Processing of African Nightshade

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Fruits and Vegetables Processing Unit,
Nelson Mandela African Institutiton of Science and Technology,
Arusha, Tanzania

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For communication

Dk. Edna Makule
Project coordinator, FruVaSe-Tanzania,
Nelson Mandela African Institution of Science and Technology,
S.L.P. 447, Arusha, Tanzania.
Phone No.: +255 714 492 626
Email: **edna.makule@nm-aist.ac.tz**

TABLE OF CONTENTS

1. BACKGROUND INFORMATION 5

1.1. African Nightshade 5

1.2. Types of ANS found in Tanzania 5

- *Solanum scabrum* 5
- *Solanum villosum* 5
- *Solanum nigrum* 6

1.3. Availability of ANS 6

2. POSTHARVEST HANDLING 7

2.1. Collection of fresh ANS from farm or market 7

2.2. Packaging and Transportation of ANS leaves 8

2.3. Receiving house (Sorting, cleaning, and grading) 9

3. PROCESSING OF ANS 10

3.1. Importance of processing 10

3.2. Types of ANS processing and preservation technologies 10

3.3. Selected technologies for processing of ANS leaves 10

3.4. Drying of ANS leaves 11

- Requirements for drying of ANS leaves 11
- Procedures for preparing dried ANS 11
- Packages of dried ANS 14

3.5. Fermentation of ANS 14

- Requirements for fermentation of ANS 14
- Ingredients for relish making from fermented ANS leaves 14
- Procedures for Spontaneous fermentation of ANS leaves (Pickle making) 15
- Quality control/assurance during ANS leaves fermentation 15
- Relish making 15
- Packaging of relish 17
- Quality control of fermented or relish ANS products 18

4. PACKAGING AND LABELLING OF PRODUCTS 19

4.1. Purpose of packaging materials 19

4.2. Selection of packaging materials 19

4.3. Labelling of pre-packages 19

5. SELLING OF FOOD PRODUCTS 20
5.1. Finding the market for your products 20
- Selling to friends and neighbours 20
- Farmers' markets 20
- Trade shows and fairs 20
- Grocery and health-food stores 21

5.2. Ways to make the product attractive to customers 21
5.3. Marketing aspects of dried ANS and relish product 21
- Marketing aspects of dried and relish ANS 21

6. GOOD MANUFACTURING PRACTICES (GMPS) 23
6.1. Personal hygiene practices 23
6.2. Hand washing practices 23
6.3. Clothing, footwear and headwear 24
6.4. Injuries and wounds management 25
6.5. Working environment/facility hygiene 26
6.6. Design of a processing building or factory 26
7. REFERENCES 27

1. BACKGROUND INFORMATION

1.1.African Nightshade

- African nightshades (ANS) are among many underutilized and neglected African indigenous vegetables (AIVs) species
- If adequately exploited they could help to improve food, nutrition, and income among households.
- ANS is rich in macro-and micro-nutrients, including thiamine, ascorbic acid, iron, calcium, zinc and protein
- Furthermore, these nutrients are important because they prevent anemia to children and pregnant mothers, boost body immunity and many other more.

1.2. Types of ANS found in Tanzania

❖ ***Solanum scabrum***

- Broad-leaved
- Flat taste (non-bitter)
- Mainly cultivated
- High yield

❖ ***Solanum villosum***

- Narrow-leaved than *S. scabrum*
- Bitter taste
- Mainly cultivated
- High yield than *S. nigrum*

❖ ***Solanum nigrum***

- Local variety
- Narrow-leaved than *S. villosum*
- Bitter taste
- Mainly Grow naturally
- around homewards/farms
- Its seeds are not sold in markets or stores
- When the seeds are ripe they turn black or purple, the fruit is smaller than that of modern specie

1.3. Availability of ANS

- In East Africa ANS, is found in Kenya, Tanzania, Uganda, Burundi and Rwanda
- The young leaves and stems of the ANS are used as a vegetable and can be processed or cooked in a variety of ways such as boiled, dried, fried, and fermented
- The ANS are used as a traditional medicine in East and West Africa
- ANS needs immediate preparation after harvest to ensure that its quality is not lost.

2. POSTHARVEST HANDLING

2.1. Collection of fresh ANS from farm or market

Damaged leaves Nono-Womdimo et al. (2009)

- Since ANS is highly perishable, the chance of spoilage increases rapidly with time, mainly when poorly handled
- The chance of deterioration increases within 24 hours if ANS is not immediately sold or preserved after harvesting
- Excessive field heat increases metabolic activity, favors microbial activity, and increases respiration rate and ethylene production

Harvesting, storage and collection of ANS for use

Harvesting of African nightshade
https://africa-rising.net/healthy-veggie-revolution/

- Harvest ANS leaves at right maturity (4-6 weeks) planting the seedlings either by;
    - Use proper harvesting tools, e.g., a sharp knife
    - Picking young leaves and shoots or
    - Plucking or uprooting the whole plant.
- Harvest the ANS leaves early in the morning or late in the evening to avoid wilting due to high sun intensity.
- Remove mature, damaged or decaying leaves, for example, yellow and insect-infested leaves
- Avoid buying cracked ANS as they can be easily be damaged
- Avoid physical damage by;
    - not throw or pile ANS leaves in a storage container;
    - Avoid overfilling of ANS leaves in one container.

African nightshade in crates © F. Sangija

Note: Make sure ANS is fully mature before re-harvesting

- Cool the ANS immediately to remove field heat by either;
  - Putting under the shade
  - Sprinkling with water
  - Dipping in water
  - Covering with a clean cloth

Don't use bags© F. Sangija

2.2. Packaging and Transportation of ANS leaves

- Pack the ANS leaves in well-ventilated containers (g., perforated plastic basket or matenga) avoid using plastic, polyethylene bags.
- Avoid using plastic bags with no holes or bags to transport ANS
- Use cold storage such as a cool box
- Avoid mixing ANS leaves with other products like vegetables, fruits (banana, avocado, tomatoes) or other agricultural products that can impart an unfavorable smell.
- Avoid mixing ANS leaves with climacteric produce during transportation, i.e., bananas, avocados, apples, tomatoes, to avoid discoloration due to ethylene gas production.
- Avoid transportation the ANS leaves during the peak hours of sunlight

Common container for transporting ANS © F. Sangija

2.3. Receiving house (Sorting, cleaning, and grading)

- Wash ANS leaves thoroughly (under running clean water) to remove dirt, bacteria, and chemical residues before cutting if applicable
- Remove debris, destalk/destem the ANS leaves, and remove soil or any other decayed leaves.

Washing of ANS © *F. Sangija & M. Kazosi*

Sorting of ANS © F. Sangija & M. Kazosi

3. PROCESSING OF ANS

3.1. Importance of processing

- To preserve food
- To increase the commercial food value
- To improve nutrients bioavailability such as minerals, vitamins, and proteins
- To improve food safety and security
- To improve shelf life of ANS
- To reduce postharvest losses
- To ensure accessibility of food/continuous supply of food by ensuring the vegetables are available year-round.
- To improve food quality (improves flavour, texture, and aroma).

3.2. Types of ANS processing and preservation technologies

There are various traditional and modern processing technologies for ANS

Traditional and Modern processing and preservation technologies include;

- Drying, salting, boiling and fermentation
- Fermentation (acid, pH), and blanching
- Canning, freezing, and irradiation

Traditional technologies are inexpensive and do not require modern equipment; therefore, smallholder farmers, individuals can afford it.

Note; Some processing techniques degrade essential nutrients; therefore, proper care must be considered i.e., control processing temperatures and time.

3.3. Selected technologies for processing of ANS leaves

The selected technologies for processing ANS leaves are;

- Drying
- Fermentation (pickle making).


Solar driers @Kazosi, M


Fermenters ©F. Sangija

3.4. Drying of ANS leaves

❖ Requirements for drying of ANS leaves

- African nightshades (*Solanum scabrum* or *S. villosum*)
- Salt
- Solar dryer/Indirect or mixed solar depending on the environment
- Source of heat (gas, charcoal, electricity)
- Saucepan/cooking for blanching
- 2- perforated plastic crates
- 1-Large plastic basin (20L)
- 2-Small basins (5 L)
- 1-Plastic Strainer
- Wooden spoon
- White cotton cloth (2 M)
- Stopwatch (e.g. on your phone)

❖ Procedures for preparing dried ANS

- Prepare 1 kilogram of well washed ANS leaves
- Measure 8 L of clean water and put in a cooking pan (blancher)
- Weigh 240 g of salt to make a 3% salt solution and put in a blancher, mix well.

- Set the blancher temperature at 85°C and heat until the required temperature is attained.
- Set the stopwatch for 2 minutes
- Take the weighed amount of ANS leaves in a cotton cloth and submerge in water heated at 85 °C.
- Immediately start the stopwatch and wait for the 2 minutes to be over.
- Remove the ready blanched ANS leaves and immediately immerse them in ice water in a basin with 3% salt concentration for immediate cooling.
- Leave the blanched ANS leaves to cool for at least 5-10 minutes.
- Drain the water by a strainer for 2-5 minutes
- Take the ANS leaves to the Solar dryer, ready for drying and display evenly on the drying tray
- Monitor the drying process by frequently turning upside down (at least after every one hour) to facilitate uniform drying
- Check the moisture content of the dried product (should range between 6% to <12 %).
- Cool the dried products for 10 minutes at an ambient temperature
- Weigh an amount as per desired quantity to be packaged(50g-100g)
- Fill into the packages and seal
- Store at an ambient temperature in a dark room.

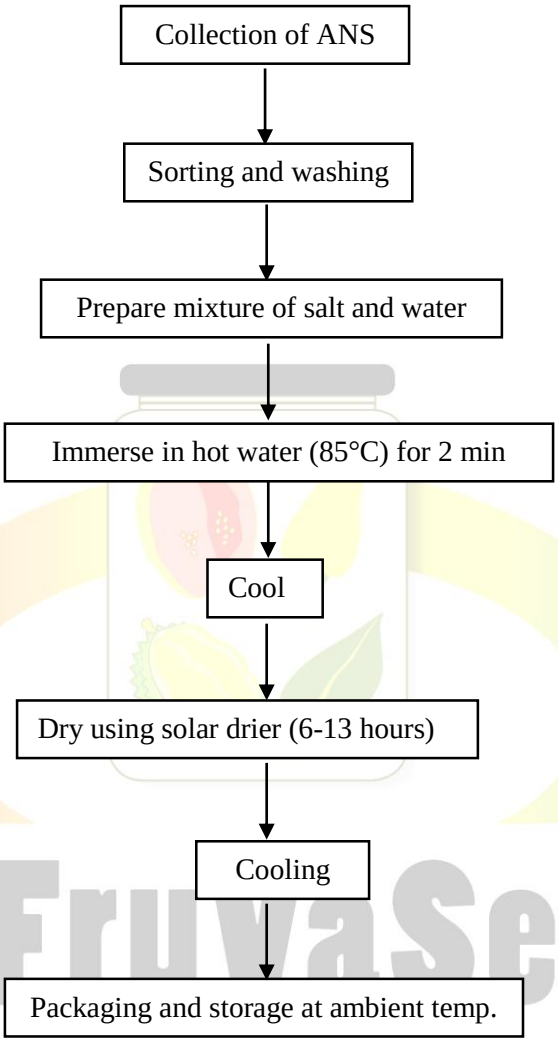

Diagram 1: Process flow for drying of ANS

❖ **Packages of dried ANS**

- Paper bags
- Aluminium polythene bag

Paper and aluminum packages @ Kazosi, M

❖ Quality control of dried ANS

- Growth of fungi/moulds
- Change in colour

3.5.Fermentation of ANS

❖ **Requirements for fermentation of ANS**

- African nightshades (*Solanum scabrum* or *Solanum vilosum*)
- Salt
- Sugar
- Fermentation containers with lid (10-20 litres)
- Weighing balance
- Plastic basin (20-40L)
- pH meter
- Strainer
- Source of Heat (any cooker; gas, charcoal)
- Sterilized stone
- Wooden spoon

❖ **Ingredients for relish making from fermented ANS leaves**

- Pepper
- Cinnamon
- Gallic
- Cooking oil
- Onions
- Bell peppers

- Turmeric
- Ginger

❖ **Procedures for Spontaneous fermentation of ANS leaves (Pickle making)**

- Weigh 1 Kg of ANS
- Put in fermenter
- Prepare mixture of salt and sugar (in ration of 4% to 2%)
- Pour the mixture on the ANS leaves in the fermenter
- Submerge the ANS in brine solution
- Cover the fermenter well to create anaerobic environment and leave to ferment at 30 °C, or ambient temperature if no incubator is available for 25-30 days.

Mchanganyiko tiyari kwa uchachushaji © F. Sangija

Fermented ANS © F. Sangija

Immersed ANS during fermentation © F. Sangija

Covered fermenter © F. Sangija

❖ **Quality control/assurance during ANS leaves fermentation**

- Increase in acidity
- Air bubbles decreases with time

❖ **Relish making**

- Prepare the ingredients [peppers, cinnamons, garlic, cooking oil, onions, bell peppers, turmeric, and ginger].

- Put cooking oil to heat for about 3-5 minutes
- Cut and add onions
- Then add 1kg of fermented ANS, followed by spices
- Cook for 10-15 minutes
- Then cool the mixture (relish) to ambient temperature
- Package the relish into bottles, then seal well, ensure the ANS are submerged in brine solutions.

ANS relish © Frank Sangija

- Store the relish at ambient temperature (for a maximum of six months or 1 year in a freezer.

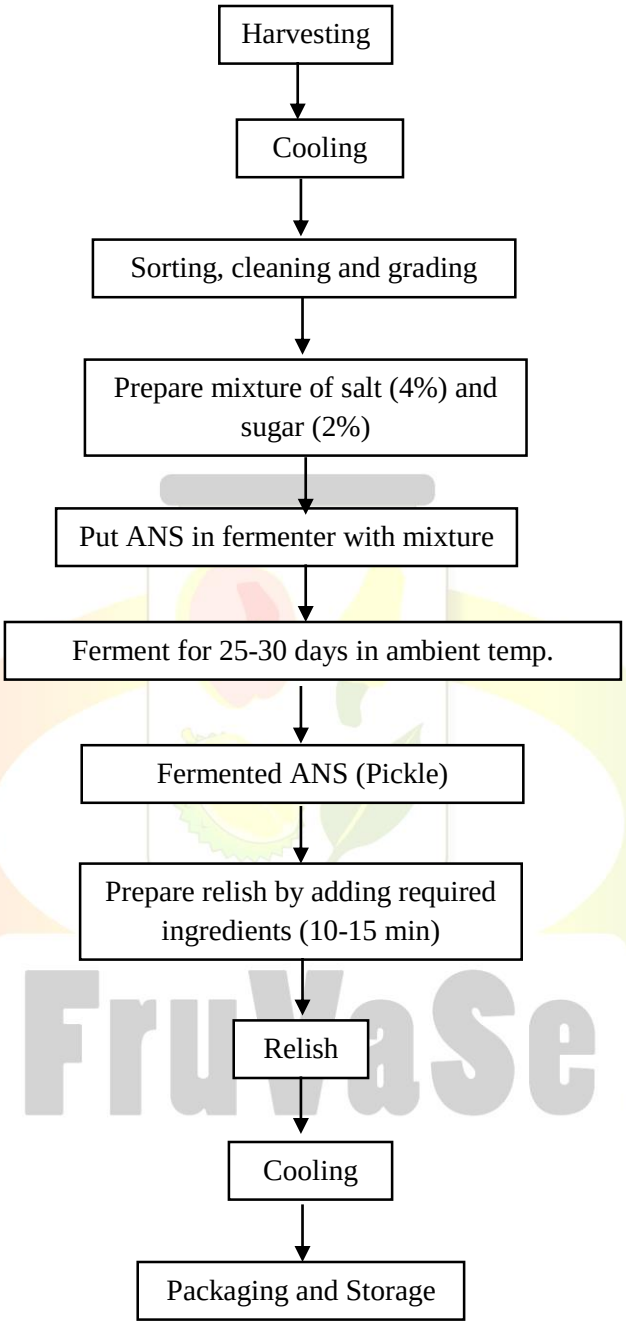

Diagram 2: Processing flow for spontaneous fermentation of ANS and relish making

❖ Packaging of relish

- Package immediately after cooling the relish.
- Avoid under and overfilling of relish.
- Preferably Aluminium polythene bag or glass bottles of 50-500 g

Packaged relish © F. Sangija

Relish packages © F. Sangija

- **Quality control of fermented or relish ANS products**
  - Growth of fungi
  - Bad smells
  - Slimmy

4. PACKAGING AND LABELLING OF PRODUCTS

4.1. Purpose of packaging materials

- To contain the food, keep it clean and secure without leakage until its usage.
- To protect food against dirt, microbes, moisture, light, etc. along distribution chain.
- Convenience handling throughout the production, storage and distribution including easy opening, dispensing, disposing and recycling.
- To enable the consumer to identify the food, and give instructions so that the food is stored and used correctly.
- Branding of the product

4.2. Selection of packaging materials

There are different types of packaging materials that are intended for different purposes. Example: metal containers, glass, paper and cardboard, flexible plastic films, low density polyethylene (LDPE).

- Criteria to be considered when selecting a suitable package:
  - Nature of the product; liquid (juice, jam, wine) or solid (fresh-cut/dried fruits).
  - Eco-friendly and legally compliant.
  - Security and durability; the amount of protection needed will of course depend on the fragility of the product.
  - Affordability and easy to use.
  - Widely availability.

4.3.Labelling of pre-packages

- Labelling includes any written, printed or graphic matter that is present on the label.
- The following information shall appear on the label of packaging material:
  - The name of the food; indicate the true nature of the food.
  - List of ingredients.
  - Net contents by weight or volume.
  - Name and address of the manufacturer, packer or distributor.
  - Lot/batch identification.
  - Date marking and storage instructions.

5. SELLING OF FOOD PRODUCTS

5.1. Finding the market for your products

There are a multitude of methods by which you can sell your processed food products. These include;

- **Selling to friends and neighbours**
  - This is the best practice for new processors to start marketing their products.
  - It is an easy way to initiate direct sales, but it does have some drawbacks.
  - It requires a lot of work to contact people to sell your products. Yet, if the quality of products is high and liked in your area, the number of consumers might easily increase through word of mouth.
  - Also, because these are your friends and neighbors, they may expect to get a lower price as a friendly bonus.
  - It is sustainable approach for market expansion through getting more customers through friends and neighbors.

- **Farmers' markets**
  - These places are perfect for direct marketing.
  - The biggest advantage of selling at a farmers' market is that you'll find many consumers in one place.
  - It is much easier to sell a little bit of produce to a lot of customers than a lot of produce to a few customers.
  - If you have something new and different from the rest of the market, provide taste samples to the customers.
  - Recipes featuring the produce are also a good marketing strategy.
  - The major disadvantages to farmers' markets are cost and time.

- **Trade shows and fairs**
  - A booth at trade shows and community events can promote the product and increase the sales.
  - These booths are a good way to tap into local markets, appealing both to brand-new customers and to people who have already heard about the product but never tried it.

- Have cards or flyers available with contacts for interested people to know where to get the product.

❖ **Grocery and health-food stores**

- These can be good outlets for the products, also wholesale selling is possible.
- You must produce many products at once to make up for your reduced income and increased time and travel.

5.2. Ways to make the product attractive to customers

- Find an attractive and convenient packaging material/s.
- Create an attractive label with all the information required by customers.
- Find a good recipe/attributes (taste, colour, aroma, nutritional value, quantity, etc.) for the targeted customers.
- Brand the product

5.3.Marketing aspects of dried ANS and relish product

- Market for dried products
  - It is uncommon to find dried vegetables products in the market, even local ones.
  - Dried and relish ANS are an exceptional and a new product.
  - Customers of this product are all people around the world.
- Selling points include:
  - Product originality e.g., prepared from fresh ANS vegetables.
  - Contains essential nutrients such as vitamin, A, B, C, minerals, proteins and dietary fibers.
  - It is a convenient product: ready-to-eat, eaten anytime, and can be mixed with other vegetables such as amaranths, and meat, fish and any other cooked foods.

❖ **Marketing aspects of dried and relish ANS**

- Market for dried and relish ANS
  - Dried and relish ANS is exceptional and a new product.
- Selling points include:

- Prepared from fresh ANS vegetables
- Contain nutrients such as vitamin A, C, and minerals
- It is a convenient product: Ready to eat for relish product and just need little preparation for dried ANS

6. GOOD MANUFACTURING PRACTICES (GMPS)

6.1. Personal hygiene practices

- All working personnel at the facility should;
  - Come to work clean.
  - Keep fingernails short and clean.
  - Don’t wear fingernails polish, false eyelashes, nails, etc.
  - Avoid touching body parts. If hands become dirty, wash them.
  - Don’t eat, drink, smoke, or spit or use medication in any of food related areas.
  - Don’t bring any personal items to the food production or storage areas including keys, tobacco, phones, candy, etc.

Trimming of nails

False eyelashes

6.2. Hand washing practices

- Proper hand washing is critical in preventing cross contamination.
- All personnel must wash their hands thorough and frequently.

Hand washing procedure

- Please follow the illustrated steps below during hand washing;

© The daily news

Hand washing frequency

- All personnel must wash their hands:
  - when starting or return to work
  - after using the washroom
  - after handling/touching ingredients, utensils, pre-package and food contact surfaces
  - after handling raw ANS
  - before putting on gloves
  - after handling garbage or waste bins
  - every time hands become dirty

6.3. Clothing, footwear and headwear

- All personnel must wear clean clothing to prevent cross contaminations.
- These rules must be followed:
  - Come to work in clean clothing.
  - Put on your apron, gloves or uniform before start working.

- Keep designated work clothing clean and in good repair (no holes, loose threads, loose buttons, etc.)
- Wear clean non-slippery shoes inside the facility.
- Do not wear designated clothing outside the production facility.
- Wear designated clothing for each different operation in the plant to avoid cross contamination.

Apron

Glove

Shoes

Headwear

6.4. Injuries and wounds management

- If a person is injured, first aid should be given immediately
- Properly cover an open wound with a plaster or non-abrasive bandage
- An injured person should not be involved in food production activities.

First Aid Kit components

6.5. Working environment/facility hygiene

- Production unit must be located in a place free of smoke and dust.
- The building must be solid, providing enough space for all production stages.
- Floor/walls must be easy to wash and drains are necessary to avoid water from lodging.
- Windows must have insect screens installed.
- Production unit must be well lit and ventilated.
- Light bulbs must be protected against breakage and explosion.
- Bathrooms must not be directly facing the production area.

6.6. Design of a processing building or factory

- The building must be designed, built and maintained according to:
    - The type of processing expected to take place.
    - Food safety during processing.
- Processing steps are required to follow a specific flow
- Storage of raw materials, packaging, and ready-made products should not allow dust, mildew, leaks, pests and other waste
- Store raw materials on crates, away from walls and ceilings to facilitate cleaning, inspection, and repelling pests such as beetles and rodents.

THANK YOU!!!

7. REFERENCES

Dinssa, F. F., Hanson, P., Dubois, T., Tenkouano, A., Stoilova, T., Hughes, J. A. & Keatinge, J. D.H. (2016). AVRDC. The world vegetable center's women-oriented improvement and development strategy for traditional African vegetables in sub-Saharan Africa. *European Journal of Horticultural Science* 81 (2): 91–105.

Edmonds, J.M. & Chweya, J.A. (1997). *Black nightshades. Solanum nigrum L. and related species. Promoting the conservation and use of underutilized and neglected crops*. Rome, Italy: Gatersleben/International Plant Genetic Resources Institute.

Yang, R. Y. & Ojiewo, C. (2013a). African nightshades and African eggplants: Taxonomy, crop management, utilization, and phytonutrients. *ACS Symposium Series* 1127 (October 2013): 137–65. https://doi.org/10.1021/bk-2013-1127.ch011

Ontita, E., Onyango, C., Onwonga, R. & Nyamongo, D. (2016). Indigenous knowledge on the uses of African nightshades (*Solanum nigram* L.) species among three Kenyan communities. *Asian Journal of Agricultural Extension, Economics & Sociology* 14 (3): 1–8. https://doi.org/10.9734/ajaees/2016/31099

Yuan, B., Byrnes, D., Giurleo, D., Villani, T., Simon, J.E. & Wu, Q. (2018). Rapid screening of toxic glycoalkaloids and micronutrients in edible nightshades (*Solanum* spp.). *Journal of Food and Drug Analysis* 26 (2): 751–60. https://doi.org/10.1016/j.jfda.2017.10.005

Odongo, G., Schlotz, N., Baldermann, S., Neugart, S., Huyskens-Keil, S., Ngwene, B., Lamy, E. (2018). African nightshade (*Solanum scabrum* Mill.): Impact of cultivation and plant processing on its health-promoting potential as determined in a human liver cell model. *Nutrients* 10 (10): 1532. https://doi.org/10.3390/nu10101532.

Gogo, O.E., Opio, M. A., Ulrichs, C. & Huyskens-Keil, S. (2016). Postharvest treatments of African leafy vegetables for food security in Kenya: A Review. *African Journal of Horticultural Sciences.* 9 (June): 32–40.