Quality Management of Citrus Fruits an Approach by Critical Success Factors

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ABSTRACT

Citrus is third most important fruit crop in our country after banana and mango, as the demand for the fruits is also increasing tremendously. The magnitude of postharvest losses in Citrus fruits vary from 25 to 30% in India as against 5-10% in developed citrus growing countries like Brazil, USA, Australia, Spain, Italy and Israel.

Hence this study is in itself being useful in identification and analysis of the factors responsible for quality management in post harvest processing of citrus fruits. The study further envisages identification, integration of critical success factors to develop performance improvement frame work [model] for the quality management in post harvest processing and the model will be validated by case studies.

Here large number of critical factors is being identified and tabulated after reviewing the literature, which will definitely play important role in the quality management of citrus fruits. These critical factors will be analyzed using different measurement scales.

Quality management shall improve shelf life, profitability, productivity, quality and organization of industry of Nagpur mandarin fruits by suggesting new methods and processes. The identified critical factors will be subjected for refinement to derive crucial CSF's before the ultimate aim of construction of model frame work.

Key words

Post harvest processing, quality management, CSF's, storage, citrus, Nagpur Mandarin, model

1. INTRODUCTION

Citrus fruit crops have got prominent place in tropical and subtropical regions. Citrus is third most important fruit crop in our country after banana and mango, hence management of citrus fruit crop like Nagpur mandarin for future use is our topmost priority as the demand for the fruits is also increasing tremendously. These fruits are rich in energy, minerals, vitamins and dietary fiber.

There is a need to conserve such valuable wealth of nation for further utilization in improving the livelihood and nutritional security. Starting with poor quality fruit for Processing will lead to a poor quality product. Hence fruit quality management is one of the major factors in post harvest processing of fruits for both domestic and international market. The loss in market share due to poor quality is affecting the economy of the producer, consumer as well as the nation and other stakeholders.

Post harvest factors i.e. Environmental factors like temperature, relative humidity and atmospheric composition play important role in shelf life and quality of fresh fruit. Post harvest handling systems involve the channels through which harvested fruit reaches the processing facility of consumer. Genetic, climatic and cultural practices are important factors effecting raw fruit composition, post harvest-life potential and response to processing. Maturity at harvest is also one of the primary factors effecting fruit composition, quality and storage life although most fruits reach peak eating quality when harvested fully ripe, they are usually picked mature, but not ripe to minimize mechanical damage during post harvest handling.

Harvesting may also mechanically damage the fruit, the choice of harvest method should allow for maintenance of quality. Handling methods should be chosen such that they maintain fruit quality and avoid delay. Time period between harvesting and consumption or delays between harvesting and cooling, storage or processing may result in direct losses (due to water losses and decay) and indirect losses (decrease in flavor and nutritional quality).

CSF are "those characteristics, conditions or variables that, when properly sustained, maintained, or managed, can have a significant impact on the success of a firm competing in particular industry". Hence this study is aimed to identification of the factors responsible for quality management in post harvest processing of Nagpur mandarin fruits, followed by integrating the critical success factors for formulating the model, validating the model, suggesting new methods and process and will lead to enhancing the performance of the system as whole. The study is exploratory in nature and will be corroborated through case studies.

2. LITERATURE REVIEW

The quality of fruits and vegetables starts deteriorating right after harvest. Primary factors responsible for poor quality are poor pre-harvest measures, agricultural practices, unbalanced use of nutrients, insect pest and disease infestation, abiotic stresses, and postharvest handling problems like, bulk dumping of produce, pathogenic infestation, bulk packing,

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problems in transportation and storage and poor market distribution [1].

The magnitude of postharvest losses in Nagpur mandarin fruits vary from 25 to 30% in India. These losses increase the percentage of unmarketable agricultural produce and bring low return to growers, processors and traders. In the long run country suffers in terms of foreign exchange earnings. Recent advances in postharvest technology have been introduced which helps in minimizing losses and increasing fruit availability with acceptable quality. Availability of large quantities of fruit over a short harvesting period poses problems for efficient marketing and utilization, owing to perishable nature of the fruit [2].

Several techniques have been used to preserve postharvest quality of perishable fruits and vegetables which include, low temperature storage, polyethylene packaging, wax coating, and modified atmospheric storage. Low temperature storage alone has been found to be insufficient in controlling postharvest losses. This may lead to physiological disorders like chilling injury, fruit decay, postharvest peel pitting, changes in fruit texture and unacceptability towards sensory attributes [3].

The physiological disorders reduce market value of the citrus fruits and development of disorders during storage depends on management of temperature, humidity and handling practices. The curing (holding of fruit for 1-2 days after harvest), brushing during washing and wax coating and packing in cartons followed by storage at low humidity having Cumulative effect on development of brown colored, sunken breakdown of collar in Nagpur mandarin [4]. The raised collar portion of Nagpur mandarin is more susceptible to rough handling than rest of the fruit surface. Kinnow fruits do not get puffy while Nagpur mandarin becomes puffy (separation of peel from segments) during storage.

Precise chilling temperatures vary greatly among species and varieties of citrus fruits [5],[6]. The storage time plays an important role in the development of CI symptoms. Generally prolonged storage of mandarins below $8^{o}C$ has been implicated in the development of CI. Some scientists believe that hybrid nature of mandarin has made it a chilling sensitive cultivar, thus exposure to low temperature storage can severely damage the fruit but holding fruit at lower temperatures is most desired practice to maintain quality after storage and extend the marketing period [7].

In initial storage periods there is not much difference in the firmness of coated and uncoated fruit, but under prolonged storage conditions coated fruits stay firm as compared to uncoated ones [8]. Besides loss in firmness, fruits after harvesting undergo different chemical and biological phenomenon such as decay, deformation of original structure, weight loss and changes in firmness and reduction in overall appearance [9]. Some of these problems are related to packaging and transportation of fruit since modes of transport effect fruit quality.

Films and coatings have received much attention in recent years because they extend shelf-life and improve food quality by providing a barrier to mass transfer, carry food ingredients, and/or improve mechanical integrity or handling characteristics of a food [10]. According to [11], [12] Kinnow and Nagpur mandarin when stored under refrigerated storage conditions, exhibited decline in juice percentage and acidity decline juice. Sharp increase in PLW of fruit occurs at room temperature, while it is significantly lesser when fruit is waxed and stored in the cold chamber [13]. An increasing trend in the PLW of fruit during storage is a major factor contributing to deterioration in the fruit quality. Impairment of fruit appearance due to loss in weight starts after the second week of storage, turning the fruit unattractive owing to formation of wrinkles on the skin as well as leathery and unacceptable condition of the peel [14],[16].

Modified atmospheric storage has been found to be effective in controlling the rate of metabolic activities [17]. It has been found to be successful in minimizing the fruit deterioration and extending the shelf life. Flavor changes in plant material are the results of change in their biosynthetic pathways, regulatory mechanisms and volatile components which are involved in fruit flavor and aroma changes. These changes influence the postharvest acceptability and shelf life in sensory perspective [18]. Scientists and food processors have long been interested in the effect of commercial processing on pesticide residues in food. More recently have reported fate of organophosphorus insecticides and fungicides in grapes, wine and their processing products [19].

Considering all the above, it is evident that the quality management is indeed required to take care of all the factors as discussed as above to extend the shelf life and increase productivity. The factors did play vital role in the quality management aspects and critical ones shall be isolated.

The role quality management has been discussed many times by the researchers. To date, however there is no systematic attempt to organize and synthesize the CSF's responsible for quality management in Post harvest processing of citrus fruits [20]. The literature implies that as the decision makers of an organization focuses on better management of such critical factors, improvement will occur in quality performance and ultimately results in improved financial performance of the organization [21].

Over the last decades, an increasing number of models have been developed for different purposes in agricultural and horticultural sciences. Those development has been stimulated by the tremendous progress made in the information technology [22],[23]. The objective of modeling is to gain insight and explain a system or to predict the response of a system in order to manage it [24],[25].

3. METHODOLOGY

The proposed work involves extensive research on the post harvest processing aspects of citrus fruits, particularly Nagpur Mandarin fruits. This research will find the factors responsible for the quality management in post harvest processing. Data collection through various methods is being contemplated. Performance of the factors responsible for quality management and problems faced by them will form the focus of data collection. The data collected will be scrutinized and analyzed using various statistical and quantitative techniques. This analysis will help in identification of critical success factor (CSFs). The work envisages integration of critical success factors to develop performance improvement frame work [model] for the quality management in post harvest processing. The developed model will be tested in post harvest processing management aspects and few case studies will be undertaken to validate the model.

At first, models were mainly used to summarize knowledge, to gain more insight and to increase the understanding of real world phenomena. The construction of models increases understanding by forcing detailed attention to the system

structure. The model behavior gives further understanding of real system behavior and how it depends upon the elements of a system structure and the inputs. In this context, models often provide the possibility to state and test different hypothetical relationships. Sometimes theoretical based models also helped to formulate new field experiments leading to a fuller understanding of the natural system. Models are also used in many ways in managing and designing. Depending on what components are given and what has to be determined, models can be used to address three categories of questions (Table 1).

The first use of models is in performing the analysis function. Analysis can be seen in Table I as the determination of the model outputs given inputs and structure of the model which approximates the structure of the real world system. This analysis function is often called model simulation. The second function models can be used for is essential for management or control problems. Given the system structure and a set of system outputs to be achieved, the problem is to find the system inputs that will match the desired outputs. One way to achieve this goal is to carry out simulation experiments using repetitive analysis to explore alternative inputs. The input values attaining the desired outputs at best are chosen as system input. The design function is essential to determine a system structure that will achieve the outputs desired for the given system inputs. Also, in this case a model of the system can be used to solve the problem using repetitive analysis to explore alternative system structures.

Table 1.Structure of Input output model for analyzing the given problem

	Controllable input	Output	Structure
Analysis	given	'?'	given
Management/Control	'?'	given	given
Design	given	given	'?'

Depending on what components are given, models can be used to give answers to different questions and to determine the missing component '?'

A typical structural view of quality management in post harvest processing is shown in Fig.1. The system is incorporated in organizational contest to achieve the desired goals of total quality management. The quality control and assurance system in post harvest management of citrus is done through the steps as mentioned in Table 2.

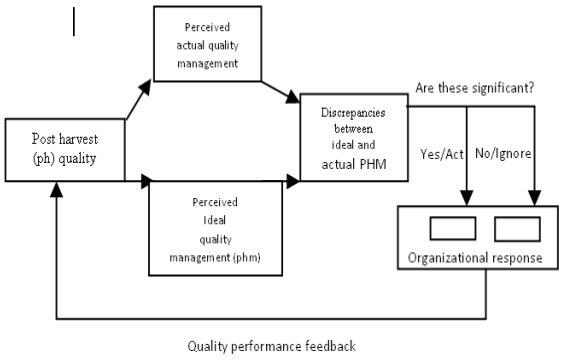

Fig.1 Structural view of quality management in post harvest processing

Table 2. Points to be emphasized for quality assurance programme in post harvest processing of citrus fruits

1.	Food industry/ Post harvest Processing company/Management	The management structure of the company must have staff for quality management with responsibilities and commitment to quality with a definite quality policy.
2.	Post Harvest Process control and quality management	The monitoring of operations in packinghouses as per the guidelines for sanitary condition of material, machines, personnel, and process-control worksheets has to be critically followed.
3.	Procurement of fruits and consumables	Quality, hygiene, and safety of fruit primarily depend on source of raw material. The grower has to comply with procedures and practices, and an inspection procedure.
4.	Labeling for Grading, packing Transportation, Storage etc.	The labels, glues, inks, and packing material used must meet international safety guidelines and requirements of the importer.
5.	Testing facilities	The field and laboratory testing facilities must be in place and regular testing of materials and fruit must be performed. The personnel should be trained and equipment and instruments must be calibrated for accuracy in measurement.
6.	Documentation and data control	The procedures followed have to be documented, process data has to be recorded in pro forma, and worksheets have to be filled out. Records of raw material quality, pesticide application records, and quality control reports have to be maintained.
7.	Quality audit	This has to be carried out by the staff other than those associated with the operation. Auditing should be done with respect to quality of material, building, and machinery. The quality system emphasizes food (fruit) safety

The critical success factors (CSF's) are identified for the integration and analysis to derive the logical frame work is in large numbers and the study is being undertaken in this regard and identified the following critical factors which are definitely play important role in the quality management of citrus fruits. The factors thus obtained are tabulated in Table 3.

Table 3.The identified critical factors in quality management of citrus fruits

Sl.No.	Critical factors	Remarks
1.	Pre-harvest factors	
	Genetic	Selection of cultivars, root stocks
	Climatic	Temperature, light, wind
	Cultural practices	Soil practices, soil type, soil nutrient, water supply, pruning, thinning, pest control, fertilizer application etc..
	Fruit maturity	Optimum taste, size, peel colour and internal quality i.e., TSS, acidity, TSS Acid ratio, Juice% etc.
	Harvesting procedures	To decrease mechanical damage.
2.	Post- harvest factors	
	Environmental factors	Temperature, relative humidity, atmospheric composition, air moment, ethylene.
	Post harvest handling procedures	Dumping, washing, sorting, sizing, ripening, inhibiting, ethylene action, cooling, storage, fruit security, in order to prevent injuries and contamination
	Time period between harvesting and consumption	Direct losses(due to water loss and decay)and Indirect losses(reduction in flavor and nutritional quality)
3.	Composition and compositional changes	Carbohydrates, Proteins, Lipids, Organic acids, pigments, phenolic compounds, volatiles, Vitamins, Minerals etc.
4.	Biological factors	Respiration, ethylene production, transpiration and water loss, physiological disorders, physical damage, pathological breakdown
5.	Pre-harvest treatments	To enhance shelf life example plant growth regulator(GA and 2,4-D sprays reduced abscission and senescence)
6.	Transportation	With shortest possible time and less injuries
7.	De-greening operations	To improve cosmetic appearance
8.	Pre-cooling operations	To remove field heat from the fruits
9.	Packing house operations	Sorting, disinfecting, washing, wax and fungicidal application, drying and size and colour grading
10.	Post harvest treatments	Chemical application, Hot water treatments, Wax and fungicide application etc.
11.	Quality control system	Quality assurance, quality control, inspection, and sanitation, Hazard Analysis, critical control points(HACCP)
12.	Acceptance versus quality in supply chain	Product related market related, economic, social, psychological issues.

The further study will be undertaken to identify more critical factors in post harvest processing of citrus fruits and will help in analyzing the complete factors to derive the crucial success factors and results in deriving a logical frame work.

4. CONCLUSION

The critical factors will be analyzed using different measurement scales for each and every quality factor responsible for quality management. Specification and measurement of the critical factors permits managers to obtain a better understanding of quality management practices and allow researchers to proceed with the task of developing and testing of quality management tools. The identified critical factors will be subjected for refinement before final conclusion.

Quality management of Post harvest processing shall improve shelf life of Nagpur mandarin fruits, will lead to improved profitability, productivity, improved quality and improved organization of industry of Nagpur mandarin fruits by suggesting new methods and processes.

The study will lead to formulating a model for quality management in post harvest processing of Nagpur mandarin fruits. This study will also help the researchers in identifying future needs and act as a database to further enhance the performance of the systems as a whole.

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Classical Biological Control of Asian Citrus Psyllid, Diaphorina citri (Hemiptera: Liviidae), in California.Â These factors, along with high phenotypic plasticity and broad ecological tolerances may also facilitate pestiferousness in agricultural and native ecosystems (Lodge et al. 2006; Davidson et al. 2011). In turn, problems associated with the introduction of alien species may be immediate and severe or populations could undergo a prolonged â€œlag periodâ€ before reaching pest status (Crooks et al. Search terms included Citrus, Citrus aurantifolia, Citrus sinensis, Citrus paradisi, Citrus fruits, Citrus fruits extract, cancer, neoplasm, neoplasia, tumor, metastasis, carcinogenesis, proliferation. The last search was performed on March 16th, 2017.Study selection: Study selection and systematic review were carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.Â Background: During the last decades, a huge body of evidence has been accumulated suggesting that Citrus fruits and their juices might have a role in preventing many diseases including cancer. Objective: To summarize the numerous evidences on the potential of Citrus juices and their extracts as anticancer agents.