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# Traditional vegetables of Zimbabwe

## Appropriate processing, storage, and packaging technologies

**Graham Anstee**

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## Summary and Recommendations

The intention of the work reported here was to establish current methods used to preserve traditional vegetables both wild and cultivated, understand how they are marketed, and look at possible improvements to processing methods. The limited time available produced more questions than answers.

Traditional vegetables are popular when fresh however when they are dried there appears to be a positive dislike to them especially amongst the young. However people who had been brought up with them especially the elderly did like them. This is the result of a limited survey

Abbreviations

HRC Horticultural Research Centre Marondera Zimbabwe
DTC Development Technology Centre University of Zimbabwe
RHC Ranch House College, Harare
CTDT Community Technology Development Trust
NGO Non Government Organisation
IDRC International Development Research Centre Ottawa, Canada

**Acknowledgements**

The assistance of Ngoni Nenguwo, Officer in charge of the Horticultural Research Centre (HRC) Marondera is very much appreciated.

**Introduction**

1. Traditional vegetables of Zimbabwe, many from wild plants are locally dried preserving them for future use. Business opportunities are developed when few vegetables are available. Farmers traditionally dry the leaves and flowers of fresh plant material in the open on rocks heated by the sun. Unfortunately these vegetables are harvested during a period of warm wet weather making drying difficult, jeopardising the quality and safety of this traditional food. There have been a few initiatives to introduce controlled drying within polythene covered wooden drying cabinets, and to teach good drying practices and technology to rural entrepreneurs. This has resulted in some good quality products being produced but in general there is a lack of understanding where drying and food safety is concerned.

2. The past and current work on processing traditional vegetables was discussed at the Development Technology Centre (DTC) University of Zimbabwe. DTC has just started a project funded by the French. One of the dryers being tried is a long polythene tunnel drawing air from one end towards fans at the other. See photographs at annex 3. Air is heated on rout and passes over the drying vegetable leaves. The vegetable leaves are on trays 2/3rds along the dryer. The project is evaluating solar drying technologies and their use for indigenous vegetables etc.

3. The teaching of drying technology and the distribution of drying equipment and designs to farmers was discussed with Emily Katsande a food Technology trainer with Ranch House College (RHC) in Harare. An overview of the teaching material and the dryer technology promoted was provided. Two dilapidated cabinet dryers were seen on site. It appeared that little work was being done in this area at present.

4. The Community Technology Development Trust (CTDT) an NGO in Harare have been active in the field of solar drying, and have promoted a solar dryer with a glass panelled solar collector attached to an enclosed drying cabinet. Much of their funding is from IDRC. This particular dryer is being used for seed drying as well as for drying vegetables. The actual drying area is very small considering the overall size of the dryer. The temperature inside some of these dryers can exceed 60°C, which could jeopardise the viability of seed.

5. Two women's groups involved in traditional vegetable drying were visited. One ladies group consisting of 20 members, dried their vegetables in a wooden drying cabinet covered with polythene, and the other ladies group of 20 members dried there produce on rocks exposed to the sun and the elements, this being a traditional method going back many years. Both groups marketed their produce, and both had their problems. Ranch House College provided the basic processing technology and instruction. The group drying vegetable leaves on rocks were concerned that their produce was taking a long time to dry, sometimes three days when the weather was bad, and that the quality was not always good. They said that they were in desperate need of a drying cabinet to overcome this problem.

6. The other group using drying cabinets dried vegetables in around 6 hours, and sometimes they could dry two batches in one day. In general the product was good but on some occasions dried material would go mouldy in the storage container which was a large drum fitted with an air tight ring clamp lid. They blamed this problem on high humidity making the already dried product damp. In reality the problem was most likely due to inadequate drying in the first place as they confessed that sometimes the product was still flexible. Lab experiments confirmed that if the leaf is still flexible its moisture and water activity is too high making it susceptible to mould.

7. Cellophane consumer packets are used to package the dried leaf, however heat sealing them is a problem. Heat sealers are electrically operated, and as there is no electricity, paraffin stoves are being used to heat seal the bags. This results in many poor seals, and the product being exposed to infestation and humidity. There is also a possibility of the product being contaminated by smoke, soot or even kerosene. This problem is typical of any processor who wishes to use heat sealed consumer packages remote from electricity supplies. Simple reliable non-electric equipment needs to be developed for this purpose.

**The General situation regarding traditional vegetables in Zimbabwe**

8. Every opportunity was taken to talk to people about traditional vegetables. It appeared that in general most people liked fresh traditional vegetables, and preferred them to those that have been dried. In contrast dried vegetables appear to be preferred by the older generation. Unfortunately there are a number of problems associated with dried traditional vegetables that need to be addressed if the general attitude towards them is to improve. People said that as children they disliked traditional vegetables especially the dried ones, but were often made to eat them. Perhaps they have been put off eating traditional vegetables through bad experiences. Children often dislike strong flavours, but are more tolerant to them as adults. The real reason is not understood and requires further investigation. It is thought that poor quality, possible off flavours, could be responsible due to inadequate drying and storage conditions.

9. In the past all traditional vegetable drying would have been done in the open on hot rocks, and under these conditions they are exposed to dust, flies, birds, rodents and insects as well as rain. With so much stacked against this product it is no wonder that it is often of poor quality and unpopular, especially with the younger generation.

10. The market was visited and products purchased. A basket of dried leaves seen on one stall had been made wet by rain. Although the Stall-Holder said the material would be dried, there wasn't anywhere clean and dry in the market for this to take place, and all the while it remained in the basket its quality would deteriorate. Lengthy drying times increase microbial loading irrespective of preparation, and re-wetting by rain will slow the drying process and make the situation worse. If the product is not

properly dry before packaging, or gets wet whilst stored, unpleasant off flavours and moulds will develop.

11. Products that are mouldy or have off flavours should not be marketed or used. Apart from any harmful affects, the product will be unpleasant, and customers that have had a bad experience especially with off flavours and odours will always associate this with dry traditional vegetables. If this is how people perceive dried traditional vegetables it will take a great deal to convince them otherwise even if improved processing techniques overcome all problems. For those that do use dried traditional vegetables, every effort must be made to ensure that the product is of the highest quality.

**The use of solar drying cabinets**

12. The term sun drying normally refers to a product exposed to solar radiation in the open, whereas solar drying is conducted within an enclosed cabinet, typically covered with polythene. A green house affect is created within the solar cabinet when exposed to sunlight. Both temperature and airflow are carefully controlled, and this creates efficient drying conditions. Products dried within solar cabinets are protected from dust, insects and inclement weather. The use of solar drying cabinets to dry traditional vegetables is relatively new, although it is very affective. Unfortunately, the polythene covering is subjected to extreme stress due to a build up of heat especially where it passes over wooden structure, and rapid deterioration often takes place. Reflective tape can be put on polythene in way of woodwork to protect it from extreme heat.

13. Retention of nutrition and vitamins during processing is important if people are to get maximum benefit from dried vegetables. Boiling in water will often strip vitamins and nutrients from vegetable leaves, and exposure to sunlight and prolonged storage is also a factor to consider. Sunlight is known to bleach out colour and heat will destroy vitamin C. Colour is a major factor when a product is marketed. A dry product similar in colour to the fresh product especially when cooked will be more acceptable than one that bares no resemblance to fresh leaves.

14. The use of enclosed drying cabinets will help to improved quality by drying the product quickly and cleanly, without exposing it to dust, flies, insects or the weather, etc. However, the type of solar drying cabinet to be used for drying traditional vegetables needs careful consideration, especially where the cost effectiveness of the operation is heavily influenced by dryer cost. Exposure to sunlight may or may not be important. Flavour, nutrition, and vitamin losses, and the degree of colour degradation due to sunlight exposure could be measured. Although sterilisation is achieved by solar radiation, only heat and airflow is required for drying.

**Boiling / blanching**

15. Apart from the mucilaginous types, all vegetable leaves are boiled before drying. This boiling time varies between two and five minutes and appears to be inconsistent; it all depends on who is processing and the type of leaves being processed. Boiling / blanching of traditional vegetable leaves prior to drying is an important part of the process. Apart from reducing the microbial load it can destroy enzymes responsible for spoilage and also remove unwanted bitterness or toxins.

16. Blanching is the term used when vegetables are plunged into boiling water for a short period followed by rapid cooling in cold water. The degree of boiling / blanching required to meet all the necessary parameters will be different for each vegetable leaf. Too much boiling will remove valuable vitamins and nutrients whilst too little could cause retention of bitterness, toxins and enzymes etc. It has been reported that bitterness in some leaves is only present after the first picking. If extensive boiling is the only answer and that results in total loss of both vitamins and nutrients; little will be gained from drying and consuming the product.

**Drying**

17. In general terms drying is a form of preservation when applied to food commodities. Moisture is removed from within the material structure to a point where there is insufficient water to support micro-organisms. At this point the material is considered stable and can be stored for a considerable time, providing that there is no re-absorption of moisture. Water activity ($a_w$) is the term used to determine the safe condition of a particular commodity. All commodities will have a different safe condition depending on acidity, however as a general rule dried traditional vegetables should be in the region of $a_w$ 0.6, which is easily accomplished under good solar drying conditions.

18. When measuring water activity a sample is placed into an airtight container with a small headspace above the sample. The sample is left for a while for the head space humidity to equilibrate with the sample, which is when the transfer of moisture ceases. The headspace relative humidity (RH) is measured and divided by 100 to give $a_w$, although instruments are generally calibrated to provide a direct reading in $a_w$. This correlation between water activity and atmospheric RH is important as it also provides a link to drying performance and when dry materials are re-humidified due to atmospheric conditions. When a commodity is being dried the local RH around the commodity must not be allowed equilibrate as under these conditions drying will stop. If the RH is 80% the material will not fall below $a_w$ 0.8, also if a commodity is dried down to a safe $a_w$ of 0.6 and is transferred into an atmosphere of 80% RH the commodity will gradually re-absorb moisture until it reaches $a_w$ 0.8.

19. For drying purpose the air must not remain stagnant around the commodity being dried. An air- flow must be created around the drying commodity, and this air must be exhausted to atmosphere to maintain the RH at the lowest possible levels. A dryer must be provided with an air inlet and outlet to achieve this purpose. Drying is enhanced by higher temperatures, which should not exceed 60°C for leaf material or

fruit. Higher temperatures can cause the surface of the material being dried to seal over preventing transfer of moisture to atmosphere (case hardening affect). Material dried under these conditions might appear dry but in reality they are not safe.

20. To reduce humidity, drying should take place in areas free of vegetation. All the dryers seen in Zimbabwe were mounted on a concrete base. The advantage of a concrete is that vegetation will not grow underneath and it is easy to keep clean and free of dust. Although nice to have, it is not strictly necessary and adds a considerable cost to the dryer installation. All dryers were well positioned, being exposed to the sun all day.

**Packaging and storage of dried vegetables**

21. Suitable packaging material and suitable storage conditions are most important for maintaining dried traditional vegetables in good condition. If the dried commodity is left in the open its $a_w$ will fluctuate under atmospheric conditions. To prevent this from occurring, the commodity should be enclosed into a dry environment, either bulk dry store or within sealed bags. The advantage of a sealed bag is that the atmosphere within is a relatively small volume compared with the commodity and will help to maintain the product stable, clean and provide a barrier against insect attack. Greater care will be required to maintain material dry when stored loose in a bulk container; it will also be more susceptible to insect attack. Also a small amount of poorly dried material could spoil the rest in a bulk store, if stored together.

22. Most dried leafy materials, loose their colour when exposed to sunlight; care should be taken to store traditional dry vegetables out of sunlight, and preferably in a dark place. If rodents are a problem sealed bags would be better kept in a metal container.

23. Solar drying can be achieved without the use of electricity, and is therefore appropriate technology for people in rural areas not yet supplied. Plastic bags, which are relatively cheap and available, provide a good packaging medium for dried traditional vegetables. Electrically operated heat sealing equipment is normally used to seal plastic bags effectively, unfortunately without electricity this becomes a problem. Heat sealing equipment clamps the two skins of plastic together, and applies heat to fuse the plastic films together. Various methods have been tried to seal plastic bags in the absence of electricity. People have used the edge of a tin can part filled with hot charcoal, an open flame from a candle, or the hot metal surfaces of a paraffin stove. Too much heat and the bag will burn through, too little and the bag will not seal properly, these are typical problems experienced, not just by people processing traditional vegetables but people processing other commodities as well.

**Value of dried traditional vegetables**

24. A price structure needs to be established for the various dried vegetables, either supplied loose or in consumer packets. This information is required to establish whether or not processing and the use of drying equipment are cost effective, and to determine pay back periods. When processing is conducted for profit the process must be cost affective. Dried vegetables are sold both loose in open baskets and packaged in retail polythene bags. Bagged material was purchased from one set of processors, although it was not certain where they marketed the product. Loose material was purchased from an open market and a modern supermarket store in Harare. The supermarket sold dried rape and dried cabbage loose by weight, whereas the market sold various traditional dried vegetables loose, but by volume (cup full). Although the processors sold their dry traditional vegetables in bags, there was no set weight. The processors stated that depending on scarcity volumes would change and

prices would remain constant for a bag of dry vegetables depending on type. A table of prices with the relative weight as purchased has been compiled at annex (a).

25. The cost of all equipment including depreciation, the raw materials, consumables, transport wages etc. must be taken into consideration when running a business for profit. Drying traditional vegetables is no different. Cost, robustness, capacity, and effectiveness of the solar dryer are most important. A sum of money should be set aside for repairing, and replacement of the dryer or buying more dryers to expand the business. Dryers should be covered with polythene protected against UV degradation, as standard polythene will degrade rapidly when exposed to sunlight irrespective of thickness. This makes a dryer more expensive initially, but in time it will be more cost effective. UV resistant polythene should be available through suppliers of horticultural green houses, although for small amounts it might be better to purchase from users of horticultural greenhouses, rather than buying in bulk.

**Marketing**

26. According to traders the market price of dried vegetables generally remains the same throughout the year, however the weight or quantity varies according to supply and demand and where the product is being sold. A supermarket sold dried rape and cabbage loose but by weight, all other dried vegetables purchased by the author were sold by volume, either loose from a baskets in the market, or in consumer packets from a producers. To make comparisons the price per kg was calculated. As tables at annex 2 indicate, the price per kg was extremely variable which makes profitability very difficult to establish. However if the traders are able to sell at the higher prices because the quality is good, profitability can be determined on this marketed product, and dryer pay back time can be calculated. Although the author's survey was too small to establish an accurate price structure it does suggest that there are huge variations.

27. Some of the processors believe that there are export markets in South Africa and Mozambique, for dried vegetables. Ranch House collage also had an enquiry for large quantities of dried vegetables, but unfortunately they were not in a position to supply. When we have nutrition data on traditional vegetables and the quality is consistently good, other markets can be explored and developed. Potential export markets require investigation.

**New developments**

28. Polythene solar cabinets are poorly constructed in general and rapidly deteriorate when exposed to the weather and sun. The use of alternative materials and construction methods is being investigated. If vitamins and colour are lost due to drying in sunlight, a metal skin could replace the polythene covering and drying would take place in the dark. Sunlight would heat up the enclosed metal box and airflow would be created by holes in the bottom and at the top at one end. The box would be painted mat black to attract the heat. This approach has not been tried

before, especially for drying vegetables. A prototype has been designed around standard sheets of galvanised steel readily available in Harare. The dryer has been designed such that the amount of timber used is minimal and the main wooden structure is external protecting it from changes in temperature and humidity. If this form of dryer proves successful it will be far more robust than existing polythene dryers. With a minimum of maintenance a metal dryer should last for many more years. The Horticultural Research Centre at Marondera has agreed to build and test the prototype dryer. A sketch of the dryer together with instructions on how to build it and Z$5,000 has been left with Ngoni Nenguwo. If successful it will be evaluated in the field. Drawings and instructions at annex (b).

**Preservation of traditional vegetables (Possibilities)**

29. Other than drying, it appeared that no other forms of preservation such as salting, fermentation and pickling had been undertaken on traditional vegetables. Some people who had experienced other types of pickled vegetables said they liked them. The possibility of making a sauerkraut product from traditional vegetables will be investigated at HRC Marondera. Sauerkraut is cabbage fermented in brine and pickled in vinegar for long term storage. Processing details have been left with HRC, to test the process substituting traditional vegetables in place of cabbage.

**Nutritional Value of fresh and dried traditional vegetables**

30. Samples of fresh and dried traditional vegetables have been collected and transported to NRI. The fresh material has been frozen, although its condition is not good. The nutritional value of both fresh and dry material should be assessed so as to determine any losses due to processing. For instance, any losses due to drying in full sun can be compared with material dried in the shade. Without this information we are unable to say whether there have been improvements or not. Also marketing of processed traditional food will be that much easier if nutritional values are known. To reduce the effects of deterioration, nutritional evaluation on fresh material might best be undertaken in Zimbabwe. It is understood that the Veterinary department at the University of Zimbabwe is well equipped for this work. Also microbiological tests should be carried out to determine how safe dried traditional vegetables are.

Annex A
**Actions points**

1. The reason why dry vegetables are unpopular, especially amongst the young, should be established. Is it flavour, texture, knowledge of the process?

2. All players must be aware of good practices and the problems associated with drying vegetables in the open.

3. Traditional vegetables dried in direct sunlight, in the dark, or through obscured polythene, should be compared to determine the best drying arrangement.

4. The degree of sterilisation that takes place during drying and that required for dried traditional vegetables should be determined.

5. The reason for boiling must be determined i.e. for blanching or removal of bitter tastes or toxicity.

6. The project should determine the minimum blanching / boiling times for each traditional vegetable to enable safe processing whilst retaining maximum nutritional content.

7. The chemical composition of the constituent causing bitterness should be determined.

8. Losses due to excessive boiling to remove bitterness should be established.

9. A simple robust and effective heat sealer needs to be designed for rural areas to overcome problems.

10. The supply position of UV resistant horticultural polythene should be established.

11. The reason for large variations in dried vegetable prices needs to be established.

12. The true market potential should be established for dried traditional vegetables

13. The Horticultural Research Centre at Marondera will build and test the metal dryer.

14. The Horticultural Research Centre at Marondera will test sauerkraut processing methods on the various traditional vegetables.

15. The nutritional value of both fresh and dried traditional vegetables should be established.