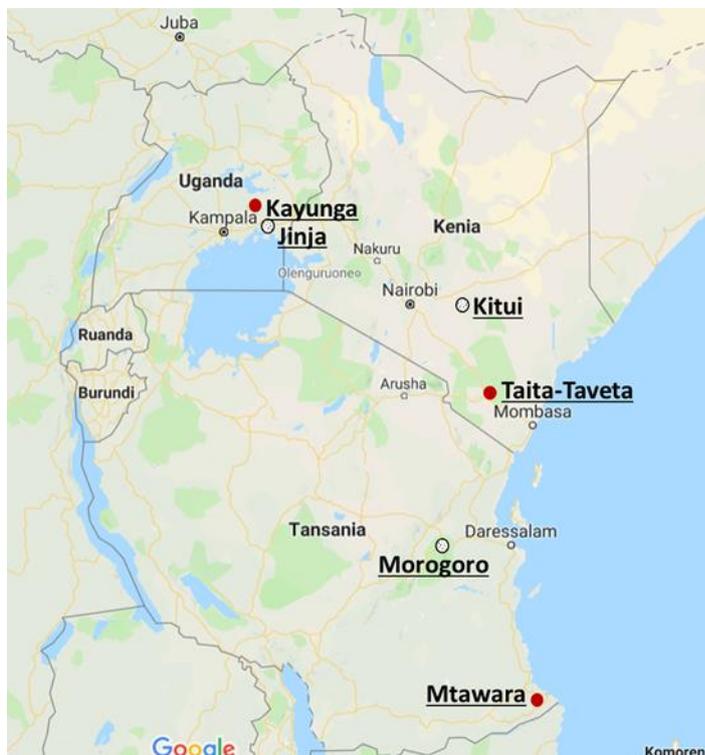


Project update

Project title (Acronym):	Fruits and Vegetables for all Seasons FruVaSe
Geographical focus:	Kenya: Kitui and Taita-Taveta Tanzania: Morogoro and Mtwara Uganda: Jinja and Kayunga
Call reference:	Innovative approaches to process local food in Sub-Saharan Africa and Southeast Asia, which contribute to improved nutrition, as well as qualitative and quantitative reduction of losses
Cooperating partners:	University of Göttingen; Erfurt University of Applied Sciences; University of Nairobi and University of Eldoret, Kenya; Nelson Mandela Institution of Science and Technology, Tanzania; Makerere University, Uganda
Duration:	1st September 2018 - 30th April 2022
Budget:	1,056,324.08 €



- Vegetable region
- Fruit region



Map of FruVaSe research region in East Africa © Google Maps





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Aim of the project:

The FruVaSe project aims to contribute to the fight against vitamin and mineral deficiencies in human nutrition in East Africa and to address the challenge of using fruit and vegetables as well as their waste, especially seasonal waste, in the value chain. Sub-goals are i) to select the most promising varieties of guava, cashew apple and jackfruit as well as the green leafy vegetables cowpea leaves, African nightshade and cassava leaves and ii) to evaluate traditional processing and shelf life extension technologies as well as to develop and evaluate new technologies, with a focus on juices, dried products such as fruit bars; sauces, relishes and pickles as well as instant soups and dried leaves; iii) the new products should be tested for consumer acceptance and possibly commercialized in pilot projects.

The FruVaSe project pursues an integrated system approach (water-energy-food-waste nexus) in order to iv) develop a model for energy-independent, resource-efficient processing methods embedded in a business model for empowering women in rural areas. In a life cycle concept, most of the plant parts of the selected fruits and vegetables are to be used: both for human consumption and as animal feed (guava in Kenya as chicken feed) or for biogas production (jackfruit in Uganda); v) in addition, a recycling concept for water and the analysis and purification of drinking water for juice production is being developed (Tanzania).

Results:

Major results of the target fruits and vegetables regarding **processing methods and food composition analysis** (WP1 and WP2), **energy use** (WP4) as well as **consumer acceptance and marketing options** (WP5) include:

Guava fruit (Kenya):

- A high variation in terms of fruit flesh colour, fruit shape, weight, length and further parameters exist among guava varieties in Kenya; also nutrient content such as vitamin C **varies greatly between different guava varieties**; edible coated fresh guava fruits can keep up to 13 days.
- Moringa blended guava nectar contains **high amounts of total phenolics, zinc, iron, potassium and calcium** as compared to commercially available guava nectars in Kenya.
- The **aroma, taste and texture** from the guava nectar was liked or liked very much by more than 80 % of consumer study participants.
- Dried guava-nut-bars (developed at UGOE) contain about 27 mg ascorbic acid in 100 g DM – the recommended dietary allowances (RDA) for teenagers of ascorbic acid is 45 mg per day.
- Guava by-products (skin and seeds) **inclusion in broiler feed** did not affect relative weight or nutrient content of broiler meat, however, it had a significant and mostly positive effect on sensory attributes such as odor, flavor, after taste and overall acceptability.

Cashew apple (Tanzania):

- During juice formulation, gelatin was found to **clarify** the cloudy juice much easier than sago; during pasteurization of cashew apple juice, time and temperature were observed to influence the color and aroma of the juice.
- Total **phenolic compounds** were observed to decrease by 62.6% after clarification and by 15.4% after pasteurization.



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- Dried cashew apples scored high (liked or liked very much) in the **sensory test** with consumers.

Jackfruit (Uganda):

- **Refractance Window Drying (RWD)** was found to be a promising drying method for jackfruit quality preservation, as it allowed for a higher retention of ascorbic acid and β -carotene compared to oven drying and solar drying.
- Dried **jackfruit powder** can be used to produce nutritious and ready-to-eat composite flours thereby eliminating prolonged cooking or further degradation of heat labile nutrients.
- Dried **jackfruit-nut-bars** (similar to guava-nut-bars, both developed at UGOE) contain considerable amounts of iron (6 mg/ 100 g DM) and zinc (5 mg/ 100g DM) – the RDA for teenagers is 8 mg per day for both minerals.
- **Jackfruit juice**, as all tested products, scored high (liked or liked very much) in the sensory test with consumers.
- Seeds and peelings from the firm variety of jackfruit are better than those from the soft variety for the production of **briquettes and biochar**.

Cowpea leaves (Kenya and Uganda):

- **Blanched oven-dried cowpea leaves** had the highest retention of beta-carotene and colour as compared to other drying methods.
- Cowpea leaf soup mix, as all tested products, scored high (liked or liked very much) in the **sensory test** with consumers.

African nightshade (Tanzania):

- In African nightshade relish, fermentation reduced anti-nutrients [tannins and oxalate] while it also had a significant effect in reduction of vitamin C; fermented African nightshade had a **storage stability of nine months**.
- African nightshade sauce including several ingredients (tested at UGOE): most formulations were found to be **shelf-stable up to 12 weeks** of storage, some even **up to 24 weeks** (at room temperature and in the dark); one formulation which showed some growth of microbes contained 12% tomato and 0% baobab fruit powder and the pH was higher; apparently the **baobab fruit powder** had a positive effect on shelf stability.
- General nutrient analysis in freshly cooked vegetable sauces showed that a **cooking time for 25 minutes** was promising for retention of ascorbic acid, and red and yellow pigments that reflects total carotenoids content.
- African nightshade relish and dried African nightshade, as all tested products, scored high (liked or liked very much) in the **sensory test** with consumers.

Cassava leaves (Uganda):

- **Dry blanching combined with pounding** resulted into retention of the highest vitamin C and β -carotene content, antioxidant activity and the least cyanide content in cassava leaves.

Further results from the sensory perception and willingness to pay study (WP5) show

- The sensory perception lead to a higher willingness to pay. **Urban consumers** were willing to pay more for the products than rural consumers. Moreover, the products were **more demanded by younger and male consumers**, particularly those who value convenience aspects of food.



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- A first analysis of demand, based on consumers' willingness to pay, and production costs of the products reveals **great profit margins for processors of cowpea leaf soup mix and guava nectar.**

Results from the nutrition survey (WP3) show

- In all three project countries, **high rates of overweight and obesity among women** in rural East Africa, especially in Tanzania and Kenya, less in Uganda.
- A diet characterized by highly processed foods is positively associated with overweight and obesity.
- Intake of vegetables is higher relative to fruits, although below recommended levels of 200grams per day (for each fruits and vegetables).
- Generally, a positive attitude towards fruits and vegetables intake (unprocessed and processed); however, inadequate processing of fruits and vegetables at household level due to lack of processing skills, technical knowhow and processing equipment.
- A high proportion (>80 %) of women in Uganda consumed foods from less than five (the minimum number of recommended) food groups.
- In Uganda, the lowest possible cost of a nutrient adequate diet was UGX 3193 or EURO 0.73 per day for women 19-49 years. The modelled diet using locally available foods met the required amounts of all the micronutrients of concern to a woman of reproductive age.

Results from the work on energy and water (WP4) is shown above for jackfruit, yet, further plant residues were analysed (Uganda) and the work on deflouridation and disinfection of drinking water is ongoing (Tanzania):

- **Biogas production** from jackfruit waste, banana peels and pineapple peels co-digested with cow dung (at MUG, Uganda): The daily biogas production was maximum from pineapple peels as 151ml at the 12th day of the experiment with 25% co-digestion with cow dung. The **quality of jackfruit derived gas** improved from 25.9 % to 69.6 % when the cow dung of 25% was added. Therefore, **co-digestion of cow dung** (animal waste) can significantly improve the biogas produced from agricultural waste.
- Suitability of **jackfruit waste for briquette and biogas production**: The starch content of jackfruit peelings and seeds from both soft and firm varieties ranged between 29.05 to 59.54% while the sugar content of jackfruit peelings and seeds from soft and firm varieties ranged from 2.04 to 68.8%. The maximum weight degradation rate for the jackfruit waste for both jackfruit varieties in briquette production occurred in the temperature range of 450-550 °C which is within the slow pyrolysis regime. Jackfruit waste from both soft and firm varieties is a potential feed stock for slow pyrolysis while **soft variety jackfruit waste is more suitable for biogas production** compared to the firm jackfruit wastes.
- Assessment of **deflouridation and disinfection of drinking water** by continuous electro-coagulation process: Operational support of the SuMeWa system by using pitting promoter and supportive electrolyte. Result 1: **Fluoride concentration was reduced** by 80%. Problem: **Clogging** of the electrode during purification of water from fluoride. Problem solving: Operate system at different operational conditions (will be tested in 2021).



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Guava fruit variety and guava by-product as broiler feed (Kenya) © Lilian Lozi and Edith Ogega



Cashew apple juice processing (Tanzania) © Angela Aluko



Jackfruit drying with Refractance Window Drying technology and final products (Uganda) © Rachel Byarugaba



African nightshade leaf based sauce: processing and sensory testing (Tanzania) © Amina Ahmed



Biogas production process: Jackfruit waste collected; Size reduction of jackfruit waste; Feeding the Bio-digester; Biogas production from the waste (Uganda) © Denis Nsubuga