

Soft Matter Approach to Effective Preservation of African Leafy Vegetables by Drying: SoLVeD

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Introduction

African Leafy Vegetables (ALVs) are indigenous plants in sub-Saharan Africa. They are rich in **nutrients** such as vitamin A, vitamin C, iron and calcium and play an important role in the dietary intake of vitamins and minerals of local populations. ALVs are highly liable to spoil once harvested, however, and an **effective and affordable preservation method** is urgently needed. One approach is the use of a desiccant such as **superabsorbent polymers (SAP)**: these polyelectrolyte networks are well-known for their capacity to absorb large amounts of water.

Results and Discussion

Paste after cooking (slimy)

Jute Mallow
Corchorus Olitorius

Slender Leaf
Crotalaria Ochroleuca



Moisture content fresh leaves in % dry basis (d.b.):

- Jute Mallow 282 ± 42%
- Slender Leaf 565 ± 130%
- Cowpea 509 ± 44%
- Nightshade 471 ± 99%
- Amaranthus 313 ± 29%

Fibrous species

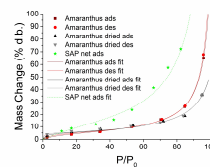
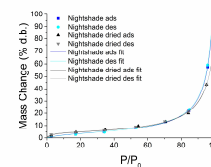
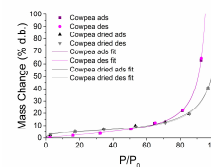
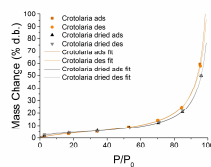
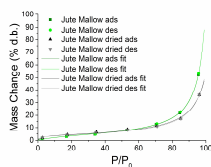
Cowpea
Vigna Unguiculata

Giant Nightshade
Solanum Villosum

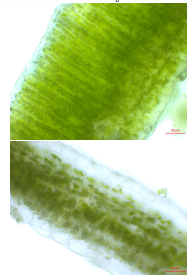
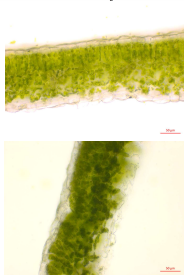
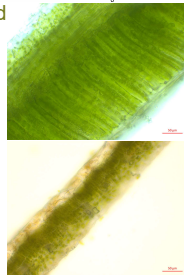
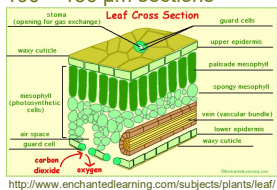
Amaranthus
Amaranthus Blitum



Adsorption of water as a function of relative humidity (P/P_0): **microbial safe P/P_0 60%¹ → Moisture Content 10 – 14% dry basis**



Structure of fresh (first row) and rehydrated (bottom row) leaves: Brightfield Microscopy with 100 – 150 μm sections



Moisture Sorption Isotherms: Fitting GAB model^{2,3}

$$MC = \frac{M_0 \cdot K_G \cdot k \cdot a_w}{(1 - k \cdot a_w) \cdot [1 + (K_G - 1) \cdot k \cdot a_w]}$$

Amaranthus	M_0	K_G	k
Fresh des.	0.05	20	0.97
Pre-dried ads.	0.05	55	0.91
SAP net ads.	0.15	3.8	0.97

MC = moisture content (% d.b.)

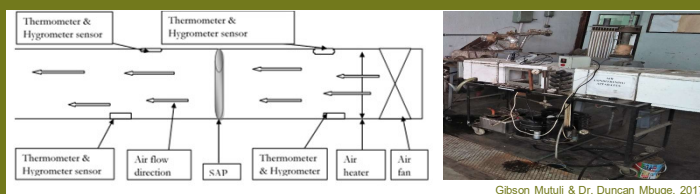
a_w = water activity (P/P_0) = RH/100

M_0 (%) = Monolayer sorbent content on the internal surface

K_G = GAB parameter heat of sorption of the monolayer region

k = GAB parameter heat of sorption of the multilayer region

Design of Drier: University of Nairobi



Gibson Mutuli & Dr. Duncan Mbugu, 2017.

Summary

- Extent of rehydration was dependent on the drying method.
- No significant differences between moisture sorption isotherms of the five ALV species.
- Superabsorbent polymer moisture sorption capacity at microbial safe water activity ($a_w = 0.6$) 3x higher than for ALV leaves.
- Microbial safe water activity with leaves at a moisture content of ~ 14% dry basis: maximum for effective preservation.
- Leaf micro-structure and cell-compartmentation significantly affected by oven drying at 40 °C: reduced thickness, shorter palisade parenchyma and chloroplasts⁴ not intact.

References

- Agryropoulos *et al*, LWT - Food Sci. Tech. 2012, 47 324-331.
- Mbugu *et al*, J. Food Sci. Tech. 2016, 53(8), 3157-3165.
- Chayjan and Esna-Ashari, Res. Agric. Eng. 2010, 56, 69-76.
- Quartacci *et al*, J. of Exp. Botany 1997, 48(311), 1269-1279.