The Development & Utilization of a Breakthrough Product: Orange-fleshed Sweetpotato Purée

- Orange-fleshed sweetpotato (OFSP) purée can be used to substitute wheat flour by 25-60% depending on the product, without affecting the quality of baking procedures.
- We developed a safe, vacuum-packed shelf-stable purée that lasts 3 months without refrigeration, using locally available preservatives
- By carefully washing the roots, it is not necessary to peel them. This has enabled a high-fiber purée (Fig. 1) to be developed that significantly improves the profit margin for purée processors.

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Fig 1. Vacuum-packed, shelf-stable orange-fleshed, high fiber sweetpotato purée can store up to 3 months with no refrigeration (Credit: T. Muzhingi)

What was the problem?

Research during SASHA Phase 1 established that OFSP purée (steamed and mashed roots) as an ingredient makes better quality baked products and is more economically viable than OFSP flour. The major bottleneck to expanding use of purée is the inconvenience of having to prepare and store the purée. Currently, processors store and utilize the roots for purée as needed; or prepare the purée and freeze it for future use. This requires a reliable cold chain.

Processors with mixed operations, such as livestock, can easily deal with the waste from processing roots, but those with limited space find dealing with the bulky root and its waste highly inconvenient. In the USA, high-end continuous flow microwave systems with aseptic packaging exist that are difficult to transfer to sub-Saharan Africa (SSA). Clearly, an affordable vacuum-sealed, food safe purée that could be stored without a cooling system has the potential to be the breakthrough technology for the expanded use of OFSP purée in SSA.

What objectives did we set?

Our research focused on developing a high quality OFSP shelf-storable purée at room conditions for at least three to six months. We also sought to develop additional cost-effective OFSP purée bakery products.

Where did we work?

The laboratory work was carried out at the Food Analysis and Nutrition Evaluation Laboratory in Nairobi, Kenya. We developed products and carried out food safety research in collaboration with Organi Ltd, a purée processing factory in Homa Bay County, Kenya. We also collaborated closely with food technologist Antonio Magnaghi of Euro Ingredients Ltd (IEL) in product development.

What did we achieve during SASHA Phase 2?

Bakeries in several countries (Kenya, Mozambique, Malawi, Ghana) are successfully using OFSP purée to make OFSP bread (Fig. 2) and consumer acceptance of the color and taste of the bread is high. In these cases, most are making the purée and using it immediately, or storing it using freezers.

OFSP purée is a wet product. Hence, good hygiene practice is essential in producing the purée. We also need to ensure that beta-carotene, the precursor for vitamin A is not lost during the storage process.

Several experiments were carried out, the results of which are summarized below:

- We compared several different combinations of chemical preservatives and natural preservatives to explore their efficacy in controlling microbial growth in vacuum-packed OFSP purée and at what cost. So-called natural preservatives (natamysin and nisin) work but are very expensive ($0.40/kg purée). The combination of recommended local preservatives only costs $0.04/kg.
- A challenge test study was carried out to determine the antimicrobial effect of locally available preservatives--sodium benzoate (0.25%), potassium sorbate (0.25%) and citric acid (1%) -- on the growth of *Staphylococcus aureus and Escherichia coli* as well as on spoilage microorganisms in OFSP purée stored at ambient conditions in vacuum-packed bags over 12 weeks. The concentrations of preservatives used were effective on improving the quality of the purée as well as suppressing foodborne pathogens during storage at room temperature.
- We investigated the retention of β-carotene content in vacuum-packed OFSP purée treated with preservatives and stored at ambient temperature, which ranged from 15° to 23°C, for up to 12 weeks. At 12 weeks, the vacuum-packed purée treated with the locally affordable preservatives had retained over 80% of the initial β-carotene content.
- We assessed the level of food safety knowledge, attitude, and hygiene practices of OFSP purée handlers at a purée factory in western Kenya. Compliance to Good Manufacturing Practices (GMPs) and environmental hygiene in OFSP puree processing environment was also assessed. Data generated were used for designing

Fig 2. Bread made by substituting 35-45% of wheat flour with OFSP purée is economically viable and highly acceptable to consumers (Credit: T. Muzhingi)

and conducting a comprehensive training program of all factory staff, that enabled the factory to attain required food safety standards.

Once the shelf-stable purée was developed, the next step was to determine whether the quality of final product, in this case, OFSP bread was affected if bread was made with fresh OFSP purée compared to using the three-month-old preservative-treated purée. The experiment replaced 40% of the wheat flour with OFSP purée of both types. The shelf-storable OFSP purée bread had a similar sensory profile to fresh OFSP purée bread, and thus can be exploited as an alternative to fresh OFSP purée bread.

At the factory, it was found that peeling the roots by hand resulted in highly variable loss rates—from 20-35% of initial root weight, significantly affecting the cost of the final product. By introducing stiff brushes to carefully clean the roots during washing, the peel could be left on. However, processing roots with peel did require a heavier-duty purée machine. Consumers could not detect any quality differences when this high-fiber purée was used to make OFSP bread, compared to the peeled purée. In 2018, EIL developed a washing machine that uses high water pressure to clean 100 kgs of roots in just six minutes.

Were there any key challenges or lessons learned?

Two major drawbacks were found in using the shelf-storable OFSP purée for bread production. First, the shelf-stable OFSP purée bread had a lower volume compared to the bread with fresh OFSP purée without preservatives. We hypothesized that the preservative sorbate slowed down the yeast activity in shelf-stable purée breads. To correct this, the recipe was adjusted. Using yeast at 1.5% of the wheat flour, 1% baking powder and adding functional gluten produced the appropriate standard volume for bread.

Secondly, the shelf-stable OFSP purée bread proofed much longer than expected compared to bread using the fresh OFSP purée and the standard white bread. Thus, shelf-stable purée with chemical preservatives is best for baked products that do not need to rise (cookies, chapatis) or for bread in smaller bakeries where longer proofing time would not be a major constraint.

Baked products are an economically viable entry point for the use of OFSP purée and are well-liked by consumers. A key challenge currently for the value chain is the consistent supply of roots for the purée manufacturers.

What's next?

We are proceeding on three fronts regarding the improvement and use of purée:

1) Working with small and medium enterprises in East Africa to use the shelf-storable purée.
2) Testing the use of the hot-fill technology, which permits developing a purée that can be stored without refrigeration for 6-12 months with minimal quality loss. Recently, we have identified a source of packaging that is affordable, which to date has been the major bottleneck to exploring this approach.
3) For large-scale processors able to invest, the use of aseptic processing for purées with a shelf-life of 24-36 months and high nutrient retention is now possible, as the company Sinnovatek (Raleigh, North Carolina) has developed a unit costing US$450,000, down from US$2.5 million. In Kenya, CIP is collaborating with Burton and Bamber Ltd, Sinnovatek, North Carolina State University and EIL to commercially test the use of this preservative free, aseptically processed OFSP purée for different bakery and culinary applications.

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