ETH zürich

Coop Research Program

Soft matter approach to effective preservation of African Leafy Vegetables by drying by desiccant/solar hybrid system

Final project fact sheet

African leafy vegetables (ALVs) are indigenous plants in sub-Saharan Africa. They are rich in nutrients such as vitamin A, B2 and 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 and hence, an effective and affordable preservation method is urgently needed. Their nutrient content was found to depend on the drying conditions. This project made use of desiccants such as superabsorbent polymers (SAP) which are well-known for their capacity to absorb large amounts of water. The moisture sorption isotherms of fresh and rehydrated leaves of five ALV species were determined and the maximum microbial safe moisture content for storage was calculated based on modelling the results. Additionally, the effect of drying on the micro- and nano-structure of the leaves was investigated to explain differences between species. Proper storage conditions were found to reduce aflatoxin production by fungi and maintained more than half of the vitamin A, C and E content of fresh leaves.

Motivation

Malnutrition in Sub-Saharan Africa, particularly in women and children, increases under drought-induced reduction of food supply. Yet in the same region, post-harvest losses of vegetables are very high, up to half the produce, mainly due to lack of appropriate packages for preservation. With increasing urbanization, there is rising demand for packaged food. ALVs sprout in large volumes during the rainy seasons and require very little inputs. Therefore, these vegetables have potential for upscaling to address food insecurity and nutrient deficiency as packaged foods for urban consumption. Despite their potential, these ALVs are only available to consumers during the rainy season due to the lack of technologies to extend their shelf life. Existing indigenous knowledge suggests that these vegetables may be dried and stored for several months. Therefore, this project aimed at designing proper processing and packaging that extends the shelf life to help the population in getting food supplies during droughts.

Objective

This project aimed at determining optimal drying conditions for processing the ALVs Amaranth, Cowpea, Giant Nightshade, Jute Mallow and Slender Leaf, using a hybrid desiccant/solar drier. Microscopic optical methods were used to understand structural changes the vegetables undergo during processing. This helped to predict optimal processing conditions that preserve the important properties of the dried vegetables. Optimal storage conditions were determined through sorption isotherms.

Research Highlights

Moisture sorption isotherms showed that the moisture content that does not participate in any deteriorative reactions was 4.5% dry basis (d.b.) for all five species of ALVs. The microbial safe moisture content, leading to a water activity below 0.6 was de-

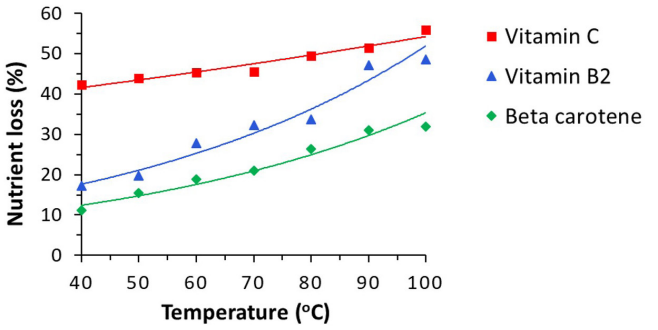

Figure 1: Vitamin A and B2 content retained upon drying at 40 °C: Cowpea

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termined to be ≤ 14% d.b. Gentle drying conditions using super-absorbent polymers and a temperature of 40 °C were shown to preserve most leaf structures and vitamins. Dried Slender Leaf and Nightshade leaves could be rehydrated to the equilibrium moisture content of the fresh leaves upon dry storage, while Jute Mallow, Cowpea and Amaranthus rehydrated to approximately half of the equilibrium moisture content compared to the fresh leaves at high relative humidity. This was explained by differences in the microstructure of the different species, particularly by the significantly longer palisade parenchyma cells for Cowpea and Jute Mallow. Whether species were fibrous or formed a paste (slimy) upon cooking did not affect their moisture sorption characteristics. Nevertheless, a significantly increased amount of starch granules in the microstructure of Cowpea and Nightshade leaves can explain their fibrous texture upon cooking. Organoleptic tests with Cowpea (fibrous) and Jute Mallow (slimy) revealed that there was no significant difference in preference between consumption of dried and rehydrated and fresh leaves. In summary, drying of African leafy vegetables was shown to be a promising method for their effective preservation and a suitable drier was designed and modelled.

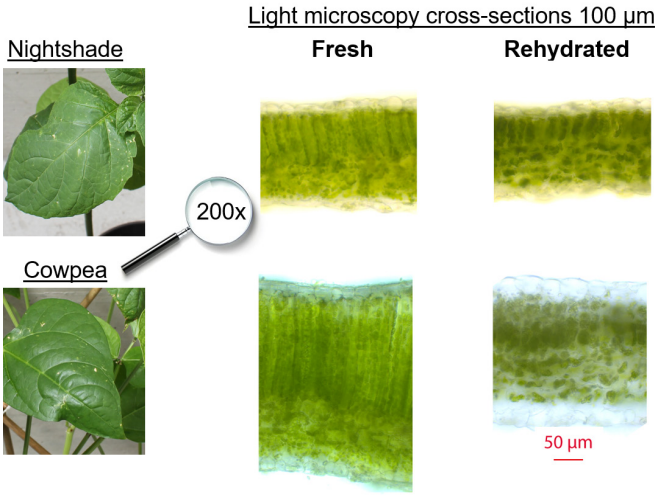

Image 1: Rehydration behavior for different species: micro-structure

Relevance to Stakeholders

The results of this project show that drying under controlled conditions is a promising way to fight hidden hunger in sub-Saharan Africa during droughts. Vitamin analysis of the vegetables showed that between 50 to 75% of their vitamin content is preserved after drying. Hence, effective preservation of African Leafy Vegetables through drying can deliver micronutrients during droughts in sub-Saharan Africa.

Image 2: Fresh African Leafy Vegetables sold at a market

Selected Publications

Mutuli, G. P.; Mbuge, D. O. Effect of Drying on the Nutritional and Organoleptic Characteristics of African Leafy Vegetables, Jute Mallow (Corchorus olitorius L.) and Cowpea (Vigna unguiculata). ***Biosyst. Eng.*** **2018.** 43: 211-218.

van 't Hag, L.; Danthe, J.; Handschin, S.; Mutuli, G. P.; Mbuge, D.; Mezzenga, R. Drying of African Leafy Vegetables for Their Effective Preservation: Difference in Sorption Isotherms and Nutrition Explained by their Microstructure. ***Food Funct.*** **2020.** 11(1): 955-964.

Media

Mutuli, G. P.; Mbuge, D. Monitoring aflatoxin contamination in dried ALVs under different storage conditions. Poster presentation, University of Nairobi Department of Environmental & Biosystems Engineering Exposition. **2018.**

van 't Hag, L.; Handschin, S.; Mezzenga, R. Soft Matter Approach to Effective Preservation of Leafy Vegetables and Reduction of Post-Harvest Losses. Virtual Conference Presentation, Institute of Food Technologists. **2020.**

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https://worldfoodsystem.ethz.ch/research/research-programs/CRP/SoLVeD.html

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