



NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Comparative nutritional analysis of *Tylosema esculentum* (marama bean) germplasm collection in Namibia

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Key definitions

- Accession- Distinct, sample of seeds representing a cultivar, breeding line or a population, which is maintained in storage for conservation
- Biofortification- The process of increasing the nutritional value of crops through the application of conventional plant breeding methods or modern biotechnology. The goal is to increase the levels of essential vitamins, minerals and other nutrients in staple crops, livestock or other food animals. Biofortification is one of the strategies to improve the nutritional status of the population, especially in developing countries.
- Malnutrition- A state of imbalance with respect to nutritional intake by a person

Food Security-???



Background of the Study

Malnutrition

- Medical condition caused by chronic consumption of an unbalanced diet.
- Under nutrition symptoms include:
 - Reduced appetite
 - General ill-health
 - Poor concentration

Stunting

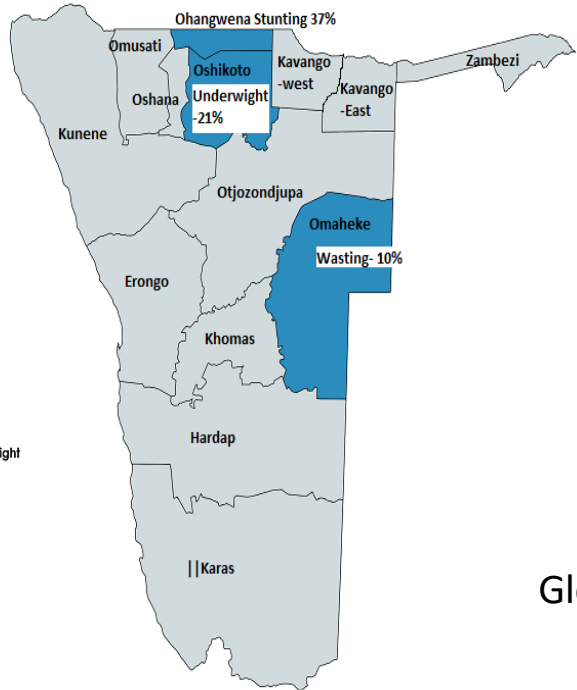
- Low weight for age

Wasting

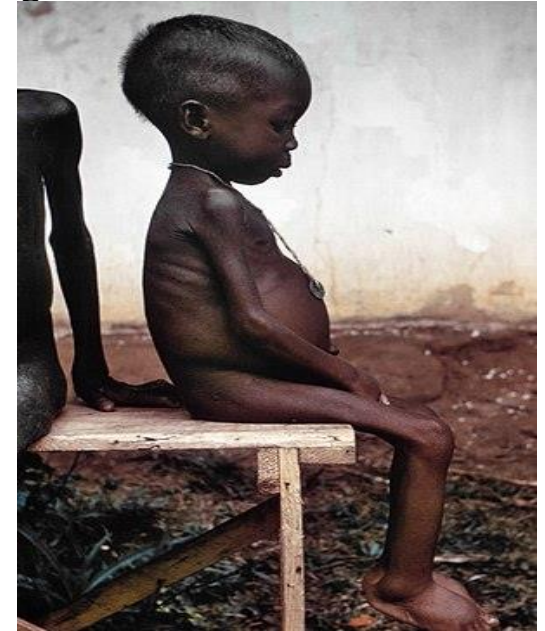
- Low weight for height

Underweight

- Low height for age



Namibia: 6.2% wasted
23.8% stunted
13.4% underweight



Globally: 7.0% wasted
21.0% stunted

Figure 1: State of malnutrition in Namibia (Ministry of Health and Social Services, 2014b)

Figure 2: A severely malnourished child (Photo credit-Lyle Conrad)



Background of the study cont'd

- Efforts to stop malnutrition involve improving food security and food access by providing nutritious alternative food sources such as *Tylosema esculentum*, marama bean.
 - Which may be incorporated into other flours as biofortification
- Marama bean is of importance as previous studies (most recently of Namibia, Botswana and South African populations) have determined that it is highly nutritious
 - However, no studies have been done on the 521 accessions in the germplasm collection of Namibia



Effects of malnutrition

- Protein-energy malnutrition (PEM),
- Micronutrient deficiencies
- Changes in natural gut microbiota
- Intellectual delays and susceptibility to infections

Solutions

- Counselling of care givers and guardians
- Solving food security issues
- Treating Symptoms
- Nutrition based interventions

Significance of the study



Figure 3: Region of *Tylosema esculentum* growth in Southern Africa



Significance of the study

Underutilized!!

al., 2010).

Figure 4:
marama bean
plant



Figure 5:
Marama
bean seeds



Research Objectives

1. To determine the micronutrient and macronutrient composition;
 - Crude Protein content
 - Crude Fat content
 - Micronutrients (calcium, iron, magnesium, phosphorus, and zinc) content
 - Carbohydrate content
2. To determine the accession with the most significant nutritional composition among the collected samples.



Research Design

Design	Description
Study area	Otjozondjupa Region, Namibia
Study type	Quantitative and Descriptive Study
Analysis:	
Sample preparation	Dried and ground to flour
Ash	Dry Ashing
Crude Protein	Dumas Combustion method
Minerals	Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) and Spectrophotometry
Crude Fat	Soxhlet Solvent Extraction
Carbohydrates	Deduction
Data analysis	One-way ANOVA



Materials and Methods

- Seeds from 10 accessions were de-hulled and ground into a flour using a laboratory mill.
- Ashing: ~3g of each sample was weighed into crucibles and incinerated at 500°C for 24hrs and again at 650°C for 4hrs.
- Crude Protein: ~140mg of each sample was weighed into tin foil cups and analysed using a **LECO TruSpec[®] Micro** N-Nitrogen/Protein Analyzer.
- Minerals: samples were prepared for analysis by microwave digestion using aqua regia of (HCl and HNO₃, 3:1). Calcium, iron, magnesium and zinc were analysed using ICP OES. Phosphorus was analysed using Spectrophotometry.



Materials and Methods cont'd

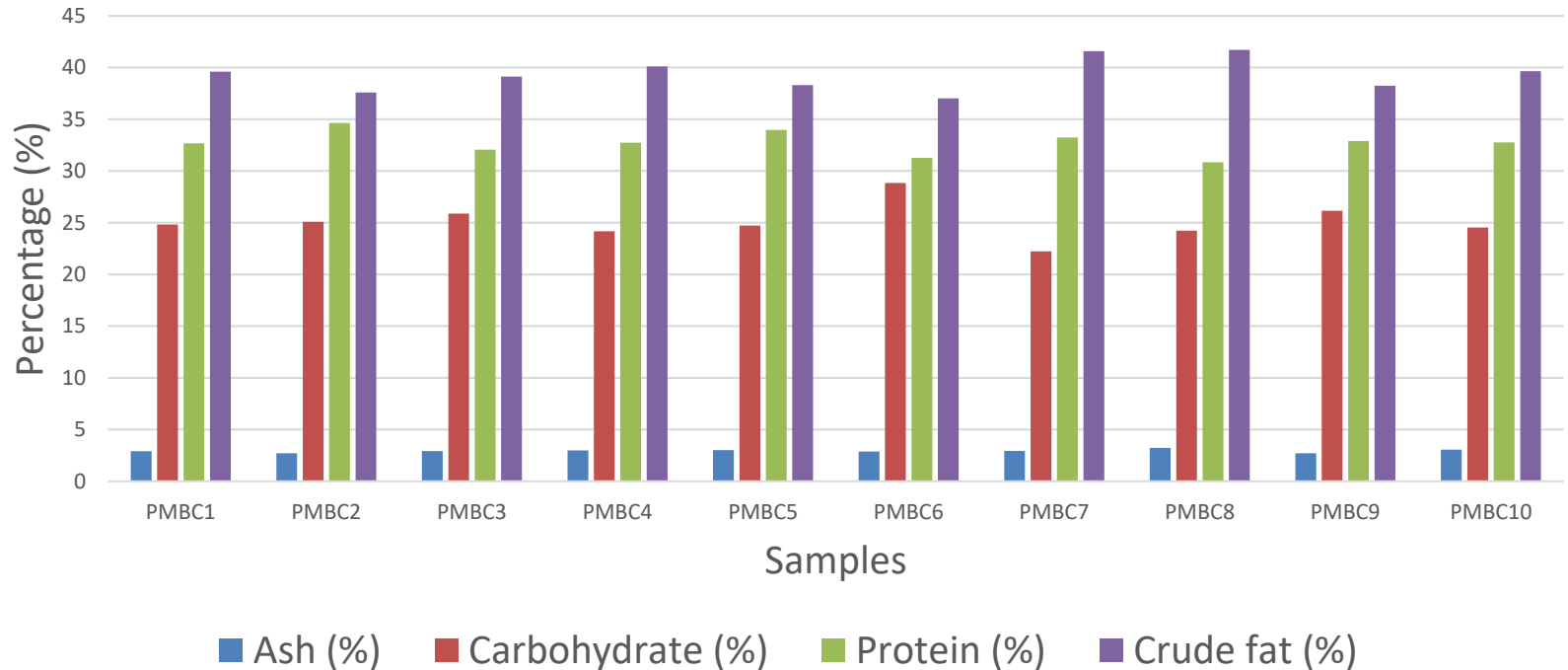
- Crude fats: the Soxhlet extraction method was used to extract crude fats from 3g of sample using petroleum ether.
- Carbohydrates: determined using deduction by calculating the percentage difference of ash, crude protein and crude fats from the sample weight using the equation below (Holse, Husted, and Hansen, 2010);

$$\text{Carbohydrate content} = 100\% - (\% \text{ Ash} + \% \text{ Crude Protein} + \% \text{ Crude Fat})$$



Results

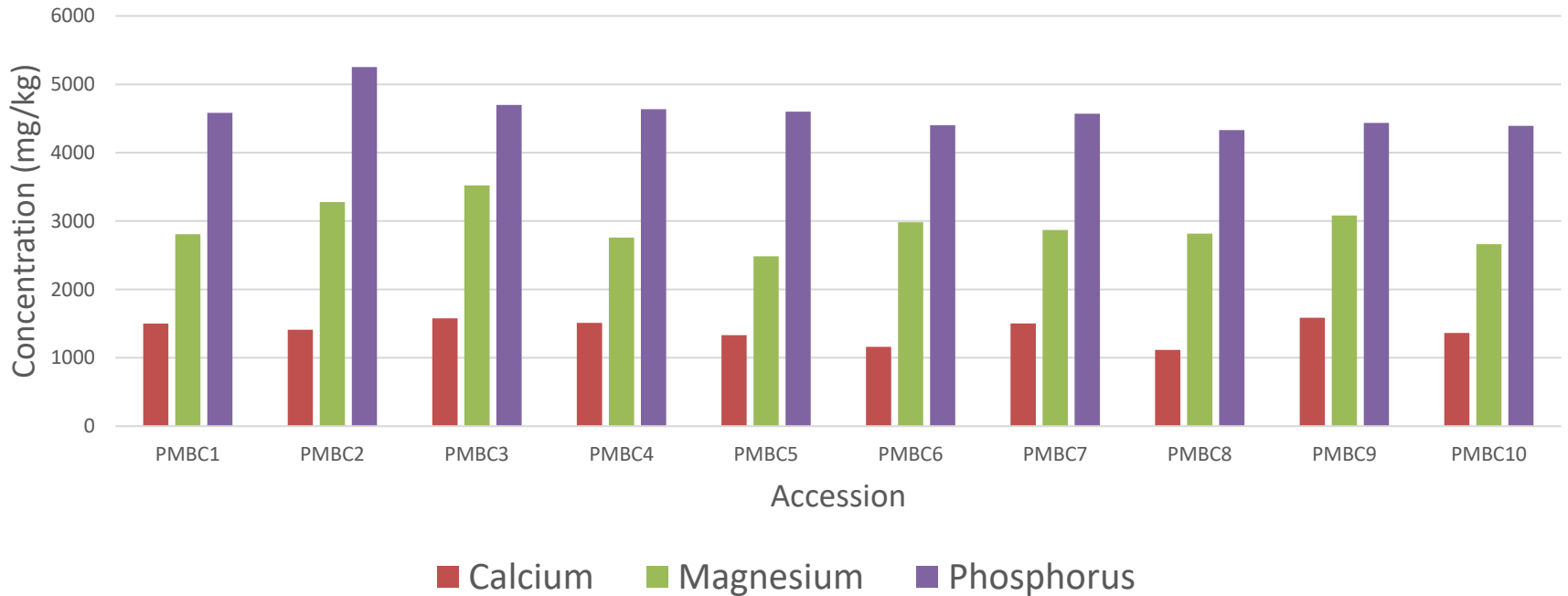
Nutrients





Results cont'd

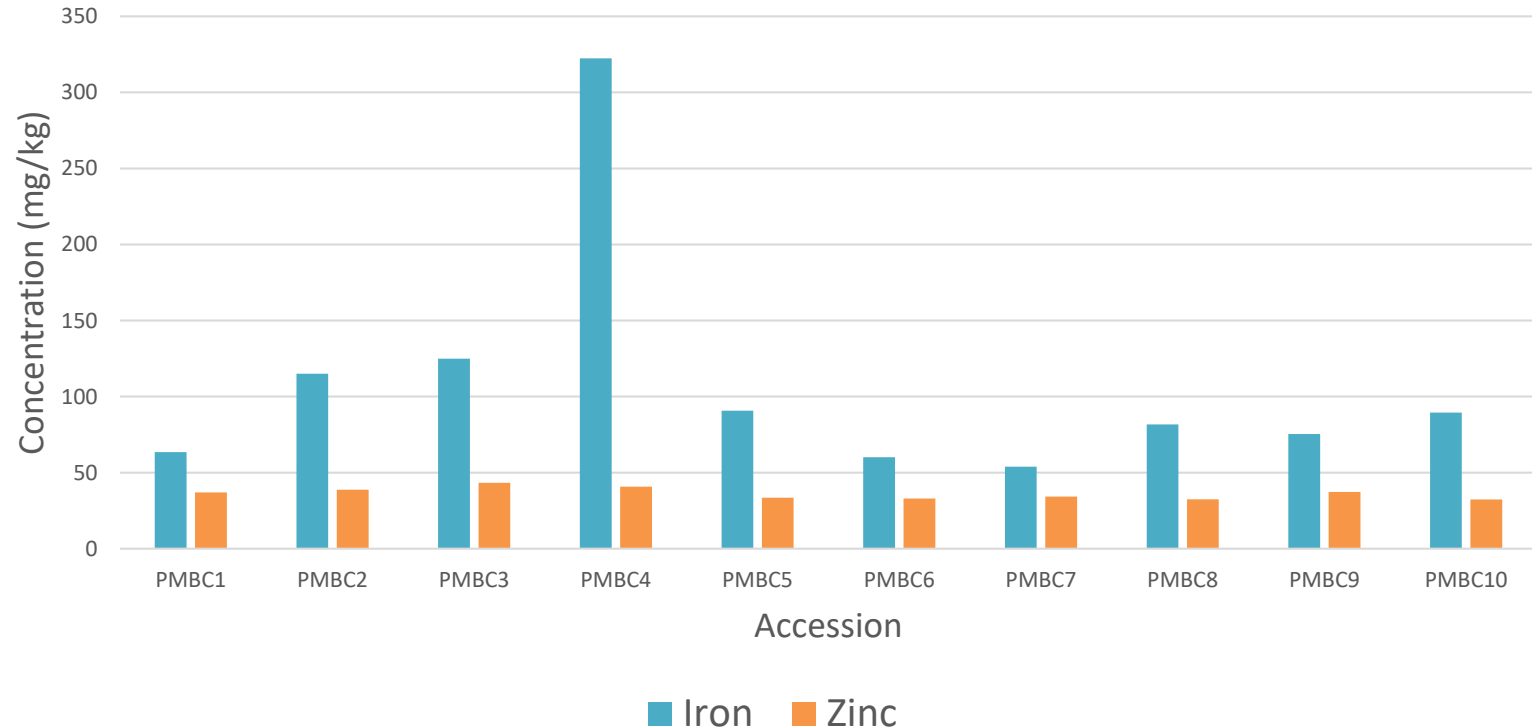
Essential minerals





Results cont'd

Trace elements





Discussion

Mineral	NA0701* (mg/kg)	BO0603* (mg/kg)	SA0703* (mg/kg)	PMBC (mg/kg)	PMBC2 (mg/kg)
P	4050–4576	3307–3383	5488–5594	3916-5268	5238-5268
Mg	3580–3593	2330–2647	3712–3783	1764-7415	2528-4860
Ca	937–1462	2038–2176	1313–1361	750-2306	814-2201
Zn	31–39	33–33	38–39	20-78	24-67
Fe	12–14	13–14	35–40	35-618	75-151

* Data obtained from Holve, Husted and Hansen (2010).



Discussion Cont'd

Nutrient	NA001 (%)	BO002 (%)	SA003 (%)	PMBC (%)	PMBC2 (%)
Protein	29.3-35.7*	28.7-32.4*	34.3-38.4*	30.1-34.8	34.5-34.8
Lipid	37.2-39.4*	31.7-42.1*	33.9-41.8*	29.9-44.1	37.4-37.8
Carbohydrate	9.4-13.6**	10.3-14.5**	-	19.4-36.0	24.1-25.8

*Data obtained from a study by Holve, Husted and Hansen (2010).

**Data obtained from a study by Mseler & Schonfeldt (2006)



Conclusions

- Data obtained from all minerals, carbohydrates and fats showed no significant difference.
- Protein content indicates PMBC2 to have the most significant amount of protein
 - PMBC2 is the most suitable accession for biofortification and domestication



Recommendations

Analyse marama bean from other regions and countries.

Test PMBC2 in composite flours of maize meal and sorghum

- Commence marama bean domestication



Publications

- Some of the work presented has been published in part under the titles:
 - Mataranyika PN, Chimwamurombe PM, Fuyane B, Chigayo K, Lusilao J. (2019). Comparative Nutritional Analysis of *Tylosema esculentum* (Marama Bean) Germplasm Collection in Namibia.** Accepted for publication to *Journal of Food and Nutrition Sciences*.
 - Chimwamurombe PM, Luchen CC, **Mataranyika PN. (2019). Redefining Global Food Security: Do we really have a Food Crisis?** Accepted for publication in the *Journal of Agricultural Sciences*.



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