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Review

Indigenous post-harvest handling and processing of traditional vegetables in Swaziland: A review

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The magnitude of post-harvest losses of fruits and vegetables in developing countries like Swaziland can reach up to 50% depending upon the commodity. The diet of rural Swazi folks is made up largely of a variety of seasonally available traditional vegetables whose nutritional and medicinal value is well appreciated. Several traditional vegetables are harvested, handled and processed using local indigenous knowledge (IK) at household level in Swaziland. Due to unaffordability of freezing and chemical processing technologies for preservation, drying has been the predominant method for traditional vegetable preservation, where the dried product is known as *umfuso*. Drying techniques which have been employed by rural folks from time immemorial are today being forgotten due to escalating rural-urban migration of younger people seeking employment in the industrial sector of Swaziland. Other techniques like solar drying and freezing if adopted may help increase chances of extending availability of traditional vegetables in Swaziland. The traditional vegetables include pigweed (*imbuya*), vegetable jute (*ligusha*), black jack (*chuchuza*), bitter gourd (*inkhakha*), cowpeas (*tinhlumaya*), pumpkins (*ematsanga*) and taro (*emadhumbe*). Research activities on indigenous post-harvest handling and processing of traditional vegetables are yet to gather momentum with the idea of incorporating use of modern methods and equipment. Local IK systems with regard to processing of traditional vegetables may be threatened by urbanization and hence the threat of losing oral tradition with time. Available information and future prospects pertaining to post-harvest handling, storage and processing of traditional vegetables has been reviewed here.

Key words: Indigenous post-harvest handling, processing, traditional vegetables, *umfuso*, climate change, biodiversity.

INTRODUCTION

Post-harvest handling refers to subsequent processes done immediately after removing a plant or plant part from its growth media till the produce reaches the final consumer in the desired form including packaging, quantity, quality and price. Conventionally the value chain encompasses cooling, sorting, cleaning, packing up to the point of further on-farm processing, or shipping to the wholesale or consumer market (Bencini, 1991; Kader, 2000). Food processing refers to any changes made to material used as food which include food preparation (Kordylas, 1990). Indigenous processing refers to those methods used since time immemorial to process vegetables in the Kingdom of Swaziland.

Common indigenous fermented foods and beverages produced in Swaziland have previously been documented (Masarirambi et al., 2009), however there is limited information pertaining to indigenous processing of traditional vegetables. Traditional vegetables like other horticultural crops experience losses between harvest and consumption. The magnitude of post-harvest losses in fresh fruits and vegetables is an estimated 5 to 25% in developed countries and 20 to 50% in developing

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countries like Swaziland depending upon commodity (Kader, 2000). Processing is undertaken for three reasons: (i) To render the produce edible, (ii) to reduce the content of plant toxins and (iii) to avoid losses by preserving the produce, that is, to prevent spoilage due to autolysis or microbiological attack (Conning, 1991). Apart from avoiding product losses energy conservation processes need to be followed in order for unit operations to be cost effective. Processing occurs at various levels in Swaziland from home industry to commercial level. Current practices of processing vegetables are similar to those found in the region at the household level (Kadzere et al., 2004) and at the commercial level where modern methods comparable to those of developed countries are practiced (Madakadze et al., 2004).

DESCRIPTION OF SWAZILAND

Swaziland is considered a developing country, but not one of the least developed countries, although grappling with poverty problems (Zwane and Masarirambi, 2009) and the scourge of HIV and AIDS. Agriculture plays an important socio-economic role in Swaziland by its contribution to Gross Domestic Product (GDP) and providing employment to the population (Manyatsi, 2005). Swaziland is in the Southern African Development Community (SADC) region and has a population of 1, 126 million people (Thompson, 2009). About 69% of the Swazi populations live below the poverty datum line. Swaziland is located in south eastern Africa and covers an area of about 17, 364 km^2 , lies between latitudes 25° 43′ and 27°19′S longitudes 30° 47′ and 32° 08′E. Swaziland is a landlocked country: surrounded on the north, west and south by South Africa; and on the east by Mozambique (Thompson, 2009). The country is divided into four agro-ecological zones namely Highveld, Middleveld, Lowveld and Lubombo plateau. In rural Swaziland the technological environment is not developed extensively hence the traditional diet is greatly influenced by the natural environment and cultivation patterns defined by the agro-ecological zones. Each of these regions has a distinctive climate, rainfall and geography (Jones, 1963; Ogle and Grivetti, 1985a). A significant sector of the population relies on the sale of traditional vegetables either grown or picked from the wild in the various agro-ecological zones.

POST-HARVEST LOSES AND TRADITIONAL VEGETABLES

Post-harvest processes, in all their various forms, bring immeasurable benefits in terms of improving produce handling, reducing food losses, increasing shelf-life and adding value to the product (Madakadze et al., 2004; Woodroof, 1975; Fellows, 1977; Nelson and Tressler, 1980). In some African countries it has been estimated that about 30% of produce is lost, and this figure can rise to 50% for very perishable foods such as fruits and vegetables (Kader, 2000). Losses occur in the field, during transportation, storage and processing. Losses of harvested produce may be in quality or quantity and may occur separately or together. Insects, bacteria and fungi are often responsible for severe losses of nutritive value in food. When bacteria and fungi develop on produce, unfavourable chemical changes occur. Some fungi produce carcinogenic toxins rendering food unsuitable for human or animal consumption (Bencini, 1991).

Traditional vegetables are those plants whose leaves or aerial parts have been integrated in a community's culture for use as food over a long span of time (Fox and Norwood Young, 1982; Chweya, 1997; Schippers, 2000; Ndoro et al., 2007). Some of these vegetables are not cultivated widely, but they are gathered from the wild. These traditional leafy vegetables are highly recommended as they form an important source of energy, body-building nutrients, vitamins and minerals (Nazare et al., 2007), trace elements, dietary fibre and proteins. They are also important in food security during times of drought and poor harvest and are also vital for income generation (Madakadze et al., 2004; Parawira and Muchuweti, 2008) and medicinal value in some instances. Household food insecurity is a serious recurrent problem for smallholder farmers for whom hunger periods and/or nutritional deficiencies are frequent. Hunger periods are periods of time in which the stocks of food staples, such as maize are scarce and household food security relies on available cash (Phakathi, 2008). Traditional vegetables have been noted for their superior attributes in alleviating problems associated with HIV and AIDS.

Food availability is seasonal (FAO, 1989) and the seasons consequently dominate the life and food habits of rural Swazis. Fluctuations in food availability are thus inevitable. A food glut normally occurs in months following rains when an abundance of fresh mealies, pumpkins, green vegetables and legumes are available. After that, food shortages are a norm. The horticultural potential is not maximally exploited because of shortage of appropriate equipment, techniques and inputs. This has been aggravated by shortages of labour following escalating rural-urban migration in search of jobs in industries in Matsapha, Swaziland. Horticultural activities are very labour-intensive and low input availability and limited irrigation facilities contribute to limited food supplies.

Consumption of traditional vegetables gives diversity in daily food intake, adding flavour and taste to the diet. The diversity in consumption will also reflect the conservation of biological diversity as local people will value the continued existence of traditional plant species used as vegetables. Withstanding their value as food, the vegetables also serve as a source of medicines; hence

Table 1. Common indigenous vegetables found in Swaziland (Anon., 2009).

Common English name	Siswati name	Botanical name
Common soap aloe	*Emahala*	*Aloe saponaria*
Pigweed	*Imbuya*	*Amaranthus hybridus*
Lamb' quarters	*imbilikicane*	*Chenopodium album*
Vegetable jute	*ligusha*	*Corchorus olitorius*
Black jack	*chuchuza*	*Bidens pilosa*
Bitter gourd	*inkhakha*	*Mormodica balsamina*
Wild melon	*inshubaba*	*Lagenaria siceraria*
Okra	*mandwandwe*	*Abelmoschus esculentus*
Cowpeas	*tinhlumaya*	*Vigna sinensis*
Pumpkins	em*atsanga*	*Cucurbita spp*
Cat's whiskers	*ulude*	*Cleome gynandra*
Purslane	*silele*	*Portulaca oleracea*
Black nightshade	*umsobo*	*Solanum nigrum*
Taro	*emadumbe*	*Colocassia esculenta*

they are important in their ecological, agronomic and cultural values (Jana, 2009; Ndoro et al., 2007). Since leafy vegetables are only available during the rainy season and their cultivation is limited, it is imperative that preservation and freezing techniques be employed in an effort to increase availability all year round. Chemical preservation and freezing techniques are not affordable in rural Swaziland. The drying techniques require exquisite attention in time and weather conditions which the older rural women had mastered, and this has evidently been lost to the modern generations.

COMMON TRADITIONAL VEGETABLES USED IN SWAZILAND

There are several traditional vegetables used in Swaziland, the extent of their utilization varying from place to place (Ogle and Grivetti, 1985b, c). Table 1 shows common traditional vegetables used in Swaziland.

According to Smith and Eyzaguirre (2007), indigenous vegetables are usually rich in nutrients such as vitamin A and iron often lacking in the diets of children and pregnant women. However, there are many factors that limit their use. These factors include the fact that people often have a negative attitude towards these vegetables and fail to appreciate their taste, preferring 'modern' foods. It can be difficult to obtain seeds or cuttings for propagation of some of the traditional vegetables. Sales in local markets are often unreliable and poor. Little research has been carried out and there is a general lack of knowledge about their potential. Some of them have erroneously been classified as weeds. Many people, especially in towns and cities, do not know how to prepare them. In fact, this knowledge is being rapidly lost as older people die. Another problem which faces traditional vegetables is that they are associated with low status. Agricultural policies usually emphasize export of cash crops and rarely fund work with traditional foods.

One way of mitigating drought and famine caused by climate change is by improving post-harvest handling, processing and subsequent utilization of vegetables harvested and consumed during drought and famine situations. Some of the vegetables are harvested and stored for future consumption. Traditional vegetables form an important component of the diet especially in situations of drought and famine. They include *imbuya* (*Amaranthus spinosus/hybridus*), *ligusha* (*Corchorus olitorus*) and *chuchuza* (*Bidens pilosa*). The indigenous vegetables are harvested and consumed as relish. Other traditional vegetables often used during times of famine are *emahala* (*Aloe saponaria*) and *emadumbe* (*Colocasia esculenta*). Most importantly traditional vegetables such as *inkhakha* and *ishubaba* have been known to combat hypertension and diabetes. It is the primary use as remedies for such common ailments that have inadvertently contributed to limited use of these traditional plant genetic resources. These vegetables are harvested and dried to make *umfuso* for use when they are out of season and during the drought period.

THE RATIONALE FOR POST-HARVEST HANDLING AND PROCESSING OF INDIGENOUS VEGETABLES

The nutritional value of indigenous vegetables is highest when they are fresh (Woodroof, 1975; Nazare et al., 2007) and has been reported to be superior to exotic vegetables like cabbage (Chweya, 1997) on a per weight basis. However, it is not always possible to consume fresh vegetables as they are only abundant in the wet season and scarce the rest of the year. Once the vegetables are harvested, they get subjected to a series of physical and biochemical changes that cause loss of

nutritional value, flavour, taste and start rotting or spoilage. Improving post-harvest handling and processing of the vegetables is one way of overcoming perishability constraints and ensuring continued high quality food supply. Several methods of vegetable preservation are available and these include, sun drying, solar drying, canning, vacuum packing, minimal processing, refrigeration, freezing and irradiation (Fellows, 1997; Nelson and Tressler, 1980; Kader, 2000; Madakadze et al., 2004; Fellows, 2009). Ohmic heat processing of foods is relatively new for food manufacturers (Vaclavik and Christian, 2008). Ohmic heating has an advantage in that this system prevents surface drying and overcooking but achieves control of microorganisms (Parrot, 1992). Drying is one of the longest established methods of food preservation, and one which occurs naturally, for example with seeds (Kumar et al., 2010). It combines the benefits of microbiological and physiochemical stability with reduction in weight and transport costs and has other advantages in handling and storage. The success of any drying operation depends on removing enough moisture from the food to achieve a water activity too low to allow microbiological growth to take place.

This in turn means there must be sufficient input and transfer of heat to provide the latent heat of vapourisation needed, and that the water or water vapour moves through the food and then away from it to separate the water from the vegetables. Moisture must be lost from exposed surfaces, normally to the air; it follows that particle size and geometry, and the relative humidity in the air used for drying are critical factors. Vegetables can be dried using several methods including sun drying, solar drying, vacuum drying, oven drying, and dehydrofreezing (Anderson, 1991; Fellows, 2009). Sun drying of indigenous vegetables is the most commonly used technique since time immemorial. Sun drying of foods can either be an alternative to canning and freezing or a compliment to these methods. Dried food is great in traditional cooking recipes and can save a lot of time and fuel (energy) in the kitchen during meal preparation time. Dried foods are also ideal for camping and backpacking as they take up little weight or space and do not require refrigeration.

HARVESTING AND GRADING OF INDIGENOUS VEGETABLES IN SWAZILAND

Leafy vegetables must preferably be harvested during the early hours of the day when they are still fresh. Harvesting is done by picking young leaves and tender stems individually or by pulling up the whole plant when it is about 15 to 20 cm in height for harvesting of the following leafy vegetables: *Amaranthus* spp, *Bidens* spp, *Chenopodium album* and *Corchorus* spp. In the vining leafy vegetable types like the *Momordica balsamina* and *Lagenaria siceraria*, part of the vine is cut from the mother plant taking care not to kill the mother plant. Tender pumpkin leaves (*tintsanga*) and vine tips are picked from the mother plants. Only dark green young and healthy leaves are harvested. The leaves are graded, discarding over mature, discoloured and or infected produce. Precision in harvesting techniques relates to the quality of the processed product. For example leaf harvesting of taro (*emadumbe*) must not limit the production of corms and cormels as recommended by Norman et al. (1992). The leaves are then washed with water or just dusted to remove contaminants in preparation for cooking or selling. The product for sale is packed in transparent perforated plastic bags. In the cucurbit group, the immature fruits are boiled whole and used as infant food. The mature pumpkin seed is dried and eaten roasted or pound into a powder to be used in other traditional relish dishes. This may also be used to supplement and fortify infant food

Where harvesting is done by uprooting the entire plant, the vegetables are tied in bunches and immersed in water to prevent plasmolysis and hence wilting while in the market. Precision harvesting techniques for *imbuya*, *chuchuza* and *emadumbe* have been documented (Beemer, 1939; Norman and Shongwe, 1993; Norman, 1994; Norman et al., 1992). Water can be periodically misted on the foliage to prolong shelf life of the vegetables. In *Aloe saponaria* the whole plant is cut from the base when it is about 10 to 20 cm in height and the leaves are cut off leaving the pseudo-stem which is the edible portion. Okra (*mandwandwe*), fruits are harvested when young and tender (2 to 3 months after sowing). A good test for ripeness is to harvest when pods snap in two parts easily. Pods are picked by hand or by cutting the stock with a sharp knife prior to formation of fibrous tissue.

DRYING OF INDIGENOUS VEGETABLES IN SWAZILAND

Sun food drying is one of the oldest agricultural techniques used to preserve food (Whitfield, 2000; Fellows, 2009). Leafy vegetables are rolled into thin bundles and cut into small pieces with a sharp knife. Small pieces ensure even drying. The cut leaves are then immersed in boiling or near boiling water or subjected to steam for a very short period, usually less than 3 min, to minimize loss of nutrients. This is referred to as blanching (Fellows, 2009). Blanching is a pretreatment that is used to destroy enzymic activity, mostly in vegetables, before unit operations of dehydration or freezing (Fellows, 2009). This procedure not only inactivates plant enzymes but removes more of oxalates (potentially harmful to children) and partially cooks the leaf tissues retaining sufficient nutrients and vitamins. The blanched leaves are spread thinly on a flat open surface directly in the sun.

Rock surfaces, grass mats (*titsebe*), trays, roof tops or bare concrete are commonly used for sun drying. The blanched produce is occasionally stirred to facilitate even drying. During the night the vegetables are taken indoors to prevent moisture reabsorption from dew or rain**.** Vegetables are regarded dry when they are hard and brittle. Dried leaves of *Mormodica* are sometimes prepared into powder and packaged in plastic bags for sale in local markets for use in relishes of other vegetable dishes to fortify the meal's medicinal component.

Pumpkin seeds are extracted from mature fruits and dried for storage. After drying the seeds are roasted and grounded and sieves are used to separate the husk from the flour or powder. The residue is cooked into stew or mixed with vegetables like amaranthus in relish. Pumpkin seeds also known as *pepitas* are small, flat, green and edible, with a chewy texture and having rich nutty flavour (Dhiman et al., 2009). The seeds of pumpkin are rich in protein and contain unsaturated fatty acid oils which are good for the heart and the body. The seeds of pumpkin comprise 3.1% of total pumpkin fruit weight and are rich in protein (33%), were reported to be high in sulphur containing amino acids and trypsin inhibitor (Samaha, 2002). Seeds contain Mg and Fe in addition to high levels of Zn, P, K, Se, Mn and Cu (Dhiman et al., 2009).

Okra fruits are often sun-dried whole or after slicing into pieces to preserve them. Dried vegetables are stored in baskets, pots, tins or jars (Bencini, 1991). The storage environment has to be as dry as possible in order to discourage any microbial growth and to achieve the longest shelf life possible. Dried vegetable material stored in the various containers when kept in dry conditions can have a shelf life of more than a year. A satisfactory shelf-life is dependent upon safe storage according to established environmental criteria both before and after processing (Harty, 1980). Traditionally vegetables are processed during the summer season when they are plenty and then used during winter or the dry season. With advances in modern technology, environmental control and storage facilities, dried vegetables can be stored for longer periods and can be made available all year round.

COOKING OF DRIED PRODUCT

Dried vegetables are initially reconstituted by soaking in water before cooking. Cooking is achieved by adding enough water to keep the vegetables covered and is brought to boil and simmer until sufficiently tender. Many vegetables lose their flavour during drying so garlic, onion, green pepper and or tomato are added during cooking to improve flavour. Amaranths, pumpkin leaves*, Bidens* spp, *Momordica balsamina* and *Lagenaria siceraria* are cooked by boiling in water. Peanut butter or cooking oil may be added to replace some of the lost nutrients, improve the flavour and contribute to the final taste. During cooking, a combination of amaranths, pumpkin leaves with *Momordica balsamina* or *Lagenaria siceraria* is common in Swaziland. Okra and jute (*ligusha*) are cooked with bicarbonate of soda or dry aloe leaf's ash or maize cob's ash called *umlotsa* in Siswati.

In pumpkin and other cucurbits, the fruit is either cut into cubes and boiled or the skin is peeled off and flesh is cut into small pieces and boiled and thickened with mealie meal to form a product called *sidvudvu* in Siswati and when milk is added after cooking it is then called *ludvwidvwi*. Fresh pumpkin seeds are boiled and eaten as *budzidzi*. Mature pumpkin seeds may be dried and stored in a dry place in the form, to be roasted, salted and eaten later. Dried pumpkin seed may be pound into a mealie product for use as a flavouring or food fortification.

CONSTRAINTS IN TRADITIONAL POST-HARVEST HANDLING AND PROCESSING

Non-availability of improved seed cultivars constitutes a major constraint to the cultivation and production of indigenous leafy vegetables of Africa (Adebooye et al., 2005) especially in Swaziland. In most circumstances excess vegetables are the ones which tend to be processed after fulfillment of present needs at a given moment.

In order to get surplus vegetable plant material, there is need to start with good seed, of good cultivars, use of good agricultural practices (GAPs) and use of reliable maturity indices (Reid, 2000; Aked, 2002). All the agro-climatological requirements of traditional vegetables in Swaziland need to be determined as a matter of urgency if enough plant material for processing is to be realized especially when up-scaling and use of modern technologies are considered

Even though traditional food drying and other processing techniques require little investment, the product quality is usually relatively low. When drying the vegetables are exposed to direct sunlight; the food pieces heat up and internal temperature rise without regulation. There is need to adopt automated modern methods (Fellows, 2009) and use of appropriate equipment (Parawira and Muchuweti, 2008; Masarirambi et al., 2009). Drying is therefore uneven, and often caramelized and crusted pieces are produced. Direct exposure to sun destroys colour, vitamins and flavour in the food. There is potential contamination with dust, dirt, insect infestation and contact with other pests. Where most vegetables are not cleaned before drying, the produce is heavily contaminated with bacteria and mould spores. The vegetables may also be drenched by rain or dew and may need further drying to avoid mould growth in storage (Kordylas, 1990). Drying vegetables in the sun is unpredictable (Kumar et al., 2010), unless temperatures are above 32°C and the relative humidity is low. If the temperature is too low and/or humidity is too high,

Table 2. Typical maximum nutrient losses due to processing (as compared to raw food). Source: USDA (2003).

Vitamins	Freeze (%)	Dry (%)	Cook	Cook+Drain	Reheat
Vitamin A	5	50	25	35	10
Retinol activity equivalent	5	50	25	35	10
Alpha carotene	5	50	25	35	10
Beta carotene	5	50	25	35	10
Beta cryptoxanthin	5	50	25	35	10
Lycopene	5	50	25	35	10
Lutein+Zeaxanthin	5	50	25	35	10
Vitamin C	30	80	50	75	50
Thiamin	5	30	55	70	40
Riboflavin	0	10	25	45	5
Niacin	0	10	40	55	5
Vitamin B6	0	10	50	65	45
Folate	5	50	70	75	30
Food folate	5	50	70	75	30
Folic acid	5	50	70	75	30
Vitamin B12	0	0	45	50	45
Minerals	**Freeze**	**Dry**	**Cook**	**Cook+Drain**	**Reheat**
Calcium	5	0	20	25	0
Iron	0	0	35	40	0
Magnesium	0	0	25	40	0
Phosphorus	0	0	25	35	0
Potassium	10	0	30	70	0
Sodium	0	0	25	55	0
Zinc	0	0	25	25	0
Copper	10	0	40	45	0

souring or molding may occur (Sprenger, 2005). In rural Swaziland, small grass mats (*titsebe*) are placed on rooftops of huts under the hot sun and low humidity without interference from rain, wind and domestic livestock for about 3 days.

PROCESSING LEADS TO NUTRITIONAL LOSSES

The biggest challenge in processing vegetables is subsequent nutritional loss (Conning, 1991; Leoni, 2002). A general guide of nutrient losses when food is processed has been compiled (USDA, 2003) Table 2. Actual losses incurred depend on various factors which include food type, temperature and cooking time. It can be seen that drying leads to the largest nutrient losses followed by cooking and lastly freezing (Table 2). Therefore freezing offers the best opportunity for processing food including vegetables. Availability of freezing facilities are however another challenge. Nearly all food preparation and preservation methods lead to losses. Food processors and nutritionists need to find ways of minimizing nutritional losses without compromising the health of the consumers. Alternatively, to combat losses and improve human health, food fortification may be more widely used (Honein et al., 2001; Henry and Heppell, 2002). Leoni (2002) reported on various ways of improving the nutritional quality of processed fruits and vegetables using tomato as a model.

ENERGY MANAGEMENT

Energy cost cutting is every processor's concern. There is need to design an energy-saving programme in food processing. However this is relatively hard for small processors and those who process seasonally like the indigenous vegetable processors in Swaziland and the region. There is also need to follow energy saving techniques in the processing area and in the warehouse. For example, upgrading light fixtures and motion sensors to switch off lights in low-traffic areas (Sperber, 2009). Swaziland and the whole of SADC are facing energy challenges which will worsen in future if enough is not done to generate more energy in the region. However there is a window of opportunity in the region to tap into large reserves of natural gas recently discovered in Matebeleland province of Zimbabwe.

CURRENT STATUS OF POST-HARVEST HANDLING AND PROCESSING OF VEGETABLES IN SWAZILAND AND THE SOUTHERN AFRICAN DEVELOPMENT COMMUNITY (SADC)

The aims of the food industry today, as in the past, are fourfold:

1. To extend the period during which a food remains wholesome (the shelf-life) by preservation techniques which inhibit microbial or biochemical changes and thus allow time for distribution, sales and home storage.
2. To increase variety in the diet by providing a range of attractive flavours, colours, aromas and texture in food.
3. To provide the nutrients required for health.
4. To generate income for the manufacturing company and its shareholders (Fellows, 2009).

To achieve the aims of the food industry, various methods of food processing and preservation can be used today. These methods include dehydration, cold and heat preservation, fermentation, minimal processing, food irradiation, additives and packaging in order to control conditions that prevent microbial growth such as bacteria and fungi. State of the art fruit and vegetable industries are found in SADC countries and respective standards associations are in place. In Swaziland, South Africa and Zimbabwe there is Swaziland Standard Authority, South African Bureau of Standards and Standards Association of Zimbabwe (SAZ), respectively. In Swaziland there is one big international company located in the Manzini region which processes fruits and vegetables following international standards. There are many medium and big fruit and vegetable processing companies in South Africa and Zimbabwe. However Zimbabwean companies which were on the decline over a decade have stabilized and started to increase their operations and output. In the absence or low production of Zimbabwean firms in recent years, processed fruits and vegetables were sourced from other SADC countries including Swaziland. Research is carried out by government institutions and University departments in the Kingdom of Swaziland. Recently attributes and consumer acceptance of yoghurt flavoured with non-cultivated indigenous fruits have been reported (Dlamini et al., 2009).

REGULATIONS IN FOOD PROCESSING

A requirement of food processing is to ensure that products are safe for consumption, and previously quality control systems were based on the inspection of ingredients and end- product testing, with rejection of any batches that did not meet agreed standards (Fellows, 2009). The idea is to make sure that good manufacturing practices (GMPs) are followed at all stages of vegetable processing so that in the end a wholesome and safe product is produced. Information pertaining to clean food processing coupled with energy conservation in an environmentally friendly manner has been reported (UNIDO, 1995; Anon, 2000; Hackett et al., 2005). It is necessary to process, package and store food under conditions that will minimize the potential for undesirable microbiological growth, toxin formation, deterioration or contamination. To accomplish this may require careful monitoring of such factors as time, temperature, humidity, pressure, flow rate, etc. The objective is to assure that mechanical breakdowns, time delays, temperature fluctuations or other factors do not allow the foods to decompose or become contaminated (Dauthy, 1995; Fellows, 2009). The pressures for this development came from two sources: first, commercial pressures including increasing competition between companies, and the need to conform to international quality legislation in order to access expanding national and international food markets; and secondly, product quality management systems required by major retailers (Fellows, 2009). A major shift in emphasis from national legislation to inter-national legislation occurred in 1994, when a General Agreement on Tariffs and Trade (GATT) recommended acceptance of Hazard Analysis Critical Control Points (HACCP) principles, developed by the Codex Alimentarius Commission, as the required standard for free international movement of food (Fellows, 2009). This is important for movement of processed vegetables in SADC and the rest of the world.

FUTURE PROSPECTS OF PROCESSING VEGETABLES

Seasonal availability and perishable nature of vegetables in general will require that they be processed to avoid waste and to make their products available to consumers all year round. The recognition that the intake of anti-oxidant vitamins, vitamin C and E, may have a protective role against cancer will mean that vegetables; a potent source of relevant vitamins will be in demand, but this will have to be in a form that protects the vitamin content (Conning, 1991). Fresh frozen vegetables will likely outpace other forms of vegetable processing in the short and medium term because it is in that processed form that relatively higher amounts of vitamins are retained (Fellows, 2009).

CONLUSION AND RECOMMENDATIONS

To avoid losses, timing of harvesting and processing is very important as well as sustainability of the product. Timing is important in relation to the readiness of the crop and to weather conditions. Harvesting in the cooler part of the day or night is recommended because the

vegetables will be having relatively less field heat. Vegetables should be dried on clean firm surfaces like black plastic sheets, metal platforms and grass mats (*titsebe* are used in rural Swaziland) raised from the ground to improve hygiene and drying efficiency. The produce should be dried in an enclosed space and the air in contact with it must be heated by solar radiation. This helps to reduce contamination by dust and to accomplish uniform drying of produce. There is an immense opportunity to introduce solar driers where the weather is unpredictable especially in the Highveld and Upper Middleveld of Swaziland. The various processing methods described here need to be developed further with fusion of modern day technology from time to time without losing the Swazi ethnicity food component. Which ever processing methods to be used in future for traditional vegetables, the methods have to be environmentally friendly, conserve biodiversity, mitigate climate change and be energy saving to be cost effective.

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