Chimbira for providing living facilities during my stay in the Republic of Zimbabwe.

The following people who played important roles at various stages of the project: Mario Ernesto, Paula Cardoso, Dr Tapiwa Mugochi, Talent Bvochora, Dr Carlos Lucas, Dr Luís Amós, Vitória Nhanombe, Jorge Nhantitima, Abisha Kasiyamhuru, eng Maida Khan, Alfred Bere, Kudakwashe Chitindingu and Fungayi Chatiza.

The Eduardo Mondlane University (UEM) and Swedish Agency for Research Cooperation with developing Countries (SAREC) for financial support of the research.

To my wife, eng Anabela Casimiro Chambule and my two daughters, Júlia and Sara Tivana for their patience and moral support.

This MPhil thesis is based on the following papers:

1. Zvauya R., Ernesto M., Bvochora T., Tivana L., Francisco J., (2002). A study of the effect of village processing methods on the cyanogenic potential of cassava flours collected from selected districts in Nampula Province, Mozambique. *International Journal of Food Science & Technology* , **37**, 463-469.
2. Tivana L. D., Bvochora J., Owens J. D. & Mutukumira A. N. (2003). "A study of heap fermentation of cassava (*Manihot Esculenta* Crantz) in Nampula Province, Mozambique". *Proceedings of 13th Triennial ISTRC Symposium, 9-15 November 2003*, Arusha Tanzania. In press
3. Tivana, L. D., Bvochora, J. M, Owens J. D. & Mutukumira A. N. Co-fermentation of cassava roots with cowpea using isolated moulds for protein enrichment of cassava flour. Manuscript
4. Tivana, L. D., Bvochora, J. M. & Pelembe, L. M. Sensory evaluation of cassava flour paste (*karakata*) prepared using flour from fermented cassava roots supplemented with cowpea. Manuscript

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