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A review on trends and approaches in post-harvest handling of pineapple

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ABSTRACT

Fresh fruit generally acts as a major source of health regulating nutrients, however, perishable natured fruits have to be maintained for quality with the combined efforts of growers, purchasers, storage authorities and retailers. Rough handling, lack of sorting and grading, inappropriate packaging, poor pre cooling and inadequate temperature regulation are still common causes of post-harvest loss of fruits and vegetables in developing countries. Pineapple fruits are to be harvested with care to avoid any mechanical injuries. In general, fruits are packed in baskets with bamboo strips or in plastic crates. While packing pineapple fruits, they are arranged in an upside down position, so that the crowns act as cushioning material preventing injuries or bruises. Storage life of fruits can be improved by proper post-harvest handling, removal of damaged parts during sorting and effective temperature modification which can help to maintain quality of produce and minimize storage loss. Apart, another practice of post-harvest loss minimization is conversion of fruits in various edible and marketable processed products.

KEY WORDS: Pineapple, postharvest loss, handling, processing.

1. INTRODUCTION

Pineapple, a non-climacteric fruit tends to be produced and utilized both as for fresh consumption and processing (Hassan and Othman, 2011). The fruits are the richest source of vitamins, minerals, anti-oxidants and phyto-nutrients that plays a vital role in maintenance of proper health and immunity level in human. Generally, the availability of pineapple in the market is seasonal and also of perishable nature. The decline in pineapple production has largely been referred due to post harvest losses that are found to have more prone to perishability (Babalola, 2008). Such losses results around 24 percent reduction with gross margin of pineapple farmers. The reasons may be attributed to cultivable area, transportation, storability and number of bruised fruits. Post-harvest loss of pineapple can also be minimized by adopting various suitable post-harvest handling practices that are presently in practice all over the world to extend its shelf life. Post-harvest handling practices *viz.*, post-harvest management, processing and value addition and waste utilization for pineapple (Hossain and Bepary, 2015). Hence, to avoid post-harvest loss, the products must be given with right postharvest management. The fruits when transported in trucks for long distance transportation, refrigerated transport is required, which slows down ripening process in turn reducing the losses. Apart, to reduce the post-harvest loss, processing pineapples into different value added product *viz.*, juice, pineapple slices RTS, jam, canned and squash can also be recommended. So, by considering those above facts, a discussion is made on trends and several approaches for certain post-harvest practices in addition to processing targeting postharvest loss minimization.

Grading: After harvest, grading based on weight is carried out. The first step is to discard damaged, undersized, misshaped and abnormal fruits from the lot. A systematic grading standard for internal markets is not available for pineapple. But for export purposes, standards fixed by importing countries are to be adhered too. According to Fruits and vegetables grading and marking rules, 2004, by ministry of agriculture department of agriculture and co-operation, criteria for grade designation with TSS level of 12°B is formulated as follows,

Extra class	:1500 gm and above
I class	:1100 – 1500 gm
II class	:800 – 1100 gm
III class	:< 800 gm (www.iica.int)

Storage: Being a highly perishable fruit, pineapple cannot be stored for long time. Usually fruits are packed and transported to destinations as early as possible. Cold storage conditions of 10-13°C and 8-10°C for mature fruits and ripe fruits respectively, at 85-90% relative humidity is also recommended. As with other non-climacteric fruit, controlled atmospheres via decreased oxygen levels (2-5%) or increased carbon dioxide levels (5-10%) gets recommended. The fruit waxes generate higher internal concentration of 5% and reduced oxygen tensions (WU, 2012). This suggests that some beneficial effect would be gained from controlled atmosphere (4% oxygen) treatments in reducing chilling injury symptom development. Modified atmosphere packaging and low temperature storage slow down the undesirable change in quality of fresh cut pineapple fruits and improves shelf life (Montero, 2008). The fresh-cut 'Smooth Cayenne' pineapple pieces can be stored at 10°C for 4 days or 0°Cat for two weeks when combined with 10% CO_2 and 8% oxygen, without any symptom of chilling injury (Marrero and Kader, 2006).

Moreover, the changes in translucency in tissues to impart colour change during storage 'f' fresh cut pineapple at 5°C under different packing conditions (Marta, 2007). Fruits of Kew variety can be stored for about 12 days at 21°C whereas along with wax coating, storage life increases to 16 days. Dipping fruits in 2, 4, 5 T (500 ppm) followed by wax coating can increase storage life to 30 days at 21°C. Other growth regulator solutions, such as NAA (500 ppm) or GA_3 (100 ppm) if sprayed on the fruits help to increase shelf life to 41 days.

Packing: Preferable fruits are packed vertically on the base by putting dividers between the fruits in the boxes with sufficient ventilation to provide quick exit of heat.

As per IPNAP (International Packing Norm for Agricultural Products) the product should be graded as per size and kept at 7-10°C temperature and 90% RH. Pineapple fruits of net weight 10 to 15 Kg are packed in the boxes of different size to prevent any injury in the shell or crown. However, the small sized pineapples are to be packed at 6 Kg for shipping or upto 20 Kg when the fruit size is large.

Post-harvest physiological disorders:

a) Chilling injury: Fruit chilling injury has been called endogenous brown spot, internal browning. The symptoms of CI includes a) wilting, drying, and discoloration of crown leaves; b) failure of green shelled fruit to yellow; c) browning and dulling of yellow fruit; and d) internal flesh browning (Lim, 1985). The control of CI symptom has been achieved by waxing, polythene bagging and controlled atmospheres as reported by Abdullah et al., (1985). He added that the selection of hybrids for higher flesh ascorbic acid concentration significantly reduces CI symptoms.

b) Flesh translucency: Flesh translucency is a physiological disorder where the pineapple fruit flesh shows water soaking symptoms (Chun et al., 2016). This occurs when the fruit shell is still green. Translucent fruit are more prone to mechanical injury during harvest, post-harvest handling (Py, 1987) and shipping as fresh fruit. These green-shell translucent fruit degreen rapidly when treated with ethephon. The translucency of the pulp can also be reduced through waxing (Chen and Paull, 2001).

c) Black rot: *Chalara paradoxa* is a facultative parasitic fungus which causes black rot in pineapple fruits where the broken peduncle remains wet, such fruits are also referred as leakers (Paull and Reyes, 1996; Reyes, 2004). It is also associated with translucency of fruits. Inoculation of pineapples with 10^4 spores/ml concentration of *C. paradoxa* followed by hot water (54 °C) treatment for 3 min had been reported to bring effective control of black rot disease for 21 days when stored at 10°C and for 48 hours under ambient condition (28 ± 2 °C temperature) as reported by Thakor and Sawant, (2008). Application of microbial antagonists can effectively reduces postharvest rots of pineapple fruits, simultaneously reduces use of fungicides. So, add to food safety, it minimizes environmental damage (Droby et al., 1991).

Inhibition of *C. paradoxa* multiplication in presence of *Pichia* isolates at 22 °C for 7 days might be attributed with competitive inhibition for space and nutrition or due to production of growth inhibition by the yeast isolate (Marta, 2007).

d) Others: Crown dehydration, sun burn, malformations, mechanical injury due to rodents and insects are another postharvest problem which induce greater loss during storage.

Processing: More than 95% of pineapple production in the world is being processed. Major share is utilized for canning. However in India, utilization pattern is different, major portion of produce is used for fresh fruit consumption. About 10% of fruits produced are utilized for processing. Fruits are processed into products such as juice, syrup, jams, squash, RTS beverages and dehydrated slices and tidbits. The percentage share of different products are pineapple slices 36-38%, pineapple juice 41-42%, pineapple pulp 6-8%, pineapple jam 5-6%, pineapple squash 3%, others 3%. Pineapple slices and pineapple juice has a major share among different forms of processing (Shrinivasan et al., 1977).

Canned pineapple: Canned pineapple slices are universally accepted product, which are used as dessert as well as for the preparation of different dishes. Medium to large sized and cylindrical shaped fruits as in Kew variety are ideal for canning. In this variety, the fruits have a length / breadth ratio of 1.5 and taper ratio of 0.96 at ripe stage which make them suitable for canning (Chadha et al., 1972).

Pineapple juice: Pineapple juice is prepared from extracts obtained by crushing pieces of fruits and proper physical separation of solids. In 1988, a processing unit to make pineapple concentrate with a crushing capacity of 2 tonnes / hour was set up by the NERAMAC (North Eastern Regional Agricultural Marketing Corporation Ltd.) at Nalkata near Agarthala in Tripura. This unit helps to utilize available fruits for making concentrate and also in expanding area and production under pineapple in the north eastern states. Shelf life of fruit juice can be enhanced through pasteurization; packing in sterilized bottles or bags; coated cans, multi laminates etc. and use of a preservative or refrigeration to develop additional barriers for preventing microbial spoilage in fermentation. The juice may be packed through hot- fill process, cold-fill process or aseptic process.

Hot fill process involves filling the canes with juice preheated to about 96°C, sealing the can lids, inverting the cans, holding at this temperature from 1 to 2 min depending on cane size and cooling to about 38°C. Cold fill process involves filling the canes with juice preheated to about 60°C, sealing the can lids, processing in continuous agitating cookers to product temperatures greater than 87.7°C and cooling in continuous, agitating coolers to about 38°C.

The aseptic process entails sterilizing the product and package separately, usually with use of high temperatures, short time heating and filling the sterile containers with sterile product under sterile conditions. Pineapple juice can be preserved as single strength after blending with other fruit juices to maintain acidity or sensory

quality. The pH should be maintained to keep the stored fruit juice acceptable for human consumption. Blending can be one of the techniques to improve, maintain storage life through pH and acidity maintenance and through preventing fermentation. Pineapple juice blended with carrot and orange juice in 60:10:30 ratio revealed it as the most effective juice blend for minimized changes with TSS 10°Brix to 12°Brix and acidity 0.97% to 1.83% (Jan and Masih, 2012).

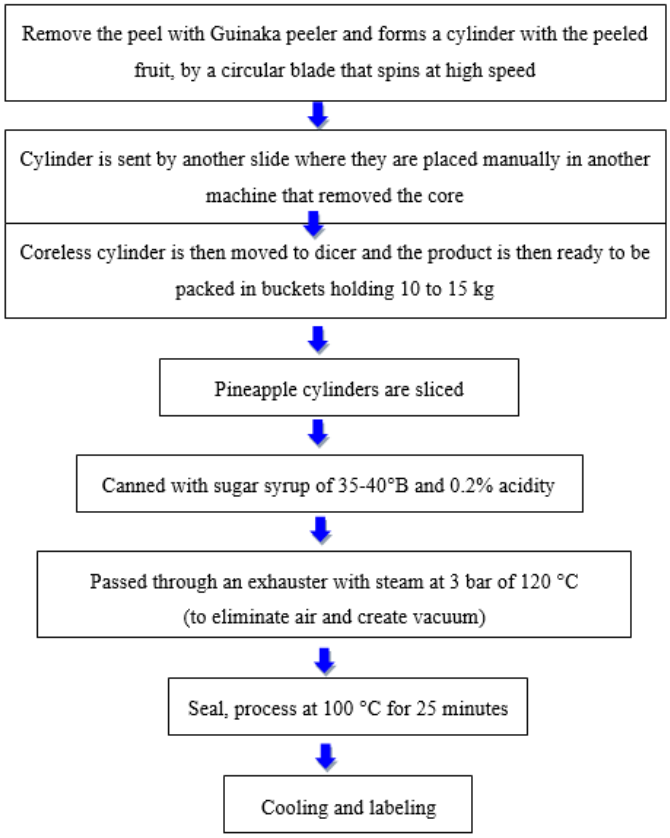
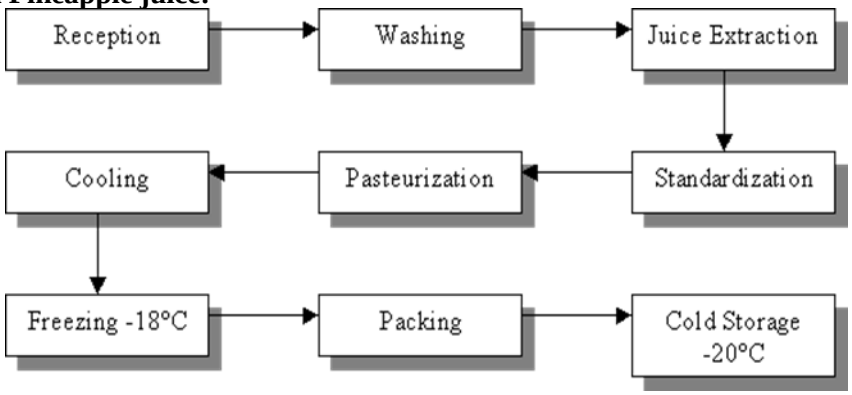


Figure.1.Canning process flow diagram

Processing of frozen Pineapple juice:



Candied pineapple: Candied pineapple is one of the most popular dried pineapple products. Osmotic dehydration of pineapple can be done by placing it in sugar solution of high osmotic pressure which produces safe, stabilized, nutritive, tasty, cost effective concentrated product (Rashmi, 2005). Soaking of pineapple slices in 40°B sucrose solution for 8 hours at 30°c gives maximum dehydration of 90%. Soaking of pineapple slices in 40°B sucrose solution for 24 hours at 60°c has maximum ascorbic acid content of 55.7 mg/100 g of pineapple. Osmotically dehydrated pineapple slices in sucrose solution of 40°B for 24 hours at 60°c is more preferred for colour, flavour, texture and taste to product (Thakor and Sawant, 2008).

Bromelain: Bromelain, a proteolytic enzyme known to derive from the juice and stem of pineapples (Gautam, 2010) tends to be widely utilized in food sector for several aspects like meat tenderization, baking processes, prevention of browning of apple juice, chill proofing beer; to increase the solubility of gelatin for drinking and in the leather tanning process. In recent times, it can be used in medical field as a treating aid for digestive problems, anti-inflammatory action after surgery, reduction of swellings with physical injuries and in cancer treatments. In cosmetic sectors, they

are used as an active ingredient to provide gentle peeling effects (Khan and Abourashed, 2010). Moreover, the stems are used as waste by-product and so, it acts as a very cheap source for production of bromelain (Tochi, 2008). Apart, it also been reported that bromelain can also be extracted from other plant parts like peel, core, stem and crown (Ketnawa, 2012). Among several parts, the highest protein contents with proteolytic activity tends to be obtained from the extracts of the crowns while lowest values from the stem.

Pineapple fiber: Among various plant parts of pineapple, leaves tends to yield a strong, smooth, white coloured glossy silk with medium length fibre of high tensile strength. Certain cultivars of pineapple are cultivated specially for fibre production and from them, 'Perolera' a pineapple cultivar highly suits for fibre extraction with its longer, wider and rigid leaves. Basically, the process of fibre extraction performed in two ways *viz.*, manual and mechanical methods. In manual practice, the ingredients are decorticated by beating and rasping and stripping, and then left to ret in water to which chemicals like 0.5% urea or diammonium phosphate (DAP) may be added to accelerate the activity of the microorganisms (Asim, 2015). The main aim of this activity is to digest the unwanted tissue and separate the fibers. The remaining material gets washed clean, dried in sun and combed. But in case of mechanical process, the machinery that used in banana fibre extraction from its pseudostem be used.

Other products: Besides main products from fruits, a range of byproducts are also available from different parts of the plants.

- Alcohol prepared from mill juice through fermentation
- Organic acids such as citric, malic and ascorbic acids are extracted
- Starch manufactured both from matured fruit and stems
- From waste materials of processing factories cattle feed known as ‘pineapple bran’ is prepared
- Pineapple cloth as ‘pina cloth’.

2. CONCLUSION

Pineapple is one of the most important fruit crop of India tends to have high perishability coupled with poor transport networks and a long term chain for marketing intermediaries, that have failed to turn into profitable venture for farmers. Pineapple often faces several problems with its post-harvest life than any other crop mainly with its physiologically active phase even after harvest and non-climacteric nature. So, an efficient post-harvest system with scientific facts can tends to extend the shelf life by adopting suitable post-harvest handling practices including proper packing and transportation. So in such sense, the reduction of post-harvest product losses is a key issue to ensure the future global food security.

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