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Technology on Reducing Post-harvest Losses and Maintaining Quality of Fruits and Vegetables in Bangladesh

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Abstract

The post-harvest handlings of fruits and vegetables scenario is quiet unsatisfactory and mostly comprise of traditional techniques practiced by the growers, traders and processors, owing to which considerable deterioration in physical and nutritional qualities of the harvested produced in Bangladesh. It is estimated that the post-harvest loss of fruits and vegetables in the country is about 25-35% (Mia and et-al, 2008). Therefore, improvement of these indigenous practices and development of low cost new technologies through precise research efforts has now become essential to prevent the huge post-harvest losses of fruits and vegetables in view of ever increasing, demand for food and nutrition. In the development plans, considered post-production phenomenon merely as a support programme and the allocated resources for this sub-sector was only negligible amount of the total investment in agriculture sector. Under such situation, reduction of post-harvest losses has become the prime issue to increase the availability of fruits and vegetables at household level. However, the existing status of post-harvest handles including packaging, transportation, storage, processing and preservation of our harvested fruits and vegetables and to identify the loss reduction interventions. The experience in developed countries shows that the post-harvest losses of fruits and vegetables produce could be reduced by using the technology together with appropriate selection, preservation, transportation, packaging, processing and marketing. However, the developing country like Bangladesh suffer much of the post-harvest losses due to a number of factors such as lack of adequate knowledge and information, the unavailability of appropriate technology under funded research and development. However, many countries in this region possess their own indigenous, inherited knowledge in the field of post-harvest technology which perhaps has been neglected in the hurry to modernize. It is high time that the scientists and policy makers come together, discuss the issue of post-harvest technology and developed knowledge to facilitate the exchange of available technology and information between them.

Introduction

Agriculture is the predominant sector of the economy of Bangladesh. The agriculture sector creates not only large number of employment opportunities but it also provides a source of livelihood to the majority of the people of Bangladesh. The classical domain of investment on agriculture sector has undermined the role of post-harvest technology. Most of the fruits and vegetables are good sources of vitamins and minerals. So, emphasis should be given on availability and of consumption of various quality fruits and vegetables. The low consumption of fresh fruits and vegetables during off-season should be considered as a major concern from the standpoint of nutritional status of a country.

In Bangladesh, the production of vegetables is 2.7 million ton, potato 6.6 million ton and fruit is about 5.5 million ton (BBS, 2008). The present productions can hardly fulfill 50% requirements of the nation. Besides a significant portion of fruits and vegetables (25-35%) is lost due to improper post-harvest handling and processing resulting huge shortage of fruit and vegetable in the country. That is, consumption of the fruit and vegetable is almost half than the recommended doses. Consequently, vast majority of the peoples are suffering from various nutritional deficiency diseases.

Different Operations of Fruits and Vegetables after Harvesting

Harvesting of fruits and vegetables, are done manually. During harvesting maturity indices are not yet followed by farmers. To catch the high prices, farmers are generally harvest their fruits and vegetables very early when the nutritional quality is poor. Proper grading, sorting, packaging even pre-cooling is not generally done. Resulting, deterioration has been starting just after harvesting. However, the losses at the different stages of storage, grading, sorting, packaging, transport and finally marketing as a fresh produce is account for 25-35 percent. Such an enormous loss has proved a great handicap in exploiting the full potential of the increasing production of these crops and thereby improves the rural income, employment and nutrition of the population. The production and marketing of these commodities suffer from the uncertainty and instability of the market conditions and since these are grown by small and marginal farmers and handled at the retail level by poor sections, the effect is very frustrating. The infra-structural support available for the handling of about 15 million tonnes of fruits and vegetable, including potato produced annually, is too inadequate in the country. The practices currently in use in post-harvest handling and standards of material or facilities being used for storage, packing and transport are indigenous and outdated, contributing directly to the above loss.

1. Fruits

Maturity indices for mango cultivars namely *Gopalbhog*, *Khirshapat*, *Langra*, *Fazli*, *Bombai* and *Aswina* have been standardized. The optimum maturity time for harvesting;

- *Gopalbogh*, *Khirshapat*, *Langra*, *Fazli*, *Bombai* and *Aswina* were 87-91, 87-95, 97-105,112-120, 97-105 and 139-146 days respectively. The indicators applied were color, specific gravity and sinking and floating behavior of mangoes in salt solutions of different concentration. The mangoes harvested at above age were found to have 9-10 days shelf life at ambient temperature with good eating quality. All the methods are easily adoptable by the growers.
- Mangoes treated with hot water and transported through paper carton or plastic creates performed better in reducing transport losses.
- An evaporative cooler without use of refrigeration was designed and fabrication for short-term preservation of fruits and vegetables during dry season for use at farmer's level with maintaining relative humidity 90-99% and lowering temperature to an extent of 13℃ was attained. This cooler has excellent potentiality for village level storage of harvested fruits and vegetables for a short period.
- Physical injury of banana was minimum when transported in plastic crates.
- For local marketing, litchi having bunches in perforated polyethylene bags which were put in plastic crates for transporting to distant place can be maintained the shelf life for 3 to 4 days.

2. Vegetables

Leafy vegetables viz. spinach, red amaranth and Indian spinach packed in perforated packages give longer shelf life.

Processing and Preservation Technologies of Fruits and Vegetables

1. Preservation of Fruits by Steeping

Preservation by steeping in brine solution has been in practice from time immemorial. Sodium chloride acts as a preserving; conditioning, flavour enhancing and taste-improving agent in the processed and preserved foods. The vegetables preserved by steeping can be used for pickling or home cooking after leaching out the salt and acid. The fruits like green mango, olive, golden apple, *satkora* etc and vegetables like tomatoes, carrot, cauliflower , cabbage, bitter gourd, peas, mushroom and animal foods (meat, fish and poultry) could be preserved in an acidified sulphited brine solution (Ranote et al. , 1991; Pruthi et al., 1990)

Preservation of green mango by steeping

Fresh, sound green mangoes are selected, washed and removed the stalk and cut into slices by hand cutter. After removing the seed and foreign particle again they are washed with clean water, blanched for 2 min at 90^0c and cooled immediately. The blanched slices were soaked in the

solution containing 8% salt. 0.6% acetic acid. 0.02% turmeric powder and 1000 ppm SO_2 in a clean plastic drum and closed airtight and stored in dry, clean and cool place at room temperature. The self-life of the mango slices in the brine solution is 8 months. PRAN group also steeps the mango slices using the same procedure.

Preservation of olive by steeping

Fresh, mature sound green olives are selected, removed the stalk and foreign particles, washed with clean water and blanched for 3 min at 90℃ and cooled immediately. The blanched olives are soaked in the solution containing 8% salt, 0.6% acetic acid, 0.02% turmeric powder and 1000 ppm SO_2 in a clean plastic drum and closed airtight and stored in dry, clean and cool place at room temperature. The self-life of the olives in the brine solution is 8 months.

Preservation of golden apple by steeping

Fresh, mature, sound, green golden apple are selected, removing the stalk and foreign particle washed with clean water and blanched for 3 min at 90℃ and cooled immediately. The blanched golden apple are soaked in the solution containing 8% salt, 0.6% acetic acid, 0.02% turmeric powder and 1000 ppm SO_2 in a clean plastic drum and closed airtight and stored in dry, clean and cool place at room temperature. The self-life of the golden apples in the brine solution is 8 months.

2. Preservation of Fruitpulp

Preservation of mango pulp at ambient temperature

Mango is an important fruit crop in the country with a production of about 0.77 million ton (BBS, 2007). The approximate harvesting period of mango is June-August. Like most other fruit crops, mango is a highly seasonal crop. Mangoes are highly perishable in fresh form and shelf life is extremely limited to about a week only. Preservation of pulp extracted from fresh mangoes in production season can be an alternative way to make it available during the off-season. The semi-processed pulp may be used for processing into products like jam, drinks, squash, nectar etc. This type of processing may be adopted at home level and at community level. The technology is inexpensive and do not need sophisticated equipment and machinery. The small entrepreneur may come forward to adopt the technology especially in the production areas since the technologies are inexpensive and do not need sophisticated equipment and machineries.

Preservation by semi-processing consists of alternation of the biological activity in mango pulp. This is achieved through inactivation of the enzymes responsible for larger number of biochemical reactions that characterize fresh mangoes. In addition to enzyme inactivation, processing eliminates many microorganisms on or within the commodity that might cause rotting or decay so as to prolong the storage life of the product much longer than storage in fresh form.

Mango pulp after extraction should be strained in mosquito net/bamboo made sieves to remove the fibers and other coarse fractions. Heating of pulp should be done to attain temperature of 85-90℃ with addition of 100 ml water per kg pulp followed by 10 minutes heating at this temperature and maintained the acidity at 0.9% with the addition of citric acid. Sodium benzoate (1000 ppm) or KMS (1000 ppm) should be added to the pulp before 2 minutes of completion of heating. After completion of heating, the pulp filled hot into sterilized bottles followed by further processing of the filled bottles for 20 minutes in boiling water. The processed bottles are scaled and kept inverted for 5 minutes. When cool, the mouth of the filled bottles is dipped in molten wax and then the bottles are stored in a dry, clean and cool place. The size of the bottles may vary but the steps of sterilization, hot filling, inverting, waxing, cooling etc. should be rigidly followed for any size of bottle, PRAN group also preserves these pulps by mechanized process and follows the HACCP requirements.

Preservation of tomato pulp at ambient temperature

Tomato is one of the most important vegetables in our country. It is extremely perishable and can not be preserved in fresh stage. Huge post harvest losses of the harvested tomatoes may occur due to inadequacies in transportation and storage facilities which brings substantial loss to the growers and hence to the national economy. Preservation of tomatoes as semi-processing system not only takes care of the marketable surplus but also ensures the supply of raw materials for finished products like sauce, ketchup, drink etc, (Rodrigez et al., 1975; Nickerson and Ronsivalli, 1976). A simple technology of concentrating tomato pulp kept in locally available containers might be a solution to the problem of huge tomato loss during harvesting period.

Tomato pulp after extraction and strained through mosquito net/bamboo made sieves to remove the seeds and other coarse fractions. The pulp is concentrated in open cooker as per method outlined by Bhatia (1982). The pulp is concentrated to 10^0B from the initial TSS 4^0B and then citric acid0.2% and sodium benzoate (1000 ppm) are added. The pulp is filled hot into sterilized bottles followed by further processing of the filled bottles for 20 minutes in boiling water. The processed bottles were sealed, kept inverted for 5 minutes. When cool, the mouth of the filled bottles is dipped in molten wax and then stored in a dry, clean and cool place. PRAN group also preserve these pulps by mechanized process and follows the HACCP requirements.

3. Preservation of Fruit Slices in Sugar Syrups

Select firm-rip fruits (mango, pineapple, jackfruit etc.) and wash, peel and slice. Sterilize clean neutral glass containers by dipping them in boiling water for at least half an hour. Place the fruit slices in the container and then put 30-40^0B (30-40% sugar in water w/w basis with 0.05% citric acid) sugar syrup into the filled container up to the brim. Exhaust the bottle in boiling water for 7 minutes. Seal the bottle loosely and process in boiling water for half an hour. Remove the container and place it inverts position. After cooling store it preserves at room temperature.

Transportation of Fruits and Vegetables

In the rural areas, from field to hat/bazaar, the farmers are generally used shoulder slings for transportation of fruits and vegetables. However, for short distance vans (manual) and auto pickup are used. For long distance, fruits and vegetables are transported through truck. Besides roads, fruits and vegetables are also transported by boat or launch. It is very unfortunate that there is no cool chain system in transporting fruits and vegetables. Moreover, the produces are loaded in ways which promotes major problems such as inadequate transport containers, inappropriate staking, inadequate packages, very rough loading method, poor and non existence of air circulation, heating and mechanical injury to the produce. Consequence, a significant portion of fruits and vegetables is lost/ damaged during transportation.

Packing of Fruits and Vegetables

The major portion of the fruits and vegetables are sent directly to the major markets for disposal. The rest of the produced is packed loosely in bamboo baskets, gunny bags, wooden boxes. But banana and pineapple are directly transported by Truck. These consignments are exposed to the sunlight and other weather abbreviations, causing huge losses in their quality as well as total weight. However, mango fruits are packed with bamboo basket with rice straw for internal markets. Report quotes the following factors responsible for the damages of fruits after harvest:

i. Packing either too tightly or too loosely;
ii. Packing fruits of different maturity;
iii. Poor quality packing material and packing cases;
iv. Expose to sun and rain;
v. Delay in disposed, and
vi. Frequent transshipment, loading and unloading and all involving rough handlings.

The shortage of fruit boxes and its high cost has posed another problem for the marketing and distant shipment of fruits. Packing and packaging systems are important of the post-harvest chain of fruits and vegetables. Packages are made of different sizes, shopes and materials depending on the type of the fruits and vegetables and their uses. Generally low cost packages materials are used for transporting or marketing of fruits and vegetables. The materials are used as followed:

i. Bamboo baskets,
ii. Gunney bags and socks,
iii. Plastic creates,
iv. Hardboard, etc.

Standardization of package is not yet established in Bangladesh. However, it varies from 10 kg to 80 kg depending on type of fruits and vegetables as well as distance. For carrying wholesale market the trader’s prepared big bag and its size up to 500 kg capacity.

Processing Fruits and Vegetables into Pickles

Mango, jackfruit, aonla, brinjal, ber (jujube), taikar, Indian olive, and golden apple are under utilised but popular fruits and vegetables were processed into pickles with the ingredients of chilli powder, garlic, ginger, turmeric powder, mustard powder, green chilli, sugar, fenugreek powder, salt, cumin powder, mustard oil and acetic acid.

1. Olive Pickle

Ingredients

Item	Quantity	Item	Quantity
Olive	1 kg	Mustard powder	20 gm
Sugar	100 gm	Cumin powder	2.5 gm
Garlic	30 gm	Fenugreek powder	5 gm
Ginger	60 gm	Salt	50 gm
Chili powder	20 gm	Mustard oil	400 ml
Turmeric powder	10 gm	Acetic acid	15 ml

Methods of preparation

Select sound, tender and mature green olive, wash and cut the slices of the fruits. Blanch the slices for 10 minutes with 0.05% turmeric powder and then drain out the water. Fry the slices in mustard oil and then remove from the pan. Prepare ginger and garlic paste with addition of 1% acetic acid; add chili powder and turmeric powder with paste. Fry the mixture paste in left over mustard oil of the pan. Add fried olive slices, sugar, cumin power, fenugreek powder and mustard powder gradually. At last, add salt and acetic acid and cook up to complete removal of water. Fill the pickles in sterilized glass container keeping the oil layer on the top. Seal the cap airtight and store them at ambient temperature.

2. Mango Pickle

Ingredients

Item	Quantity	Item	Quantity
Green mango	1 kg	Turmeric powder	10 gm
Ginger	60 gm	Salt	50 gm
Garlic	30 gm	Fenugreek	5 gm
Sugar	100 gm	Cumin	5 gm
Chili powder	30 gm	Mustard oil	400 ml
Mustard powder	20 gm	Acetic acid	15 ml.

Methods of preparation

Select sounds, tender and immature green mango, wash and cut longitudinally in to 4 pieces and remove seeds of the fruits. Soak the pieces into 2% salt solution with 0.05% turmeric powder. After removal from the salt solution, blanch the pieces for 5 minutes at 100^0C and drain out the water. Fry the pieces in mustard oil and remove from the pan. Ginger and garlic are made into paste with addition of 1% acetic acid; add chili powder and turmeric powder with paste. Slightly fry the mixture paste in the left over oil of the pan. Add fried mango pieces, sugar, cumin powder fenugreek powder, and mustard powder gradually. At last add salt and acetic acid and cook up to complete removal of water. Fill the pickles in sterilized glass container and sealed airtight and store them in dry, clean and cool place at ambient temperature.

3. Brinjal Pickle

Ingredients

Item	Quantity	Item	Quantity
Brinjal	1 kg	Green chili	30 gm
Dry chili powder	30 gm	Fenugreek powder	5 gm
Garlic	30 gm	Cumin powder	2.5 gm
Ginger	60 gm	Salt	50 gm
Sugar	200 gm	Mustard oil	400 ml
Turmeric powder	10 gm	Acetic acid	15 ml
Mustard powder	20 gm		

Methods of preparation

Select sound long type brinjal, wash and cut into 5 cm pieces and halves them longitudinally. Fry the pieces in mustard oil and then remove from the pan. Green chillies are soaked in 4% acetic acid. Ginger and garlic are made into paste with addition of 1% acetic acid. Add chilli powder and turmeric powder with the past. Fry the mixture paste in the left over mustard oil. Add fried brinjal, green chilli, sugar, cumin powder, fenugreek powder and mustard powder gradually. At last add salt and acetic acid and cook up to complete removal of water. Fill the pickles in sterilized glass container and sealed airtight and store them in dry, clean and cool place at ambient temperature.

4. Garlic Pickle

Ingredients

Item	Quantity	Item	Quantity
Garlic bulb	1 kg.	Mustard powder	10 gm
Sound bulb	30 gm	Cumin powder	5 gm
Ginger	60 gm	Fenugreek powder	5 gm
Sugar	100 gm	Salt	50 gm
Dry chilli powder	30 gm	Mustard oil	400 ml
Turmeric powder	10 gm	Acetic acid	15 ml

Methods of preparation

Select sound garlic, peels the thin skin and wash with clean water. Fry the garlic in mustard oil and the remove from the pan. Ginger and garlic are made into paste with addition of 1% acetic acid and the mix chilli powder and turmeric powder with the paste. Fry the mixture paste in the left over mustard oil. Then add fried garlic, sugar, salt, cumin powder, fenugreek powder and mustard powder gradually to the mixture paste. At last add salt and acetic acid and cook up to complete removal of water. The pickles are then filled in sterilized glass container and sealed airtight and store them in dry, clean and cool place at ambient temperature.

5. Ber and Tamarind Mixed Chutney

Ingredients

Item	Quantity	Item	Quantity
Dry and clean ber	1 kg	Black pepper powder	1 gm
Tamarind	250 gm	Cloves powder	0.5 gm
Sugar	1.25 kg	Cinnamon powder	1 gm
Salt	32 gm	Joyfal	1 gm
Salt (Bit laban)	5 gm	Joyatri	0.5 gm
Dry chilli powder	6 gm	Salt	59 gm
Fenugreek powder	5 gm	Mustard oil	100 ml
Mustard powder	12 gm	Acetic acid	6 ml
Cumin powder	2.5 gm	Sodium Benzoate	0.75 gm
Kawlanji	8 gm		

Methods of preparation

Select ripe and dry ber, wash and then immersed in water for whole nigh. On the following day boil the ber until becomes soft. Remove the pan from the burner and after cooling separate the pulp by pressing with hand. Soak required amount of tamarind pulp in water and the remove the pulp and filter by using a bamboo sieve. Mix the ber pulp with the tamarind pulp and add required amount of sugar and the heat the mixture. Add oil, salt and spices one by one and continue the heating. When the mixture becomes concentrated and acetic acid and cook until the Brix rises to 62^0 B and the add sodium benzoate. Remove the pan from the burner and transferred the chutney into sterile glass jar.

Conclusion

Reduction of post-harvest losses has become the prime issue to increase the availability of fruits and vegetables. A significant portion of the produce is lost but it can be overcome by processing into different products. The processing methods are simple. If practical training and demonstration are provided to the rural people and if they adopt the technology, it will play a vital role in reducing the post-harvest losses of fruits and vegetables. The policy should encourage the gender groups for improving adoption of technology and reducing losses. It can also create job opportunities for disadvantages section of population.

Recommendation and Suggestion

Bangladesh has excellent environmental resources for the production of fruits and vegetables. To meet the challenges on global safety requirements Bangladesh should gradually takes necessary measures throughout the food chain from farm to table for the maintaining international quality and safety of fruits and vegetables. For this, the following recommendation and suggestion may be followed:

- Human resource development (HRD) on post-harvest technologies;
- Infrastructure development for R&D, education, extension, training, input supply, marketing, processing, storage, etc.;
- Development of supply chain for horticultural produces;
- Cooperative basis marketing should be explore;
- To make available like equipments, chemical, glassware for small scale cottage industry;
- The fiscal policy of the government should be conducive for post-harvest development;
- Interest free bank loan should be provided to post-harvest and processed sectors for sustain development;
- Priority should be given towards development and expansion of processing technologies and facilities suitable for export of processed food products;
- Exsumption/ withdraw excise duty, VAT and other taxes, etc. may encourage processed fruits and vegetables; and
- Develop industries for diversified use of agricultural products.

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