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ON
Opportunities for Value addition in Horticulture for Hortipreneurs

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COMPENDIUM

EDITORS

Dr. V. K. Jayaraghavendra Rao
Dr C K Narayana
Dr. R. Venkatta Kumar
Dr. Shahaji Phand
Dr. K Sai Maheshwari
Dr Vishal Nirgude

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Opportunities for Value addition in Horticulture for Hortipreneurs

Edited by: Dr. V.KJayaraghavendra Rao, Dr. R Venkattakumar, Dr. C K Narayana, Dr. Shahaji Phand, Dr.K Sai Maheshwari, & Dr. Vishal Nirgude

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This e-book is a compilation of resource text obtained from various subject experts for the Collaborative Online Training Programme of ICAR- Indian Institute of Horticultural Research, Bengaluru & MANAGE, Hyderabad on Opportunities for Value addition in Horticulture for established Agripreuners under ACABC, from 14-16 July 2021. This e-book is designed to educate extension workers, students, research scholars, academicians related to Horticulture and extension methodologies for promotion of hortipreneurship, for value addition, and doubling farmers' income. Neither the publisher nor the contributors, authors, and editors assume any liability for any damage or injury to persons or property from any use of methods, instructions, or ideas contained in the e- book. No part of this publication may be reproduced or transmitted without prior permission of the publisher/editor/authors. Publisher and editor do not give warranty for any error or omissions regarding the materials in this e-book.

MESSAGE

National Institute of Agricultural Extension Management (MANAGE), Hyderabad is an autonomous organization under the Ministry of Agriculture & Farmers Welfare, Government of India. The policies of liberalization and globalization of the economy and the level of agricultural technology becoming more sophisticated and complex called for major initiatives towards reorientation and modernization of the agricultural extension system. Effective ways of managing the extension system needed to be evolved and extension organizations were enabled to transform the existing setup through professional guidance and training of critical manpower. MANAGE is the response to this imperative need. Agricultural extension to be effective demands sound technical knowledge to the extension functionaries and therefore MANAGE has focused on training programs on the technological aspect in collaboration with ICAR institutions and state agriculture/Horticulture universities, who have expertise and facilities to organize technical training programs for extension functionaries of the state Horticulture department.

In India, the Horticulture sector contributes the nutrition security, and steady income in the case of perennial crops, utilizing the marginal lands which otherwise could not have been used for demanding crops, their contribution to the nutrition security of the society cannot be discounted. The export earnings from different horticulture products and their value addition are also noticeably contributing to the National income. Amongst the Horticulture farmers, the horticulture farmers suffer from glut and, during corona, the direct marketing channels are yet to be structured and poor marketing facilities has led to their low income. These raised the issue of sustainability of horticulture production and marketing in spite of the high demand for horticultural products. In this context, the value addition in Horticulture ensures profitability and sustainability.

It is a pleasure to note that, Indian Institute of Horticultural Research, Bengaluru and MANAGE, Hyderabad is organizing a collaborative training program on Opportunities for Value addition in Horticulture for established Agripreuners under ACABC, from 14-16 July 2021, and coming up a joint publication as e-book on Opportunities for Value addition in Horticulture for Hortipreneurs, as an immediate outcome of the training program.

I wish the program be very purposeful and meaningful to the participants and also the e-book will be useful for stakeholders across the country. I extend my best wishes for the success of the program and also I wish Indian Institute of Horticultural Research, Bengaluru many more glorious years in service of Indian agriculture and allied sector ultimately benefitting the farmers. I would like to compliment the efforts of Dr. Shahaji Phand, Center Head-EAAS, MANAGE and Director, Indian Institute of Horticultural Research, Bengaluru for this valuable publication.

(P. Chandra Shekara)
Director General, MANAGE

FOREWORD

Although Indian Horticultural production has surpassed Agricultural production at a record 326mt last year ending 2019-20, and In the financial year 2020, fresh fruits were the leading horticulture product exported from India based on value of over 54 billion Indian rupees. Over 819 thousand metric tons of fruits were exported that year from the south Asian country. farmers could not get the expected prices and therefore the income increases are yet to be realized against the potential. Value addition in Horticulture through the transfer of Horticultural technologies to develop hortipreneurship is a focussed area that contributes to value addition, increase in income, and export-oriented income through diversification, handling storage, processing, and packing. The Indian Institute of Horticultural Research, Hessaraghatta Bengaluru has commercialized more than 300 technologies, through technology transfer, hortipreneurship, and development of value-added products for domestic and export through training, business incubation, and acceleration These products and their associated technologies should be communicated to a larger audience.

In this context, ICAR-IIHR is conducting a free online training program on "Opportunities for Value addition in Horticulture for established Agripreuners under ACABC, from 14-16 July 2021" sponsored by the National Institute of Agricultural Extension Management (MANAGE), Hyderabad for the Extension officials of state/central horticulture departments, Horticulturists, faculty of SAUs/KVKs/ICAR institutes, etc. during 14-16th July 2021 through Cisco Webex Online Platform. The lectures of this online course are exactly designed to expose the participants to various aspects of hortipreneurship and value addition opportunities through extension methodologies tailormade for Horticulture technology transfer which is a different game per se, both through virtual and Real-time modes of technology delivery and dissemination. I hope that the participants from different parts of the country would be immensely benefitted from this online course by interactions with expert resource persons selected for the training. I have no doubt that the course will be intellectually rewarding to the participants.

I would like to take this opportunity to congratulate MANAGE and ICAR- IIHR for their fruitful collaboration towards benefits to the farmer community, and stakeholders in Horticulture. I also congratulated course directors and course coordinators for their untiring work, and high level of enthusiasm.

(BNS MURTHY)

Director, ICAR-IIHR

PREFACE

This e-book is an outcome of the collaborative online training program on "Opportunities for Value addition in Horticulture for established Agripreuners under ACABC, from 14-16 July 2021" The editors' main aim is to provide insights to hortipreneurs regarding value addition opportunities in horticulture right from production to value addition and export. The hortipreneurs should know the entire value chain of Horticultural produce. They can be benefitted from getting knowledge of various Horticultural technologies and products. The current information in product development will help them to do well in Horticulture business

The editors felt that all the experience of resource persons of this training should be clubbed together to form a unique proposition on value addition in Horticulture and their opportunities thereof. Horticultural science is subjects which have different magnitudes, scales, and directions. Coordinating both subjects from a common point was indeed a challenging job. The experts and resource persons in Horticultural science contributed immensely and tirelessly to develop various chapters of this e-book in a very short period. They all deserve to applaud. The editors extend their sincere thanks to all the experts who have contributed valuable time and put sincere efforts to produce this e-book.

The editors also thank MANAGE, Hyderabad for the financial support to the training program. The editors express gratitude towards the director, ICAR-IIHR for the constant encouragement for this training and e-book creation for the participants. The editors hope that this e-book will help participants as well as other extension people across the country to gain valuable information on horticultural production, handling, storage, processing, and value addition for domestic and export markets

Editors

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Hortipreneurial Dynamics

*V.K.JAYARGHAVENDRA RA0

Horticulture value chains are facing growing consumer expectations for variety, food safety, and security. Most horticulture supply chains operate in a push- based approach rather than demand-driven or pull-based, which leads to a mismatch between demand expectations and supply-side capabilities. In developed markets in, India, horticulture supply chains are experiencing excess capacity, lack of differentiation, and lower prices and ultimately leading to glut. Last year the 326 mt of Horticultural production for the year ending 2019-20, Emerging market challenges are more related to supply shortage, lack of product variety, and safety and quality of the produce. All this leads to low income among hortipreneurs, who lack visioning and strategy for production and value addition opportunities in horticulture.

This mismatch between expectation and supply calls for restructuring of the horticulture production chain from a push-based system to a combined push-pull system. A combined push-pull approach ensures that market dynamics are taken into consideration when it comes to making decisions about technology adoption and production capability. The Indian Institute of Horticultural Research at Bengaluru has a basket of 300 plus technologies for commercializing and licensing to hortipreneurs, which includes varietal, production technology, crop protection, and post-harvest technology both handling, storage, and processing. Hortipreneurs in India agree that achieving the optimal push-pull requires tailored business models in Horticulture through a sound DPR(Detailed Project Report) and tailormade Business plans on many technologies at different scales are developed at IIHR and Hortipreneurs, will have to take advantage of it through our BPD(Business Planning and development unit. Hoe the hortipreneur approaches the business opportunity with vision and strategy has to scout for a genuinely differentiated business model. To facilitate the right interpretation and understanding we define the critical components that constitute a business model, Entrepreneurial dynamics, psychology of an entrepreneur, his motive, the strength of his achievement motivation coupled with the right business model and technology holds the key for a profitable horticultural entrepreneurial venture. Changes in the business environment along with innovation procedures bring about new situations that need to be solved not just effectively but with care and in an original way and finally with added value for the customer, e.g., Probiotic Juice, novel packing in horticultural produce and processed products. In spite of a record horticultural production, the Hortipreneur is not able to increase his income, because only selling fresh fruits and vegetables he has to market in a buyers' market as the production is more than the demand and supply is very huge leading to glut. So the only solution for achieving a higher income is value addition of horticulture products, and tapping the new opportunities emerging in Horticulture so that the hortipreneur is abreast with the latest Knowledge and his return on investment is ensured, enjoy through diversification and value addition and simple selling of fruits, vegetables, and flowers alone cannot increase the income of a Horticulture farmer.

Hortipreneurship is one of the key drivers for economic development. During an economic crisis, the importance of entrepreneurship development increases. Entrepreneurship has been linked to improved growth, increased wealth, and quality of life. In developing countries like India, planning, and implementation for the development of entrepreneurial programs are essential for raising the living standard of the vast majority of the backward regions because of their over-dependence on agriculture for employment Thus, entrepreneurship development appears to be the best substitute to find employment opportunities, income generation, poverty reduction and improvements in nutrition, health and overall food security in the national economy. And avoiding glut experienced in fresh fruits, vegetables, and flowers in the market, and value-added product marketing holds the key.

Agriculture is considered as the main economic activity which adds to the overall wealth of the country. In the past, agriculture was seen as a low-tech industry dominated by numerous small family firms, which are mostly focused on doing things better rather than doing new things. However, over the last two decades, this situation has changed dramatically due to economic liberalization and a fast changing society. Agricultural companies have to adapt to the erratic demands of the market, varying consumer habits, triggered by globalization and exposure, stringent environmental regulations, new requirements for product quality, food safety sustainability, and so on. These changes have opened up new opportunities nd challenges the way for new entrants, are innovation, and portfolio Hortipreneurship. Farmers,

researchers, agricultural businesses, and governments have recognized this and emphasized a more competitive Hortipreneurial environment.

The Hortipreneurial skills of farmers need to be developed and addressed by all stakeholders in the agricultural socio-economic network especially ICAR IIHR has been doing this in Horticulture production, value addition, diversifying networking, and strengthening the supply and value chains in Horticulture. There are various strategies available to farmers for survival and changing their economic environment which results in business growth. For example, the farm enterprise may be expanded through tourism or other forms of non-agricultural business, or by integration of the value chain by engaging in food processing, direct marketing in times of CORONA and Post CORONA, or through organic production of Horticultural products. The social and economic environment of farming should not be underestimated when studying and promoting the development of entrepreneurial skills. Entrepreneurship can only be improved when the entire agricultural socio- technical network is involved in the process,

The business management skills, availability of funds, market availability and accessibility, and technology adoption are the weak links in Hortipreneurship. Therefore triggering the minds of the hortipreneurs in spite of the low success rate in successful Hortipreneuring(around 5 percent) is the key to refreshing the existing hortipreneur and the emerging hortipreneur into new vistas and opportunities in the horticulture value addition sector, a low turnout is not a testimony to stop the Horticultural entrepreneurship promotion per se. the product or service may or may not be new or unique but value must be inculcated by the entrepreneur. Entrepreneurship in Horticulture can also be defined as the formation of a novel economic organization for the intention of growth under risk and uncertainty in Horticulture, employment generation, poverty reduction, improvements in nutrition, health, and overall food security in the national economy, especially in rural areas. In the face of growing unemployment and poverty in rural areas, there is the urgency of entrepreneurship in Horticulture for more productivity and profitability.

Psychology of a Hortipreneur

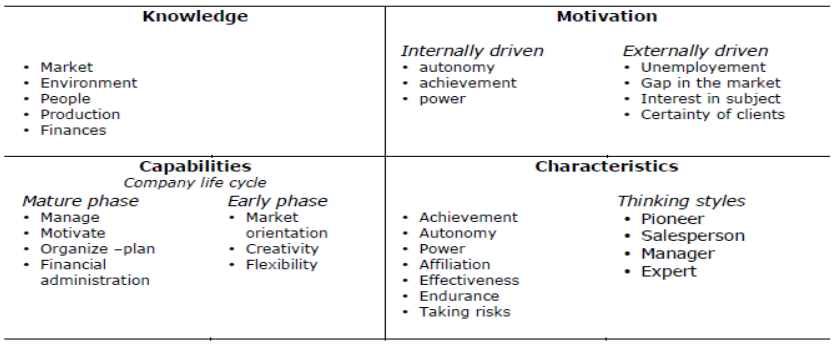
A hortipreneur when he starts a venture may not have the full feasibility ratios in mind about the venture, so need to upgrade from scratch and make his decisions data-driven and not emotion-driven, do thorough homework, browse various websites, discuss with experts, and practice hortiprenuers, and then come to various business decisions of production, marketing, etc. and value packing is another dimension to reduce costs without compromising on the utility of packing.

The Hortipreneur should be optimistically ambitious and go slow through a pilot-scale and upscaling after the required break-even, and not jump into venturesome decisions. The Hortipreneur should have an experimental mindset, base his decisions on data, and have a reasonable amount of flexibility. But most hortipreneurs or entrepreneurs are ambitious and emotional, the research indicated, and they jump to conclusions in haste and hence suffer losses and mishaps, this needs to be rectified.

Entrepreneurial Competencies

The entrepreneurial competencies are a combination of various dimensions of a hortipreneur, like Knowledge, motivation, capabilities, and personal characteristics, the combination of all these affect the entrepreneurial outcomes.

Figure 3: Entrepreneurial Competences



Knowledge about market, environment, people customers, production processes of competitors and finances for the technology are important besides intrinsic motivation, autonomy and achievement nd power dimensions need to be satisfied for the hortipreneur, and a hortipreneur requires different skills at different stages of the product life cycle, like in early introduction and growth stage he requires capability to target his product, position the product through a market orientation strategy with creativity and flexibility of pricing to capture the markets to increase the market share and market growth, while t the maturity stage of the product he needs to manage his business as a cash cow and maintain his market share and growth, and his market position and not be subject to vulnerabilities of the market, for this, he needs to plan, organize, and have a good financial administration and some of the characteristics he needs to pick up or inculcate to be in the business include, endurance, risk taking, affiliation with success ventures, and gain control on power and autonomy of his business and not to depend on others for the success and maintenance at initial stages, his thinking style must be of pioneer, salesperson, a manger and an expert till such time the business establishes.

Conclusion

Hortipreneur is not born but made through systematic training inculcating good corporate practices, and sound business skills, he needs to do a thorough SWOT analysis of his strengths, and weaknesses and improve upon, by also tapping the opportunities, and minimising the threats for his business, and he should scan the PEST(Political, Economic, social and technological) changes occurring on a daily basis to inculcate the changes and corrections to take his business forward on a sound profit and sustainability of business, therefore hortipreneurial dynamics to conclude is an adaptation strategy of an hortipreneur to tap the emerging opportunities in Horticulture while visioning the future through systematic inventive thinking, and making required changes from the hortipreneur side, in terms of Knowledge, and the required skills, and also develop the required attitude by behavioural adjustments from self and the enterprise changes to inculcate, profitability and sustainability in the long run, he half hearted, hortipreneur, who puts half efforts without full mind and dedication, cannot expect any fruits, whilst the dedicated hortipreneur, who puts all the elements in a systematic way is bound to reap the benefits of his efforts and grow into a big business.

Role of Farmers Producers Organizations (FPOs) in Tapping Value Addition Opportunities in Horticulture

R Venkattakumar, Principal Scientist and Head (I/C), Division of Social Sciences and Training, Indian Institute of Horticultural Research (IIHR), Bengaluru, Karnataka

Introduction: The wide range of agro-climatic and agro-ecological situations that prevail in the country supports the cultivation of a variety of horticultural crops. The horticultural sector in the country is experiencing phenomenal growth as far as to increase in area, production and productivity are concerned. However, there is a lot of opportunities for enhancing productivity, post-harvest processing, value addition, hi-tech horticulture, precision farming, etc. Hence, it will be enterprising to develop this sector, especially among the marginal and small farmers, so that that it will help them double their income from the farm sector. While considering the situation of small and marginal farmers, a sizable portion of whom are under distress situation, due to possession of fragmented land holdings, lack of adequate knowledge and lower level of adoption towards improved production technologies, low productivity, which resulted in lack of surplus produce for processing, lack of adequate price for the product due to operation of market intermediaries, etc. Hence, there is a need for a vibrant structure that can organize small and marginal farmers based on their commodities and enable them to move across various agricultural operations.

Amidst such scenario, the concept of 'producers company' emerged, through which, the primary producers who either produce or operate the commodity can initiate and run a company for production, processing, value addition, marketing, and export. By considering the scope of this concept, the already existing cooperatives and other farmers organizations are also allowed to transform themselves as 'Farmers Producers Organizations (FPOs)', so that they can avail the benefit of the Government of India, especially through organizations such as Small Farmers Agribusiness Consortium (SFAC) and National Bank for Agriculture and Rural Development (NABARD) (Venkattakumar et al, 2019). The concept of FPOs has been promising, as it has provisions for organizing the small and marginal farmers and performing collective agricultural operations. Hence, the concept has been promoted among all the sectors of agriculture and rural development. However, it is imperative to study the performance of such FPOs in terms of their operational mechanism, challenges faced, critical success factors experienced, and impact in terms of providing various services to the farming community. This paper presents case studies on the performance of two FPOs and recommendations proposed based on the performance of nine FPOs, who were studied under a research study conducted by the Division of Social Sciences and Training, IIHR, Bengaluru for their effective performance.

Performance of Ayakudi Guava and Fruits Producers Company Limited (AGFPCL), Dindigul, Tamil Nadu

The producer members dealt with crops such as guava, sapota, mango, amla. The Company was established during 2009-10, facilitated by Tamil Nadu Agricultural University (TNAU) under National Agricultural Innovation Project (NAIP). There were 750 members, including 100 women, representing 25 villages and 35 Self-Help Groups (SHGs), registered under Small Farmers Agri-business Consortium (SFAC), with the primary objective of "enhancing profitability of farmers through value addition and market linkage". The majority of the members were old, had middle-high level of education, had 6 years of membership in the company, had medium farm size (5-10 acres), all are irrigated, had an annual transaction up to Rs. 1,60,000/- with the FPO. The FPO has established its own by-laws, with a share value of either Rs.5000 or Rs.1000/-.

A B Sc (Agri.) graduate was engaged by the FPO for advisory services; Off-campus training programs were organized in collaboration with TNAU researchers; Planting material, high-density planting, ultra-high density planting were the technologies introduced by the FPO; Fertilizers, PP chemicals, micro-nutrients, bio-formulations, farm implements, etc. were supplied by the FPO through wholesale price; Members were promoted to involve in value addition of guava fruits (juice from guava) and further marketing; Market outlet was established for the sale of value-added products of producer members.

The prevailing caste system, obtaining license recognition from development departments, obtaining matching grants by SFAC, establishing links with financial institutes, running business activities (due to lack of experience), and arranging for dovetailing of Government schemes were the challenges faced by the FPO.

Built-in trust, crop advisory, effective input distribution, the introduction of technological interventions, and facilitating marketing were the critical success factors of the FPO. The effectiveness of the FPO performance towards social and economical indicators, as perceived by the producer members is given in Table 1, whereas that of the perceived overall performance effectiveness is given in Table 2. The organizational pattern of the FPO is given in Figure 1.

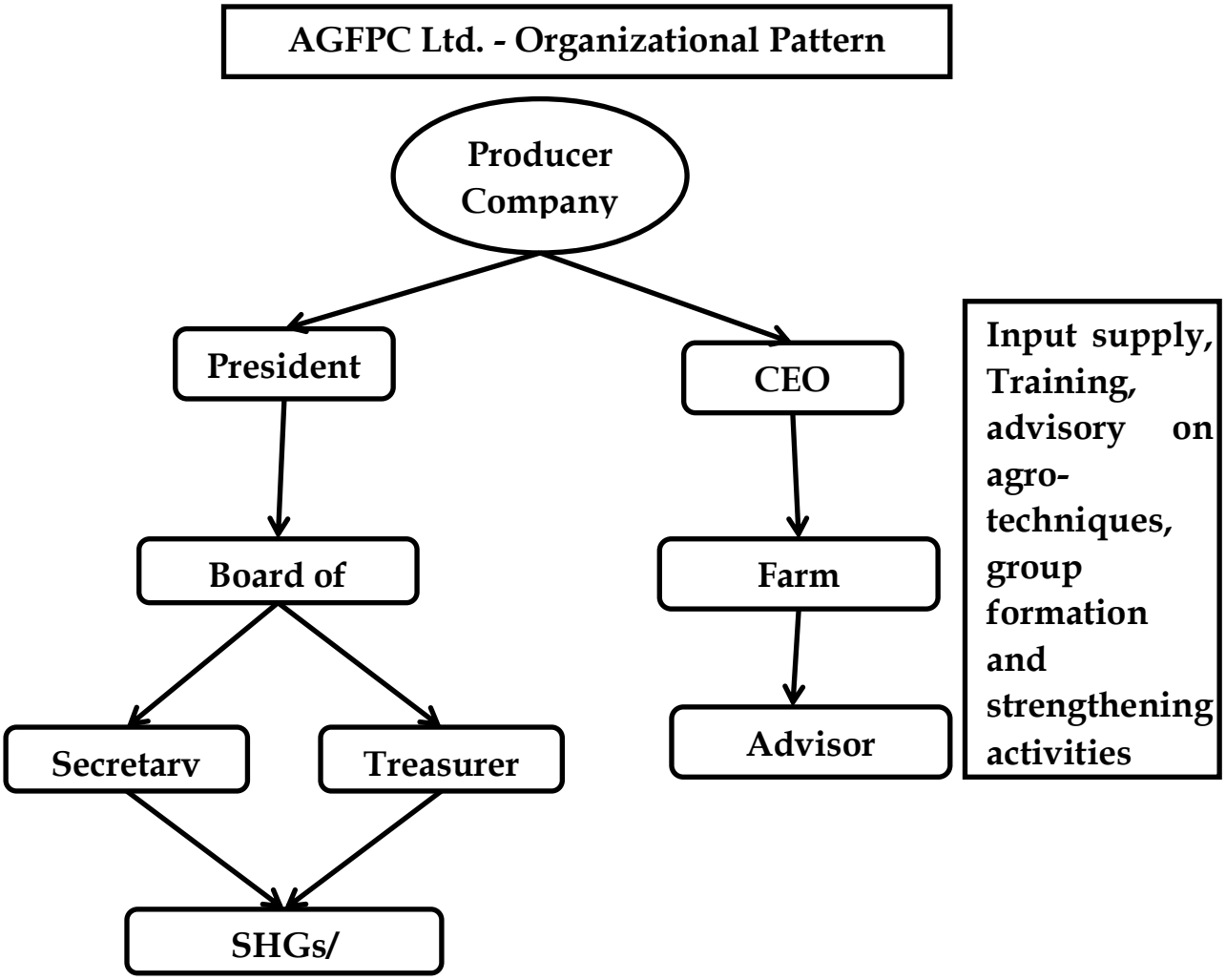


Fig. 1. The organizational pattern of AGFPCL

Performance of Raigod Navachaitanya Jyothi Producers Company Limited (RNJPCL), Zaheerabad, Telangana

This FPO was established in 2011-12 with the support of SFAC, subsequently supported by Azim Premji Philanthropic Institute (APPI). There were 2235 producer members with 250 women members, representing 10 villages and 145 SHGs. The FPO was facilitated by Vrutti, a Bengaluru-based Non-Governmental Organization (NGO), with a primary objective of "Creating sustainable livelihood opportunities through providing on and off-farm activities". The majority of the producer members were middle-aged, either middle-high school-educated or illiterate, had marginal farm

size (up to 2 acres), all were irrigated. The members had 5 years of membership with an annual transaction of Rs.25,000-50,000/-. The FPO established its own by-laws, with a share value of Rs.500/-.

The FPO gives seasonal advice through Professor Jaishanker Telangana Agricultural University (PJTAU) and the State Department of Horticulture (SDH) on integrated nutrient management, pest and diseases management practices of vegetables. Introduced technologies related to onion and tomato. Supply of seeds, plant protection chemicals, fertilizers at wholesale price through sales license has been done by the FPO. A direct market link through 'Wal-Mart' of Hyderabad was done. Linking with crop loans and insurance (State Bank of Hyderabad, Andhra Bank, Syndicate Bank), establishing storage structure with the support of National Cooperative Development Corporation (NCDC), providing information services through Mobile App and dovetailing schemes of Departments of Agriculture and Horticulture, Government of Telangana were the other extension services offered. The FPO had a strong organizational structure (Fig. 2) with SHG coordinators at the village level, business development service providers at the Mandal level, and cluster coordinators at Divisional Level.

Breaking of the loan-based relationship between farmers and dealers, delayed distribution of inputs while dovetailing government schemes, prevailing caste system, rapport building, and arranging collateral security for loans for producer members were the challenges faced; while built-in trust, strong institutional structure, livelihood promotion by farm and off-farm activities, crop advisory, credit and crop insurance support, effective input distribution, the introduction of technological interventions were the critical success factors of the FPO.

Table 1. Perceived Effectiveness* of Producer Members against Social and Economical Indicators

Social Indicators		
Indicators	**Response - AGFPCL**	**Response - RNJPCL**
Farm mechanization	9.0	4.2
Input availability	9.0	6.5
Access to credit	4.4	6.4
Cropping intensity	9.0	7.0
Productivity of commodity	9.0	7.0
Profitability	9.0	7.0
Assured buy-back	4.8	6.5
Assured market price	9.0	5.4
Value addition linkage	4.5	5.0
Economic Indicators		
Indicators	**Response - AGFPCL**	**Response - RNJPCL**
Knowledge on production technology	9.0	7.0
Adoption towards production technology	9.0	7.0
Access to training	9.0	7.0
Input purchase	8.0	5.6
Output marketing	4.3	5.6
Reduced social conflicts	6.5	5.0
Benefits for backward people	7.6	6.9
Benefits for women	7.3	6.9

* Rating against a continuum ranging from 1- Strongly disagree to 9 - Strongly agree

Table 2. Perceived Effectiveness* of Producer Members towards Overall Performance Indicators

Overall Performance Indicators	**Response - AGFPCL**	**Response - RNJPCL**

Member cohesiveness	4.7	5.0
Avoiding domination	4.6	5.0
Transparency	4.8	5.0
Heterogeneity	4.8	4.9
Eliminating political intervention	4.6	4.7
Participation in decision making	4.6	4.5
Selection/ election	4.8	3.6
Transparency in financial transactions	4.8	2.0
Adhering to rules	4.8	0.0
Record maintenance	4.6	0.0
Business activities	3.8	0.0
Ways of raising funds	3.7	0.0
Fixing the reserve funds	0.0	0.0
Sharing the profit	4.7	0.0
Dovetailing of Government schemes	0.0	0.0

* Rating against a continuum ranging from 1- Strongly disagree to 5 - Strongly agree

AGFPCL-Ayakudi Guava and Fruits Producers Company Limited; RNJPCL-Raigod Navachaithanya Jyothi Producer Company Limited

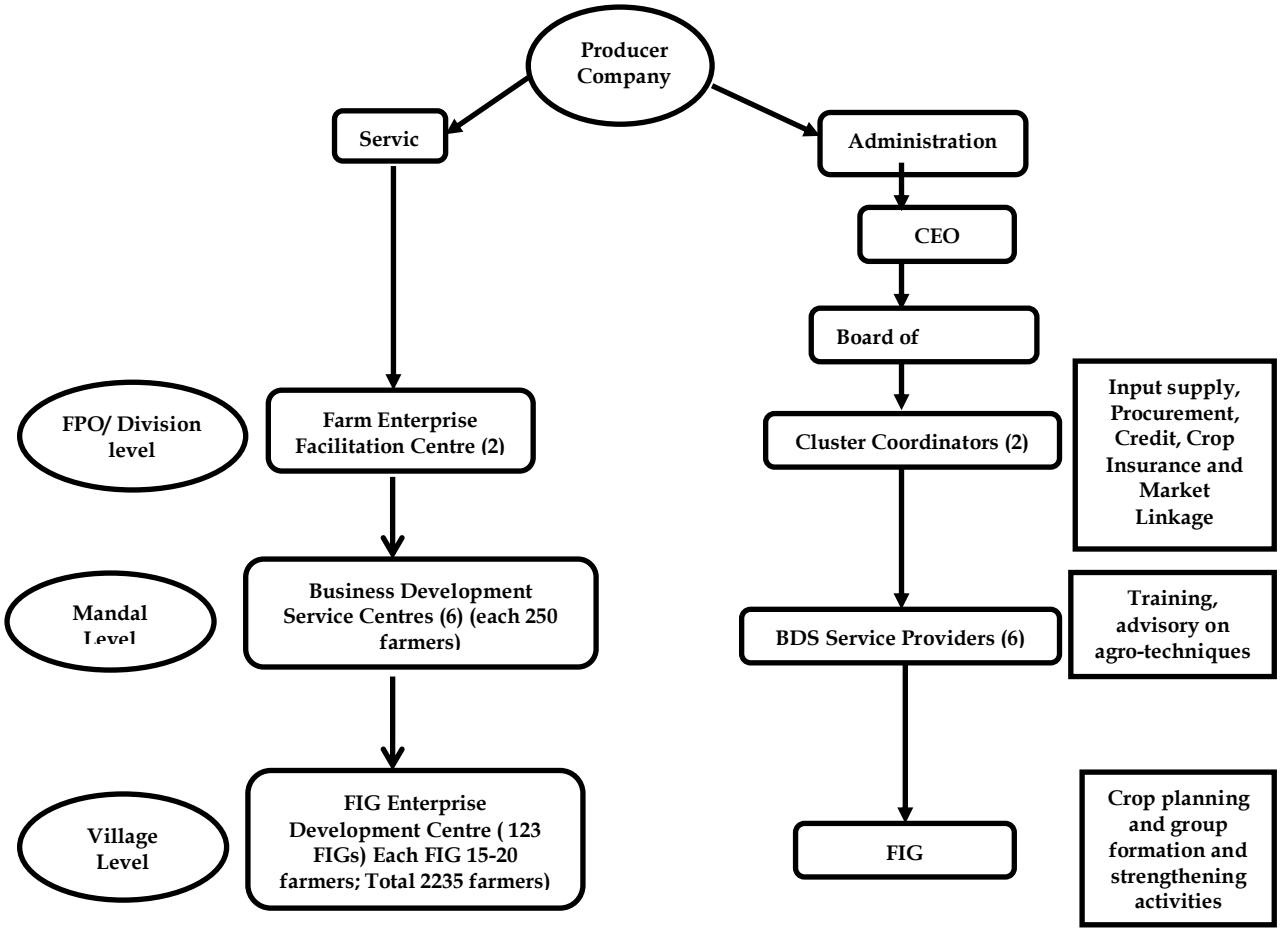


Fig. 2. The organizational pattern of RNJPCC

Strategies recommended for the effective performance of FPOs

The FPOs, in general, have a simple organizational pattern. It is headed by an elected President, who is the chief of the decision-making process, also advised by a set of regularly elected boards of Directors (10-15) including women representatives. Apart from the Board, the company has an elected Secretary. This honorary body is adequately supported by an appointed staff such as a Chief Executive Officer (CEO). The appointed staff, in general, facilitates the producer members through input supply, arranging either on-farm or on-campus training, advisory on agro-techniques, group formation, strengthening activities, etc. However, the FPOs lack an adequate number of appointed staff at various levels such as a village, block/ taluk, for extending broad-based services to the producer members. The general structure of FPOs with needed interventions is depicted in Fig.3.

Recommendations for structural reforms

Chief Executive Officer

- He should be a Management Graduate from a reputed business management institute so that they can manage the FPOs in a business mode.

Agricultural Officer/ Field officers

- FPOs may appoint agricultural or horticultural officers to take care of the agro-advisory, capacity building, supply and value chain guidance, field diagnosis and advocating solutions, etc.
- Their qualification may be fixed at the graduate level or diploma level in agriculture, horticulture/animal husbandry, etc.

Input distributors/ managers

- Companies may appoint input distributors/ managers for involving agri-input supply, output procurement and monitoring, and other supply and value chain activities of the FPOs
- Their qualification may be fixed at the graduate level or diploma level in any field.

Village extension workers

- NGOs may be supported by SFAC/NABARD to appoint extension workers to work with farmers of companies for social engineering, training and capacity building, concept promotion, awareness creation, etc.
- Their qualification may be fixed at the graduate level or diploma level in any field or field like Bachelor / Masters in Social Works (BSW/MSW).

Recommendations for functional reforms

- The resource institutes (RI) may have to educate the office bearers and producer members to initiate the transaction at the earliest possible so that the producer members will have motivation towards the activities of the FPOs.
- The FPOs must start the input distribution activity at the earliest possible and maintain it so that the producer members will be benefitted from the purchase of inputs at whole-sale price and realize the benefits. Once they realize the benefits from the activities of companies, they will start their patronage towards the business of FPOs.
- The FPOs also at the earliest possible, may have to take initiatives to start procurement of output for the major crops of the producer members, so that scale of the economy may be brought out in marketing and new markets and channels may be found for the benefit of the producer members.
- The FPOs must provide enough space for the participation of all producer members in the decision-making process through the representation of the Board of Directors.
- FPOs also must provide space for socially backward and women producer members to participate in the transactions and other activities. This will enhance participation from all corners.
- As far as overall performance is concerned, the FPOs must avoid political interventions.

- conducting election/ selection of Board of Directors, maintaining transparency in financial transactions, maintenance of office records, different ways of raising funds, fixing of annual reserve funds, dovetailing of Government schemes and finally sharing the profit accrued out of transactions must be done regularly so that the producer members will have faith on the activities of companies without any suspicions on the company activities.

Conclusion

There are many FPOs functioning around horticultural commodities. These FPOs gain significance as horticulture commodities have a lot of scope for supporting the livelihood security and doubling of farm income of farmers, especially small and marginal farmers. Based on the assessment of the performance of nine selected FPOs on horticulture, structural and functional reforms are suggested, so that the performance of these FPOs can be enhanced, if adopted.

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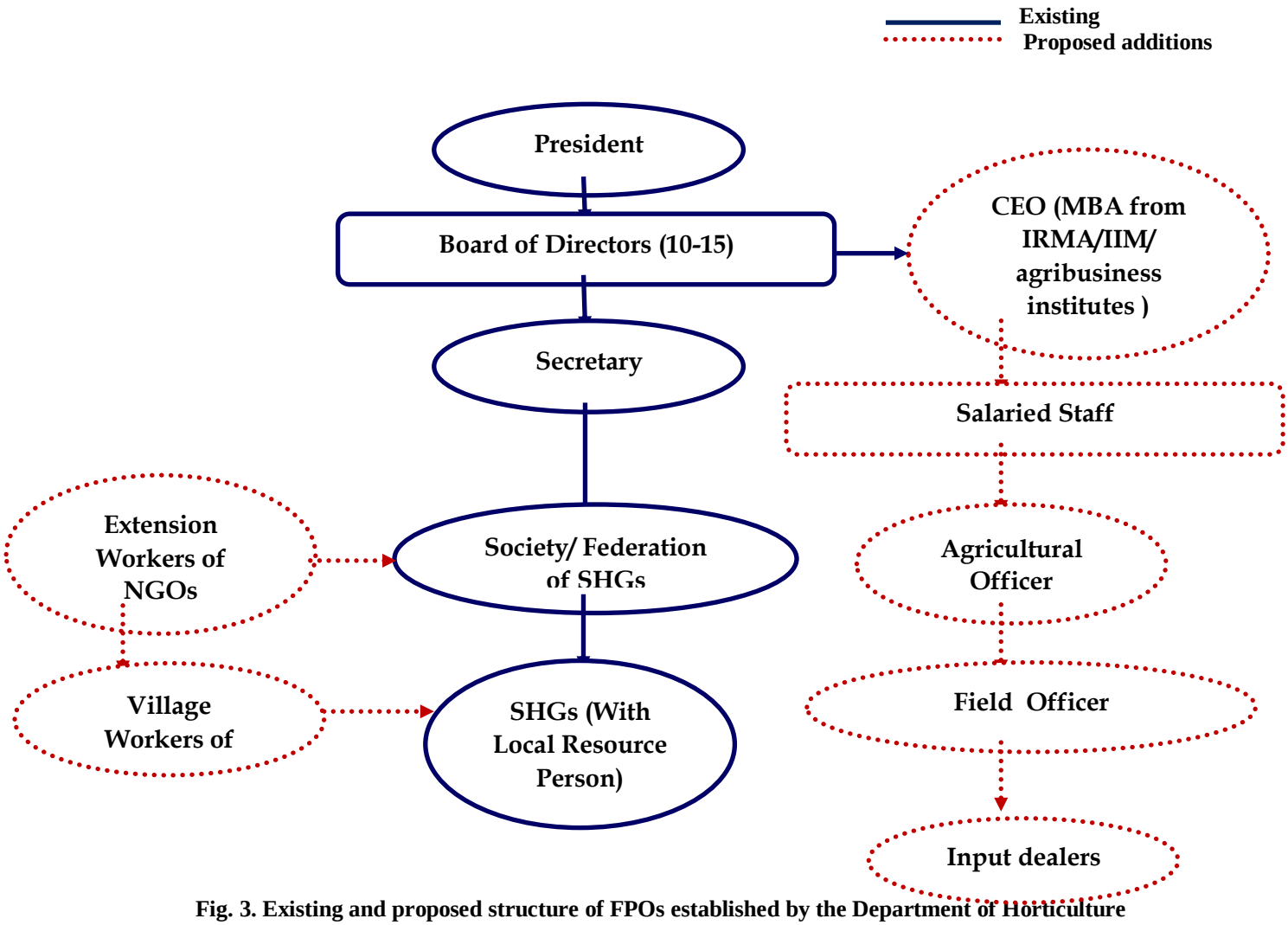


Fig. 3. Existing and proposed structure of FPOs established by the Department of Horticulture

Drying and Dehydration of Fruits & Vegetables

Dr. RB Tiwari, Principal Scientist (Hort.), Division of Post Harvest Technology and Agricultural Engineering ICAR-Indian Institute of Horticultural Research, Hessaraghatta Lake Post, Bangalore-560089

Introduction

In human nutrition, fruits and vegetables play an important role towards making of a balanced diet and prevention of several chronic diseases. Fruits and vegetables provide 90% of the vitamin C and 60% vitamin A in the world. Fruits are a natural source of energy, vitamins, minerals, and dietary fiber. Typically contains between 10% and 25% carbohydrates, less than 1.0% of proteins, and a very small amount (less than 0.5%) of fat. Important fruit minerals include Ca, Mg, Na, K, P, Cl, and S and, in micro quantities, Fe, Cu, Co, Mn, Zn, I, and Mo. Potassium is the most abundant mineral in fruits followed by calcium (Kader and Barret, 1996). The minerals, vitamins, antioxidants, and dietary fiber content in fruits and vegetables might confer these health protective benefits.

Tropics and subtropics are the stellar producers of a variety of fruits; majority if not all is perishable and prone to postharvest decay However, being perishable and highly seasonal in nature their availability becomes difficult besides it suffers from very high post harvest losses and gluts. Value can be added to the agricultural and horticulture produce to increase the shelf life of the commodity. As India produces a variety of commodities, so there are ample of opportunity in the food processing for the entrepreneurs that includes areas like Bakery, Snacks, Beverages, Convenience, Food, Dairy, Meat and Poultry etc. Various institutions have developed technologies which has successfully adopted for entrepreneurship development specially for small and medium entrepreneurs. There are many challenges for small and Medium Enterprises in India, so innovation management in the food sector is very crucial. Food processing has been used to convert raw agricultural produce into edible, safe, healthy and nutritious food products and to preserve foods. The technologies should help in ensuring microbial and chemical safety, whilst improving nutritional quality, physical and sensory properties of food products. Food processing is an essential tool in feeding the increasing world population (Knorr and Augstin, 2021).

The Food Processing Industry is pressurized to improve the quality and pace of its innovation processes. These all can be tackled by entrepreneurship in food processing (Negi,2013). Traditionally fruits and vegetables are processed by various techniques into jam, ketchup, puree, pulp, juice, beverages and dehydrated products.

Studies indicate that the role of fruits together with their nutrients in the prevention of non-communicable diseases could be stronger than vegetables. This happens because fruits provide essential vitamins, minerals, as well as various phytochemicals that confer significant health benefits other than basic nutrition. Further, healthy eating has become one of the most important factors in food choice among governments and cultured consumers. They were conscious that more frequent consumption of fruit and vegetables should be a part of a healthy diet (Margetts et al., 1997).

In order to develop convenient options of fruits and vegetables with enhanced functional attributed a diversified range of non-traditional products such as dehydrated slices/ fruit bar/ powder, vacuum fried, fortified, dehydrofrozen, or ready-to- eat, ready to use, nutrient- dense diet are some of the new development in processed food sector. By using osmotic dehydration process, at ICAR-IIHR, Bangalore different fruits such as mango, pineapple, papaya, jackfruit, guava aonla etc has been successfully, developed and commercialized. Osmotically dehydrated fruit and vegetable slices and fruit bars are highly nutritious and suitable for using as snacks. Because of the growing consumer demand for healthy, natural and convenient foods, fruit and vegetable based snacks are becoming popular which would be an ideal food format for exploitation of benefits of fruits (Tiwari, 2019).

Besides this, process for dehydration of other vegetables viz. onion, carrot, cauliflower, French bean, okra, pumpkin mushroom has also been developed. Dehydrated vegetables can be used in place of fresh vegetables in off-season and also for making vegetable soup etc.

The aim is that people should have access to a broad choice of technologies that are competitive and comply with food safety and quality standards which can be suitable employed for entrepreneurship developmental activities. A detailed account of processes/ technologies involved in development of novel kind of fruit and vegetables has been presented.

Food Processing Systems

Major aims of food processing:

- Extend the shelf-life of food and serve as the surge capacity in nature's seasonal cycle. (*Supply-Demand*)
- Enhance the acceptability (flavor, color, texture) and safety of food. (*Tasty and safe*)
- Provide nutritious foods enhancing good health, strengthening bodies and empowering mind. (*Healthful diet*)
- Help build communities and generate income for the farmers and manufacturers. (*Business*)

Preservation techniques commonly used today are:

Canning – by heat processing, **Dehydration** – by water removal, **Freezing**- at low temperature, **Freeze-drying** – Through sublimation, **Pasteurizing** – heat processing, **Salting** Pickling, **Fermentation** fermented product, **Chemical preservation** – use of chemicals like potassium metabisulphite, sodium benzoate

What fruit and vegetables can be preserved by freezing?

Practically any fruit and vegetable can be processed, but some important factors, which determine whether it is worthwhile, are:

- The demand for a particular fruit or vegetable in the frozen form;
- The quality of the raw material, i.e. whether it can withstand processing and retain nutritional qualities;
- Regular supplies of the raw material of required quality and quantities.

Even when a variety can be processed, it is not suitable unless large and regular supplies are made available. An important processing center or a factory cannot be planned just to rely on seasonal gluts; although it can take care of the gluts it will not run economically unless regular supplies are guaranteed.

<u>Value added products from products of vegetables</u>:

Tomato	- Canned whole or in form of pulp, puree, paste or juice and also in form of sauce or ketchup, dehydrated tomato slices.
Onion	- Dehydrated (flakes, granules, powder), paste Peas - Canned, frozen, dehydrated
Okra	- Canned, frozen, dehydrated
Watermelon	- Ready to serve beverage
Cauliflower	- Frozen, dehydrated
Carrot	- Dehydrated, Frozen, juice
Beans	- Canned, dehydrated, frozen
Mushroom	- Canned, dried, frozen
Pickles	- mixed vegetables like cucumber, cauliflower, carrot, peas

Consumer preference for Fruit & vegetable- need for the development of diversified fruit and vegetable products

In this fast pace world, time is a factor which also affects eating habits and choice of food. Fruits and vegetables are neglected for consumption owing to the above reason, that any kind of fresh fruit and vegetable need a primary preparation which can be washing or peeling at least or for more type of fruits and vegetables operation may be many fold and it also requires specific place and instrument. One of the barriers in increasing fruit and

vegetables consumption is time required to prepare them. Thus, it is not surprising that if it comes to fruit, consumers require product available in many outlets most of the year, suitable for many uses, with long shelf-life and not messy (Jesionowska et al., 2008).

Processing: Processing of perishable has been a prime protector of food. The vegetables are processed into more stable products, that can be stored for extended period of time by canning, drying, freezing or through chemical preservation.

Actually processing includes all the steps begins after harvest and ends before consumption of food. Normally handling, transportation, reception, temporary storage, washing, sorting, skin removal/peeling, size reduction i.e., dicing/slicing, blanching followed by either canning, freezing or drying.

Blanching - Blanching consists of heating the food rapidly to a predetermined temperature, holding for a specified time, then either cooling rapidly or passing immediately to the next processing stage. It can be done using hot water or steam. It is a must step before drying or freezing of vegetables to inactivate peroxidase enzymes. It helps clean the material and reduce the amount of micro-organisms present on the surface; preserves the natural colour in the dried products; it shortens the soaking and/or cooking time during reconstitution. Blanching time differs with type of vegetables.

Dehydration: Drying or dehydration is an age old technology. The removal of moisture prevents the growth and reproduction of micro-organisms causing decay and minimizes many of the moisture mediated deterioration reactions. Drying brings about substantial reduction in weight and volume minimizing packing, storage and transportation costs and enables storability of the product under ambient temperatures, features especially important for developing countries. As per requirements prepared fruits and vegetables are given different pretreatments followed by drying using cross-flow air drier at temperature range of 55-60°C. Different dehydration method are sun drying, solar drying, cabinet drying, vacuum drying, drum drying, spray drying, osmotic dehydration and freeze drying.

As per requirements prepared, vegetables are given different pretreatments before they are subjected for dehydration. Vegetables are dried using cross-flow air drier at temperature range of 55- 60°C. Examples of dehydrated products are dried onion flakes/onion powder, dried carrot slices, dried bean, cauliflower and dehydrated mushroom.

Open Sun Drying : Open sun drying has a profitable activity, but it has some associated problems like: damage due to rain, insect, dust and dirt contamination. This results not only in deterioration in quality of produce but also affects appearance, nutrient quality and shelf life adversely

Solar drying : Solar drying is a continuous process where moisture content, air and product temperature change simultaneously by the solar radiation. The drying rate is affected by ambient climatic condition- temperature, relative humidity, sunshine hours, available solar radiation, wind velocity, frequency and duration of rain showers during the drying period. The hybrid solar drying has great potential to be incorporated into family agriculture, increasing the income and productivity of small farmers. The system is an excellent alternative for tropical regions with high solar incidence (Roratto et al., 2021).

Raisins (Dried Grapes):

Raisins are used in food preparation and considered as delicacies. Manufacturing of raisins has been an important preservation industry in the grape growing areas of Maharashtra and Karnataka. Grapes with high TSS are found better for raisin making. Fresh grapes bunches are wished, sulphited, and than berries are dried under shade for making raisin. Thompson seed less and Arkawati varieties have been found to be suitable for raisin making.

Anardana:

Dried seeds of sour var. of pomegranate are called anardana. It is used as an acidulant and also in the other industries. Acidic hybrid `***Amlidana***' has been developed at IIHR, which is suitable for anardana making.

Dehydrated French beans :

`Dehydrated French bean is used in place of fresh vegetables and also in noodle and vegetable soups. Green colour, long, straight, tender pods of medium size, thick wall and small seed, lack of fiber or string are the desired qualities in varieties for dehydration. French bean varieties Arka Komal and Arka Suvidha released by ICAR-IIHR Bangalore are best suited for dehydration. The optimum maturity indices for these varieties are 17 days old pods weighing 6-7 g and 16 days old pods with weight of 5-6 g. The various steps in the dehydration process are given in the flow chart.

FLOW CHART FOR DEHYDRATION OF FRENCH BEAN:

Selection of suitable variety and harvesting at optimum maturity

⇩

Sorting, grading and washing

⇩

String removal, trimming and transverse cutting (2-3 cm)

⇩

Dipping in aqueous alkali solution for 30 min

⇩

Draining and thorough washing with clean water

⇩

Blanching in boiling water containing additives for chlorophyll fixation

⇩

Drying in cabinet drier at 55-60 ^{o}C to < 10 per cent moisture content

⇩

Packing in laminated pouches

⇩

Storage

Dehydrated onion:

Dehydrated onion flakes and powder are highly valued products in the international market and in great demand. Dried flakes, the major processed product of onion are derived by the process of dehydration in which the moisture content is reduced to a minimum optimum level of 5 per cent to prevent the growth of spoilage microorganisms. The reduction in weight and volume and also minimization of packaging, storage and transportation cost brings value addition. White variety of onion with high TSS (15-20°Brix) such as Arka Pitamber, RHR White, Pusa White Round are most desirable for dehydration. Since dehydration process results in the loss of some pungency

and the product is mainly used as flavour enhancer, the onion meant for dehydration should possess high pungency. Dried onion slices, coarse powders and fine onion powders has extensive application in convenience foods as flavouring for meats, sausages, pickles, ketchup, chutney, bread, biscuits, snacks, salad dishes etc.

The basic steps involved in onion dehydration are selection of raw material, sorting, grading, peeling, washing, cutting into rings after topping and tailing, pretreatment of slices in 6 per cent salt or 0.25 per cent potassium metabisulphite solution for 10 min followed by drying at 50-60°C to a final moisture content below 5 per cent. Dehydrated onion deteriorates rapidly under open condition with high humidity. Hence, packaging with 400 guage LDPE pouches or air tight pet jars is essential.

Dehydrated carrot:

Large size, fully matured carrots with high solids and carotenoid are preferred for dehydration. The carrot roots contain farm soil and needs thorough washing in clean water before peeling. The different steps of dehydration process are washing, lye peeling for 2 min, washing with water, slicing (5 cm), low temperature long time (LTLT) blanching in water containing sugar for better carotene retention, drying at 55-60^{o}C to less than 10 per cent moisture content and packing in polythene bags or pet jars. The shelf life is one year under ambient conditions.

Dehydrated cauliflower

For dehydration, selected cauliflower heads are cut into individual florets (2.5 cm thick), washed thoroughly, blanched for 5 min. in boiling water (95°C) to inactivate enzymes, reduce microbial load and to improve colour and texture dipped in solution containing preservatives and sugar. Pretreated florets are dried at 50-60°C to a moisture content of below 10 per cent. The hygroscopic nature of dried cauliflower necessitates its packing in pet jars or in polythene bags having moisture and light barrier properties. The shelf life is one year under ambient conditions.

Dehydrated Okra:

Okra pods with bright green colour, less fiber and mucilage, straight type having medium length are preferred for dehydration. IIHR released varieties Arka Abhay and Arka Anamika have been found suitable for dehydration. In dehydration process different steps involved are washing, trimming of pedicel ends, blanching in an aqueous medium containing additives and preservatives for 2 min at boiling temperature, air cooling, drying in cabinet driers at 55-60 ^{o}C and packing in polythene bags or pet jars.

General applications of dehydrated vegetables

- Commonly used Spice blends,
- Rice blends, Soup,
- Salad dressings, Sauces,
- Gravies, Salsas, Condiments,
- Canned foods, Frozen foods,
- Snack foods,
- processed foods,
- Soup Powders,
- Food Premixes,
- Health Food,
- Extruded Snacks
- Instant Food Products

Dried fruits:

Dried fruits, which serve as important healthful snacks worldwide, provide a concentrated form of fresh fruits. They are nutritionally equivalent to fresh fruits in smaller serving sizes, ranging from 30 to 43 g depending on the fruit, in current dietary recommendation in different countries. Fresh fruits are processed by various techniques to become dried fruits to prolong their shelf life. Dried fruits are a concentrated form of fresh fruits, albeit with lower moisture

content than that of their fresh counterparts since a large proportion of their moisture content has been removed through sun-drying or various modern drying techniques, such as mechanical devices, solar drying, vacuum drying, spray drying etc. Fruits can be dried whole (e.g., grapes, berries, apricots, and plums), in halves, or as slices (e.g., mangoes, papayas, and kiwis). Dried fruits are important healthy snacks worldwide. They also have the advantage of being easy to store and distribute, available throughout the year, and healthier alternative to salty or sugary snacks. Apples, apricots, dates, figs, peaches, pears, prunes, and raisins are referred to as ''conventional'' or ''traditional'' dried fruits. Meanwhile, some fruits, such as blueberries, cranberries, cherries, strawberries, and mangoes are usually infused with sugar solutions or fruit juice concentrate before drying the process is popularly known as osmotic dehydration through which various products have been standerdised as well as reported (Tiwari, 2005) in fruit like guava (Anitha et al. 2014) banana (Thippanna and Tiwari, 2015), aonla (Sumitha at al. 2015) as well as vegetables such as carrot(Selvakumar and Tiwari, 2018ab).

Dehnad et al (2016) in a recent review stated that drying is a complex process frequent in most of the food processing industries. The functional properties of food components, highly affected by the drying processes. It not only outlines the effect of drying/heating treatments on diverse biopolymers, but also compares the effect of each one (oven, sun, shade, solar, tray/cabinet, vacuum, freeze, fluidized bed, drum, and spray drying. High drying temperatures decrease the swelling capacity of carbohydrates and increase their susceptibility to breakdown during hydrothermal processes. For drying of carbohydrate sources, fluidized bed, especially at low temperatures, oven and freeze drying could yield final powders with higher functional qualities. Foam-mat, sun and freeze drying could yield better final functional properties of dried flours than oven, solar, cabinet/tray and hot air drying approaches. With microwave drying, functional properties, as opposed to nutritional qualities, could be maintained more effectively than other drying techniques, e.g. freeze drying. While application of infrared, as a novel dehydration technique, might not improve functional properties of food powders in comparison with other superior drying techniques, vacuum impregnation, another novel drying approach, could result in high saving of functional ingredients in food powders, higher anthocyanin content and better antioxidant properties of the final product.

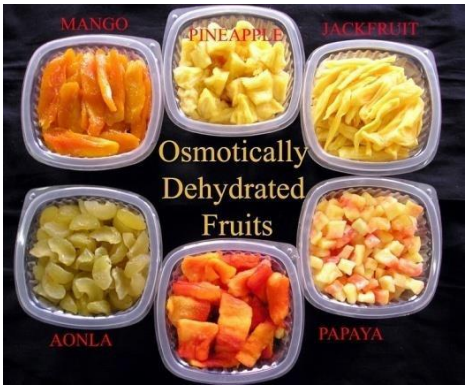
Artificial type of drying of fruits and vegetables is an important method of preservation and production of a wide variety of products such as slices, powder, chips, bar etc. Although, drying changes the physical and biochemical form of fruit and vegetable leading to shrinkage and change of colour, texture, taste etc. By use of suitable pre-treatments and drying methods, it could be possible to minimize these changes and make highly convenient products. One of such treatment is osmotic dehydration process. It improves product quality, needs less energy, helps in retention of nutritional characteristics, flavour and final product is of longer shelf-life.

The drying process may also cause changes in the physicochemical properties that could influence the final quality of the product. These modifications are changes in:

- Optical properties (colour, appearance),
- Sensory properties (odour, taste, flavour),
- Structural properties (density, porosity, specific volume),
- Textural properties
- Rehydration properties (rehydration rate, rehydration capacity) and
- Nutritional characteristics (vitamins, minerals).

Osmotically dehydrated fruits and vegetable Products:

Demand for healthy, natural and tasty processed fruits is continuously increasing not only for finished product but also for ingredients to be included in complex foods such as ice creams, cereals, dairy, confectionary and bakery products. Osmo-air dried fruits are the dehydrated fruit products based on the novel approach towards dehydration. By using osmotic dehydration process, at ICAR-IIHR, Bangalore different fruits such as mango, pineapple, papaya, banana, *aonla*, jackfruit, guava, sapota and vegetables viz. carrot, pumpkin, beetroot, muskmelon has been successfully dehydrated in to shelf stable slices which can be stored at room temperature for one year. The quality of osmotically dehydrated product is near to the fresh fruit in terms of colour, flavour and texture. It can be consumed as a snack. Such product can be used in ready to eat type of foods, ice creams, fruit salad, kheer, cakes, bakery products etc.



Osmotic dehydration process: Osmotic dehydration has received greater attention in recent years as intermediate step in drying of several fruits and vegetables. Being a simple process, it has potential advantages for the processing industry for dehydration of tropical fruits with longer shelf-life. Osmotic dehydration process involves water –rich solid products being soaked in concentrated aqueous solutions (mainly sugar or salt solutions) which creates three types of counter current mass transfer:

- an important water out flow from product to solution;
- a solute transfer, from the solution to the product; it is thus possible to introduce the desired amount of an active principal, a preservative agent, any solute of nutritional interest, or a sensory quality improvement in the product;
- a leaching out of the product's own solutes (sugars, organic acids, minerals, vitamins etc.) in negligible quantity affecting composition of the final product.

Therefore, compared to single drying process, osmotic dehydration achieves a twofold transformation of the food items, by both a decrease in water content and a solute incorporation which may result in a subsequent weight reduction. Solute uptake during osmotic dehydration modifies the composition and taste of the final product. In many cases, however, extensive solute uptake is undesirable, because of its negative impact on the taste and nutritional profile of the product. Leaching of natural acids out of osmotically dehydrated fruit also affects the taste due to change in sugar acid ratio. Further partial dehydration and solute uptake protect fruit slices against structural collapse during terminal drying.

The process is simple and involves operations like selection of fruits, cleaning, washing, peeling, curing and slicing/dicing. The prepared fruit slices are soaked in sugar solution to remove water by osmotic pressures. Then the slices are drained and dried in hot air drier. The dried fruit is packed in flexible pouches.

Parameters influencing osmotic dehydration:

The process variables such as pretreatments, temperature, nature and concentration of the dehydration solutions, agitation, additives, has been found to influence the osmotic process (Tiwari, 2005).

1. Composition -nature and molecular weight of the osmotic solute
2. Concentration of osmotic solution
3. Process temperature
4. Duration- immersion time
5. Pretreatment
6. Agitation/circulation of osmotic solution
7. Food to osmotic solution ratio
8. Shape, size and thickness of fruit pieces (surface area)
9. Variety and maturity of fruits used.
10. Food structure (porosity etc.)
11. Pressure(high pressure, ambient or vacuum)

Advantages of Osmotic dehydration: Though many advantages have been attributed to osmotic dehydration, important ones are as follows:

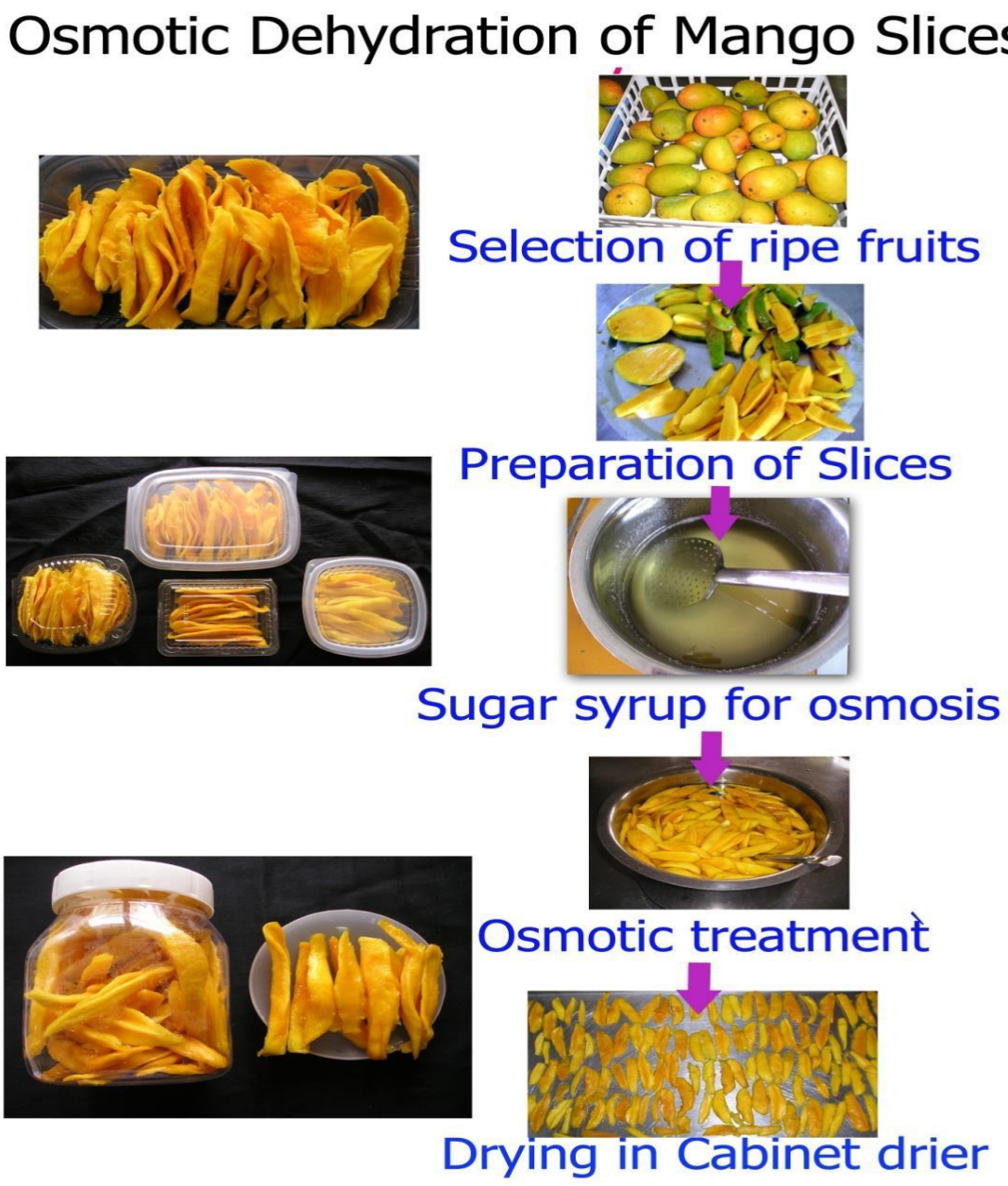
1. Minimum lose of colour and flavour.
2. Flavour retention is more when sugar or sugar syrup is used as an osmotic agent.
3. Enzymatic and oxidative browning is presented.
4. Sweetening of the product.
5. Reduces the water removal lead at the dryer
6. Increases the solid density of the product, which can be subsequently freeze dried.
7. Textural quality will be better After seen situation.
8. Simple facility and equipments are required
9. Energy consumption is very less.
10. The process is less expensive.

Freeze-drying

Freeze-drying is the process of dehydrating frozen foods under a vacuum so the moisture content changes directly from a solid to a gaseous form without having to undergo the intermediate liquid state through sublimation. In this process, the product maintains its original size and shape with a minimum of cell rupture. Removing moisture prevents a product from deteriorating at room temperature. The process is used for drying and preserving a number of food products, including meats, vegetables, fruits, and instant coffee products. The dried product will be the same size and shape as the original frozen material and will be found to have excellent stability and convenient reconstitution when placed in water. Freeze-dried products will maintain nutrients, color, flavor, and texture often indistinguishable from the original product.

Depending on the product and the packaging environment, freeze-dried foods are shelf-stable at room temperature for up to ten years or more, if canned, and between 6 months to 3 years if stored in a poly-bag container. The main determinant of degradation is the amount and type of fat content and the degree to which oxygen is kept away from the product.

The Benefits of Freeze-Drying are it retains original characteristics of the product, including: color, form, size, taste, texture, nutrients; cold storage not required ;reconstitutes to original state when placed in water ;Shelf stable at room temperature ;the weight of the freeze-dried products is reduced by 70 to 90 percent, with no change in volume; the product is light weight and easy to handle ;offers highest quality in a dry product compared to other drying methods.



Fruit Bar:

Fruits serve as a source of energy, vitamins, minerals, and dietary fiber. One of the barriers in increasing fruit and vegetables consumption is time required to prepare them and the high perishability. Processing these high value food into fruit bars or fruit leather can be a good, convenient and better alternative. Fruit bar is the product prepared by blending fruit purees or pulp extracted from ripe pulpy fruit, sugar or other nutritive sweeteners and other ingredients and additives desired for product and dehydrated to form sheet which can be cut to desired shape and size. Fruit bars can also be nutritionally improved through fortification such as concentrated protein sources to improve its food value. Further, fruit bars can also act as suitable matrix for incorporation of prebiotics as well as probiotics. Sugar is an important ingredient in traditional fruit bar preparation. There is possibilities of use of alternate sweeteners and other sugar substitutes for preparation of fruit bar to meet the increasing demands of low calorie snack food. There is also great potential for use of solar energy as well as alternate drying techniques for popularization of fruit bar processing in rural areas (Tiwari, 2019). As mentioned before, mango fruit bar is traditionally prepared by adding cane sugar to ripe mango puree, spreading the puree on bamboo mats and drying the pulp in the sun (Gujral and Brar, 2003). At ICAR- IIHR Bangalore technologies for making different types of fruit bar such as mango bar, papaya bar, guava bar and their blend have been developed (Singh and Tiwari, 2019 and Tiwari, 2019) as well as commercialized. An alternate way of using raw mango fruit for bar making has also been developed using combined processing technology. Singh and Tiwari, 2019 reported that, blended guava-papaya (40:60) leather was found best among other treatments in terms of quality and acceptability. It had a good yield of 26.78 % with 15.75 % moisture content and 0.59 water acidity which promises a good storability and safety. It was highly acceptable with maximum sensory acceptability in terms of colour, flavor and texture (total 80.78 out of 100) with acidity 1.22 %, reducing sugar 39.44 %, non-reducing sugar 29.41 % and total sugar 68.85 %. It improved the nutritional value with 137.3 mg per 100g ascorbic acid and 1367.3 µg carotenoids per 100 g of prepared leather.

Fruit bar preparations commercial method for the manufacture of bar making involves fruit pulp mixed with sugar paste to form sheets that are dehydrated in a tray dryer (50–60◦C, 18— 24 h) thereby obtaining a food microbiological attributes, color, and flavor acceptable (

It has been reported that Different single-type dehydration or combined methods include, in order of increasing process time, air-infrared, vacuum and vacuum-microwave drying convective-solar drying, convective drying, and freeze drying are also suggested as alternative to solar traditional drying stage. The dehydration methods that use vacuum exhibited not only higher retention of antioxidants but also better color, texture, and rehydration capacity. Antioxidant activity resulting from the presence of phenolic compounds in the bars is well established. Besides this, fruit bars are also important sources of carbohydrates and minerals. Given the wide range of bioactive factors in fresh fruits that are preserved in fruit bars, it is plausible that their uptake consumption have a positive effect in reducing the risk of many diseases.

BLENDED GUAVA & PAPAYA BAR

Conclusion:

Dehydration is widely used to preserve fruits and vegetables since the reduction of both their moisture content and water activity increases their shelf-lives significantly. For that, fresh foods are dried to reach a water activity that prevents microorganisms' growth and considerably reduces chemical and enzymatic reactions. Besides, drying adds value to fruits and vegetables and reduces storage and transportation costs, which is very important in countries with deficient transport systems. Therefore, food drying can be an opportunity to add value to products from small producers. If fruits and vegetables are dried where they are produced, this may reduce food losses and help small farmers to have a higher income. Food drying can be performed by different processes, such as convective drying, vacuum drying, freeze-drying and solar drying etc. However, during processing, undesirable changes in the sensory and nutritional properties of the food commonly occur which may be minimized by applying suitable pretreatments. Convective drying is relatively cheap and is extensively used for the dehydration of fruits and vegetables. Application of osmotic dehydration will be useful for making fruits and vegetables based snack fruit. Fruit pulps can me dried to nutritional fruit bar. Solar drying has great potential to be incorporated into family agriculture, increasing the income and productivity of small farmers

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Fruit and Vegetable Beverages

Mrs. Pushpa Chethan Kumar, ARS Scientist (Food and Nutrition), Div. of Post Harvest Technology & Agri.Engg, ICAR-Indian Institute of Horticultural Research, Hesaraghatta, Bengaluru -560089

India, due to its diversified climatic condition and soil, is able to produce a variety of tropical, sub-tropical and temperate fruits along with vegetables. India has witnessed increase in horticulture production over the last few years. Significant progress has been made in area expansion resulting in higher production. Over the last decade, the area under horticulture grew by 2.6% per annum and annual production increased by 4.8%. During 2017-18, the production of horticulture crops was 311.71 Million Tonnes from an area of 25.43 Million Hectares. The production of vegetables has increased from 101.2 Million Tonnes to 184.40 Million Tonnes since 2004-05 to 2017-18 and production of fruits has increased from 50.9 Million Tonnes to 97.35 Million Tonnes since 2004-05 to 2017-18 (http://agricoop.nic.in).

India is the second largest producer of the Fruits and Vegetables in the world with a production of 311 million Tonnes. India is the world's largest producer of bananas, papaya, mangoes and guavas, second largest producer of potatoes, green peas, tomatoes, cabbage and cauliflower. India witnesses nearly 4.6-15.9% wastage in fruits and vegetables annually, due to lack of modern harvesting • practices and inadequate cold chain infrastructure. • Processing levels in F&V currently stand at close to 2%. Fruits and vegetables are mainly processed into Frozen, pulp, puree, paste, sauces, snacks, dressings, flakes, dices, dehydration, pickles, juices, slices, chips, jams, jelly, RTS drinks and canning. India's exports of Processed Fruits and Vegetables were around USD 1.1 Bn in 2016-17, which majorly included Dried and Preserved Vegetables and Mango Pulp (Opportunities in FRUITS & VEGETABLES Sector in India, Ministry of Food Processing Industries Government of India).

Fruit and vegetable processing

Being a major producer of some of the fruits and vegetables, India is doing processing also. Among industrial sectors, food processing is the major sector. India's exports of Processed Food was Rs. 31111.90 Crores in 2018-19, which including the share of products like Mango Pulp (Rs. 657.67 Crores/ 93.97 USD Millions), Processed Vegetables (Rs. 2473.99 Crores/ 354.75 USD Millions). Eventhough India is processing crores worth of fruits and vegetables, the total processing of these commodities account to only 2%. Fruit juice is one of the popular and most preferred products of fruits. The global fruit juice market reached a volume of 45.4 Billion Litres in 2018, having a CAGR of around 2% during 2011-2018.

It is known that fruits are rich sources of many bioactive compounds such as ascorbic acid, carotenoids, anthocyanins, polyphenols, fibres, vitamins and minerals. These bioactive compounds have exhibited many health promoting actions.

Among various processed products from fruits and vegetables, beverages are the one which are more preferred by consumers due to its convenience, variety and health benefits. It has been reported that consumers prefer mixed fruit beverages and there is an increasing growth in its consumption globally.

The fruit juice market is one of the most innovative product markets and one of the most competitive segments in the beverage industry. Fruit juices form part of what are termed as 'new age beverages'.

Market outlook

Currently, there are about 75% of unorganized players are in juice fruit production. And about only 25% of established brands are involved in juice, fruit bars and packaged juice manufacturing industry. Among the different fruits, mango has the biggest share in fruit juice industry which constitutes to 60% of total fruit juice production.

Global Fruit Juice Market Trends:

The consumption of soft drinks, such as colas and flavored sodas, is reducing globally as they have high sugar content, artificial coloring, phosphoric acid, artificial sweeteners, and caffeine which can cause negative effects on the human body. Owing to this, a large number of consumers are shifting from carbonated drinks towards natural fruit juices.

Changing lifestyles and altering eating patterns of the consumers have resulted in an increased intake of affordable, healthy and quick sources of nutrition like packaged fruit juices, thereby catalyzing the growth of the market.

In order to expand the consumer-base, manufacturers are introducing a wide array of flavors, and producing preservative-free and sugar-free fruit juices. In addition to this, growth in the food and beverage industry is boosting the overall demand for fruit juices worldwide.

Earlier, a number of players were hesitant to sell their products in the emerging countries due to the lack of infrastructure and storage facilities. Nonetheless, with a rise in the number of organized retail outlets, several players are now willing to invest in these markets which are expected to bolster the growth of the fruit juice industry (imarkgroup.com). On the basis of type, the global fruit juice market is segregated as 100% fruit juice, nectars, juice drinks, concentrates, powdered juice and others. Currently, juice drinks account for the majority of the market share, representing the most popular product type. Juice drinks contain several vitamins, flavors and anti-oxidants owing to which they are preferred by the consumers.

Based on flavors, the market is classified as orange, apple, mango, mixed fruit and others. Amongst these, orange fruit juice holds the majority of the market share as it is rich in vitamin A, vitamin C, calcium and iron.

On the basis of distribution channels, supermarkets and hypermarkets represent the largest segment as they offer easy access to a wide variety of fruit juices depending on different brands, types and flavors. Supermarkets and hypermarkets are followed by convenience stores, specialty food stores, online retail and others.

Technological overview

According to the US Code of Federal Regulations, "juices directly expressed from a fruit or vegetable (i.e., not concentrated and reconstituted) shall be considered to be 100% juice and shall be declared as '100% juice.' Fruit juice obtained from fresh fruits may have lesser amount of vitamin C, calcium and dietary fibre which otherwise shall be obtained by consuming fresh fruit.

As per the FSSAI (Food Safety and Standard Authority of India), Thermally Processed Fruits Juices (Canned, Bottled, Flexible And/Or Aseptically Packed) means unfermented but fermentable product, pulpy, turbid or clear, intended for direct consumption obtained by a mechanical process from sound, ripe fruit or the fresh thereof and processed by heat, in an appropriate manner, before or after being sealed
in a container, so as to prevent spoilage. The juice may have been concentrated and later reconstituted with water suitable for the purpose of maintaining the essential composition and quality factors of the juice. It may contain salt.

Thermally Processed Vegetable Juices (Canned, Bottled, Flexible Pack And/Or Aseptically Packed) means the unfermented but fermentable product or may be lactic acid fermented product intended for direct consumption obtained from the edible part of one or more vegetables, including roots, and tubers (e.g. carrots, garlic) stems & shoots (e.g. Asparagus), leaves & flowers (e.g. spinach and cauliflower) and legumes (e.g. peas) singly or in combination, may be clear, turbid or pulpy, may have been concentrated & reconstituted with water suitable for the purpose of maintaining the essential composition & quality factors of the juice and processed by heat, in an appropriate manner, before or after being sealed in a container, so as to prevent spoilage. It may contain salt, nutritive sweeteners, spices and condiments, vinegar, whey or lactoserum having undergone lactic acid fermentation not more than 100 gm/kg and any other ingredients suitable to the product.

Some of the terminologies that are being used in the fruit juice industry are given below for better understanding.

Pulp / Puree: Pulp or puree is the pure fruit content extracted from the fruit (mostly ripe)
Pulping is done either using an industrial pulper (that comes in various capacities) or a mixer/mixie (the one used domestically in kitchen). Pulp extraction is done in case of pulpy fruits like mango, banana, guava, papaya, etc.

Pure Juice: Juice is the one which is expressed from a ripe fruit normally by pressing / squeezing or using a juicer (as in case of oranges). This is used in non-pulpy fruits like grapes, oranges, lime/lemon, etc.

Clarified Juice: Clarified juices are also pure juices from which the pulpy material / insoluble solids are removed using enzymes like Pectinases or enzyme cocktails depending on type of fruits. Clarified juices are generally clear and sparkling / transparent. Both pulpy and non-pulpy juices can be clarified if necessary.

Concentrate: It is the concentrated pulp or juice. The concentration is achieved by removing water from the pulp or juice by different means / methods / machineries. For example, mango concentrate comes in 28˚Brix format (which is almost 2-times the natural brix content of mango pulp/puree).

TSS (Total Soluble Solids): The TSS is measured using an instrument called 'Refractometer' and the value is expressed in degree (˚) Brix. This mainly constitutes sugars, acids, water soluble vitamins like C, B-complex, soluble proteins and soluble starch present in the fruit. The TSS level indicates how sweet the fruit or its juice is.

Acidity: Acidity indicates how much sour is the juice/pulp. All fruits have natural acids in them. They could be organic acids like citric, malic, tartaric or more than one of them in different proportions depending on the fruits.

Table 1: Product specifications given by FSSAI for different fruit juices

FRUIT JUICES

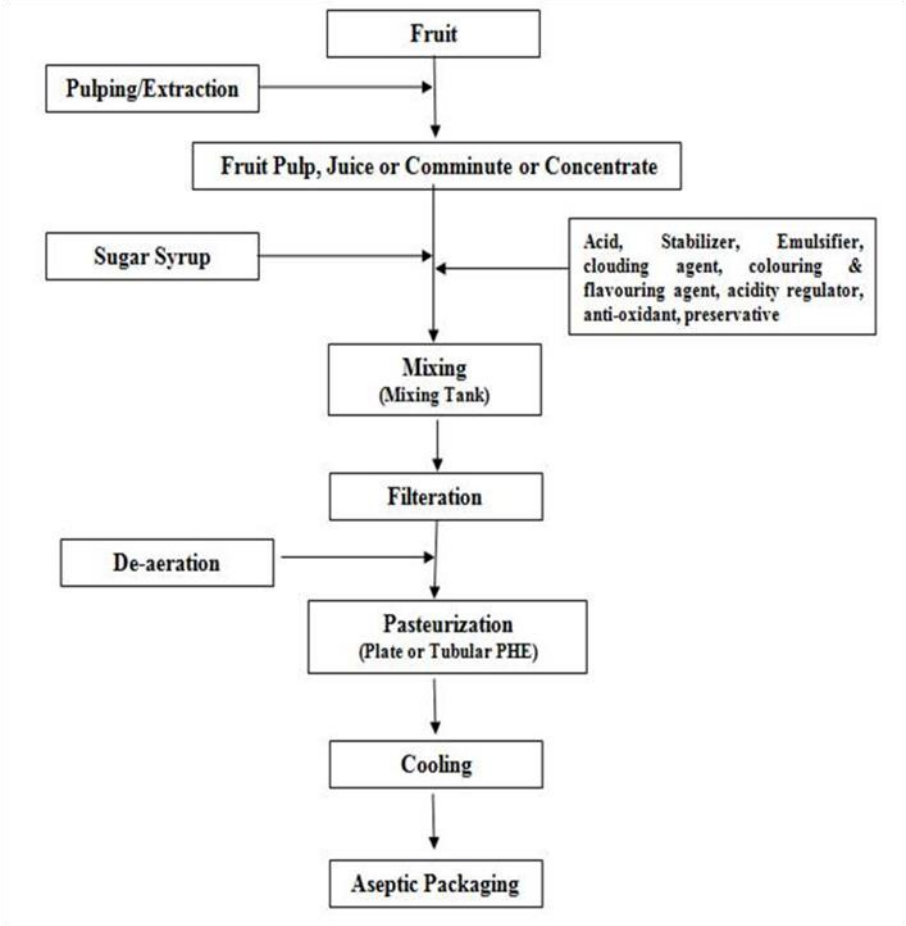
	TSS Min. (%)	Acidity expressed as Citric Acid Max. (%)	Added Nutritive Sweeteners Max (g/kg)
1. Apple Juice	10	3.5 (as malic acid)	–
2. Orange Juice			
(a) Freshly expressed	10	3.5	50
(b) reconstituted from concentrate	10	3.5	–
3. Grape Fruit Juice	9	–	50
4. Lemon Juice	6	4.0	200
5. Lime Juice	–	5.0	200
6. Grape Juice			
(a) Freshly expressed	15	3.5	–
(b) reconstituted from concentrate	15	3.5	–
7. Pineapple Juice			
(a) Freshly expressed	10	3.5	50
(b) reconstituted from concentrate	10	3.5	–

Requirements to establish a Processing Unit

Hygienic area for processing and storage
Required machineries
Man power
Ingredients

FSSAI License
Marketing strategy

Ready-to-Serve (RTS) Guava beverage



Some quality criteria of fruits required for juicing

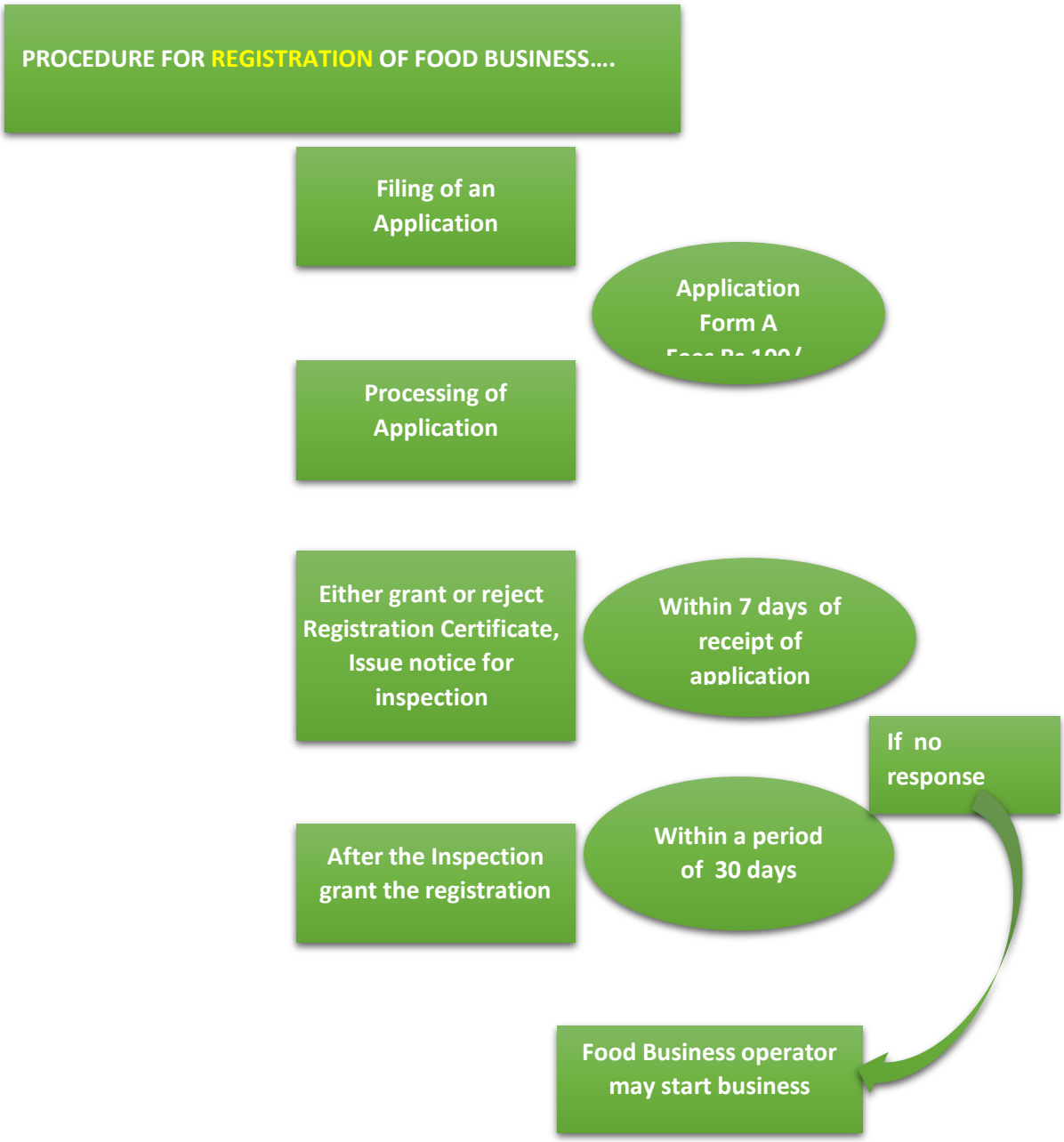
Factor	Criteria	Rationale
Maturity	Ripeness	Optimum quality
Solids	Adequate level	Affects yield, flavour
Acidity	Appropriate pH level	Flavour, sugar/acid ratio
Colour	Fully developed	Juice appearance
Defects	Appropriate level	A few can be tolerated
Size/shape	Uniform	Ease of handling/juicing
Specific chemicals	Past analyses	Reflect handling/quality
Pesticide residues	Regulatory control	Legality of product
Foreign matter	Appropriate level	Reasonable limits
Microbial count	Low total, no or few pathogens	Safety/stability of juice

Food Safety and Standard Authority of India

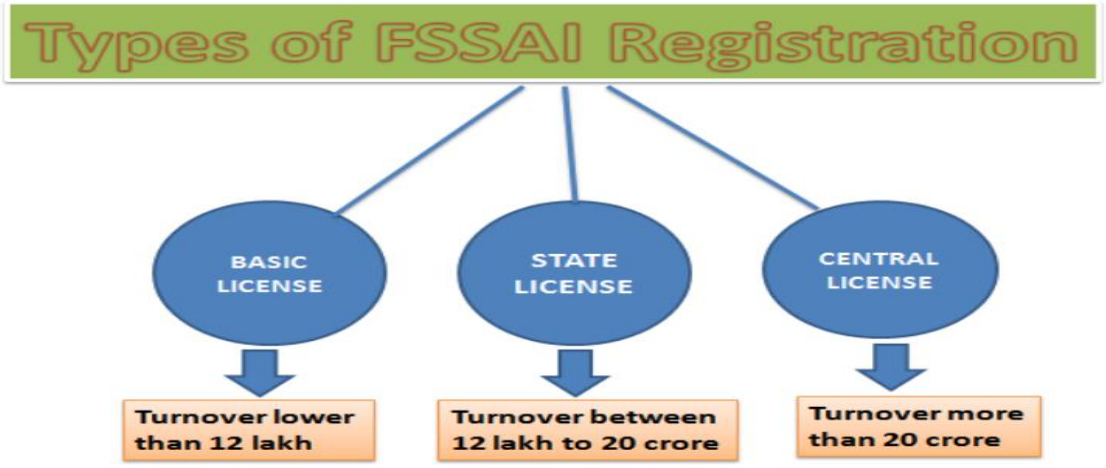
- FSSAI is an autonomous body established under the Ministry of Health & Family Welfare, GOI
- Established under Food Safety and Standards Act, 2006
- These regulations came into force on 5th August, 2011
- Responsible for protecting and promoting public health through the regulation and supervision of food safety
- The Act covers activities throughout the food distribution chain, from primary production through distribution to retail and catering.

- The Act gives the Government powers to make regulations on matters of food safety.

Licensing and registration of food business



Recently, the FSSAI has launched a new, upgraded, cloud based; user-friendly Food Safety Compliance System (FoSCoS) for food operators.



This license provides a 14 digit license or registration number. License number and the FSSAI logo on the package of the products assures quality and promotes business.

Beverage technologies available at ICAR-IIHR

RTS	**Squash**
Banana	Banana
Amla	Amla
Mango	Mango
Jackfruit	
pomegranate	Amla with Bottle gourd
Guava	guava
kokum	Kokum
Watermelon	
Blended Grape	Grape
Pineapple	Pineapple
Passion fruit	Passion fruit
Bitter gourd	

POST HARVEST MANAGEMENT OF FRUITS AND VEGETABLES

D.V. Sudhakar Rao, Principal Scientist (Hort.) Division of Post Harvest Technology & Agricultural Engineering, ICAR-Indian Institute of Horticultural Research, Bangalore-560089
E-mail: sudhakarrao.dv@icar.gov.in

Stability of fruits and vegetables as raw materials in terms of its storability and retention of quality is highly important for their better utilization and production of quality processed products**.** But fresh fruits and vegetables are highly perishable living commodities that continue to respire and transpire even after harvest till they are consumed or converted into value added products. A significant quantity of the harvested produce is wasted due to defective methods of picking, handling, packing, transport, ripening and storage before they are processed. These quantitative and qualitative losses are both important for processing industries from the economic yield and final product quality point of view. These post harvest losses can be minimized by following proper practices like harvesting at right maturity stage, adopting proper harvesting techniques, using suitable post-harvest treatments; right type of packing, transport, storage and ripening techniques (where applicable). Many processing industries procure raw material either directly from farmers or from wholesale traders. Industries can help farmers and traders in adopting right kind of post harvest management practices for different fruits and vegetables which ultimately help them to reduce these losses during the raw material handling before being processed.

1. Pre-harvest factors

Many post-harvest losses are direct result of factors before harvest. Fruits and vegetables that are infected with pests and diseases, inappropriately irrigated and fertilized, or generally of poor quality before harvesting can never be improved by post-harvest treatments. Very often the rate of commodity loss is faster if the quality at harvest is below standard. Genetic factors like variety, environmental factors like temperature, light, wind, rainfall and cultural factors like mineral nutrition, irrigation, density of planting, chemical sprays, etc. affect the attainment of maximum quality at the time of harvest and influence the storage life of these perishables

2. Maturity standards for harvest

Good quality of fruits and vegetables, which is very important for converting into value added products, can be obtained only when harvesting is done at the proper stage of maturity. In case of fruits, early harvesting at immature stage results in poor quality whereas delayed harvesting increases their susceptibility to decay. Vegetables should be harvested when they attain maximum size and yet are tender. Early harvesting at immature stage results in faster shriveling in many vegetables like okra, beans, etc, whereas delayed harvesting in root crops such as carrot and radish causes sponginess and pithiness because of over maturity.

Maturity index means, the stage of maturity at which the fruit if harvested will give optimum quality that are given below. These indices should help the processors to procure the right kind of produce either directly from the farmers or from the traders.

Maturity standards of some important fruits

Crop	Maturity indices
Mango	Light green surface colour, lenticels development, shoulder growth, specific gravity and pulp colour breaking to yellow
Banana	Angularity' and 'fullness of fingers'
Grapes	Light green surface colour, Waxy bloom, TSS content
Papaya	A trace of yellow appears on the apex or between the ridges
Pomegranate	External red or yellow colour of peel depending on cultivar, Red colour of juice .TSS content of juice around 15 to 16
Guava	Easy detachment, texture and skin colour
Sapota	Latex flow, pulp colour below peel, easy fall of surface granules

Maturity standards of some important Vegetables

Crop	Maturity indices
Tomato	• Pink stage: 30 to 60 % of surface in the aggregate shows pink or red colour. • Light red stage: 60 to 90 % of surface in the aggregate shows pinkish red or red. • Red ripe stage: More than 90 % of surface in the aggregate shows red colour.
Okra	Pods should be young, green, tender, crisp, and without fibre, • Not more than seven days after pod set • Length of the pod should be 10-12 cm (for export) • 2 days before maximum pod length • Pods readily snap when touch
Beans	• Harvested before the pods are fully grown, tender, and fleshy with bright green colour while the seeds are still small. • Should snap easily when bent between the fingers. • Pods will be ready for harvest within 14-15 days after flowering. Delay in harvesting results in pod becoming tough and stringy and loss of green colour.
Carrots	• Harvested when the roots have attained sufficient size to fill in the tip and develop a uniform taper. • Should be crisp and should not become woody. • Roots should be at least 12 cm long and 1.25 to 3.75 cm in diameter at the upper end depending on the variety.
Cauli-flower	• Curds attain full size and compact, before the flower stalks elongate and become discolored, ricy or leafy • Loosening of curds and their breaking into segments indicates over maturity accompanied by loss of flavour and market appearance.

3. Harvesting and Handling

Care in harvesting and handling is necessary to preserve subsequent quality of fresh produce. Harvesting should be done preferably in the cooler part of the day and the produce should be shifted to shade as early as possible. Harvesting of fruits and vegetables should not be done during or immediately after rains as it creates favourable conditions for multiplication of spoilage organisms. Faulty harvesting and rough handling at the farm directly affect postharvest quality and the extent of spoilage before being used by the processors. Bruises and injuries caused during harvesting and faulty handling leads to entry of micro-organisms that causes rotting, surface blackening and increased respiration and transpiration rates resulting in decreased shelf life. The harvested produce should not be directly placed on the soil but put them carefully in the clean containers preferably plastic crates to avoid mechanical injuries and for easy handling. Keep the produce under shade to avoid direct exposure to sunlight and to prevent moisture loss.

Method of harvesting:

Different kinds of fruits need different methods of harvesting; some are easily pulled, although there is possibility of tearing off of a piece of rind and/or flesh. Some produce are harvested along with stalk with the aid of a clipper or shear. Fruits in higher branches are harvested with harvesters having long pole with a bag for holding the harvested produce (mango, sapota). In banana, the trunk is cut with a sickle over halfway through and then the bunch is cut. In case of vegetables, harvesting is done by hand or using clean secateurs. The extent of spoilage during ripening of mangoes and sapota (before being processed) will be significantly less in case of fruits harvested using harvesters compared to those harvested by shaking the tree.

4. Post harvest operations

Various post harvest operations involved in fruits and vegetables include curing sorting or trimming, washing, pretreatments, precooling, packaging, storage and ripening

Curing: It is usually done in some tuber or bulb vegetables immediately after harvest for i) healing of wounds caused during harvesting (root crops and tubers) or ii) to reduce moisture or drying for toughening of outer skin and tighten/close the necks (onion). In crops like potato, sweet potato, cassava, etc curing results in suberization of outer tissues by the formation of periderm layer which reduces water loss and infection. In onion, windrow method is followed to cure in

the field, by keeping the harvested produce in rows along with leaves to partially cover the bulbs preventing direct exposure to sunlight for 4-5 days. Once the necks become tight and outer scales dries, the tops are cut by leaving about 2 to 3 cm length dry neck. These bulbs should be kept under shade for 2 to 3 weeks for proper drying of bulbs.

Sorting: It is done to remove mechanically damaged, immature and over mature fruits and vegetables; to discard rotten/diseased, insect attacked and misshapen fruits. Sorting should be done before washing.

Trimming: In grapes trimming is done to remove rotten, undersize, immature, dried, split and damaged berries from the bunches. It is done in some vegetables to remove, unwanted, discoloured, rotten and insect damaged parts (e.g., cabbage, cauliflower, spinach, lettuce) or parts that may favour deterioration or damage during later handling. Trimming helps in reducing likelihood of disease spread.

Washing: Washing of the produce is done to remove adhering dirt, dust, latex strains and to remove surface organisms, insects, and sometimes spray residues. Washing is a must in root vegetables like carrot, radish, etc and in others it is done to remove adhering dirt, dust surface organisms and sometimes spray residues. Detergents are sometimes added to water for effective washing. Under automated systems, the produce passes under a spray washer on a moving conveyor belt. Some vegetables like, onion, garlic, okra, etc., are not washed after harvest

Sanitizers: Safety of food is of great concern whether consumed in fresh or processed form. Use of sanitizers help in reducing microbial contamination to safe levels. An ideal sanitizer should be able to quickly destroy wide range of micro-organisms; non-toxic and safe; easy to use and effective in wide range of conditions. Chemical sanitizers can be used in processing facilities mainly to reduce microbial contaminants and cross-contamination of the food through the sanitation of equipment and rinsing of produce. Various sanitizer permitted to use include Chlorine, chlorine dioxide, acidified sodium chlorite, Peroxyacetic acid (PAA), hydrogen peroxide (H_2O_2), ozone, UV radiation, etc. Among these chlorine sanitizers are most widely used sanitizing agents and are approved for the sanitation of water, & processing equipment. The antimicrobial activity of the chlorine solution is dependent on the amount of free chlorine i.e., concentration of hypochlorous acid and hypochlorite ions present within the sanitizing solution

5. Post harvest treatments

Hot water treatment

Dipping of fruits in hot water of specific temperature for specified periods for the purpose of disease control, disinfestations or uniform ripening is known as “Hot Water Treatment (HWT)”. It also helps in removal of surface residues, to remove sap fallen on the fruit surface during harvesting and facilitates washing. It requires the use of specialized equipment because temperature control of the water bath is essential for the process to be effective and for prevention of damage to the fruit. A circulating pump should be utilized to mix the water to assure uniformity of temperature within the tank. A temperature of 52-55°C for 5 to 10 min is used for disease control whereas 48°C for 60 min is recommended for insect control (fruit fly) in mango. HWT can help the processers to control spoilage and get the uniform ripening of mangoes

Sprout inhibitors: Sprouting is a major problem in onion and potato during its long term storage. Sprouting can be controlled using pre and post harvest chemical treatment with CIPC. Gamma irradiation (0.15 kGy) is also commercially employed in vegetables like onion, garlic and potatoes to prevent sprouting during storage.

Ethylene inhibitors

Delaying ripening enhances the storability of many fast ripening fruits. Fruit ripening can be delayed by using ethylene absorbents (Potassium permanganate coated materials), ethylene action inhibitors (1-MCP) and ethylene synthesis inhibitors (AVG, SA and NO). These chemicals are used at very low concentration (ppb levels in case of 1-MCP and milli molar concentrations in case of synthesis inhibitors). This technique can be used by the processors to extend the processing duration of the procured produce in large quantities

Edible Surface Coating

Waxing of fruits is done primarily to reduce moisture loss and reduce shriveling and wilting thereby extending the storage life. Waxing also enhances the gloss thereby improving the sales appeal and market value. This additional coating supplements the natural protecting waxy layer. The fruits should be clean before coating, otherwise it may

enhance rotting. It is done by immersing the produce in a coating solution or by fine spraying using mechanical sprayers. The efficacy of these edible coatings depends on the type of coating, characteristics of the fresh produce and storage conditions (temperature and duration). Edible coatings are made of three major components such as polysaccharides, proteins and lipids. Various types of coatings such as carnauba wax, shellac, zein, cellulose derivatives, chitosan & its derivatives and other composite mixtures containing sucrose esters of fatty acids and sodium salt of carboxymethyl cellulose have been tested to extend storage life of different fruits Some trade names of commercially available surface coatings are Waxol, Semperfresh, Stayfresh, Tal-prolong, Xedabio wax, Citruseal, etc. Coated citrus fruits can be utilized for longer periods without affecting the juice content before being processed

6. Packaging

Packaging of fruits and vegetables is done to assemble the produce in convenient units for handling and to protect the produce during transportation and storage. A good package should aim at protection of produce from physical, physiological and pathological deterioration. An ideal package should meet the following requirements:

- Packages must have sufficient mechanical strength to protect the produce during handling, transport and storage.
- Packing material should not contain toxic chemicals that could transfer to the produce.
- The packages should allow rapid cooling of the contents
- The package should be easily disposable or recycled
- The cost of the pack in relation to the value of produce should be as low as possible.

Plastic crates and corrugated fiber board (CFB) boxes are ideal for protecting the produce. Quality of the paper used decides the strength of the CFB boxes and use of unbleached, virgin craft paper having high tearing resistance and stiffness and low rate of moisture absorption is recommended.

7. Storage

Storage of fruits and vegetables prolongs their proper utilization, preserves the quality of the living produce and helps in extending the operational period of processing industries. The main aim of proper storage is to control the rate of transpiration, respiration and disease infection and to preserve the commodity in its most usable form. The storage life of fresh fruits can be prolonged by different methods like cold storage, controlled atmosphere storage, hypobaric storage, etc.

Precooling

Precooling refers to the rapid removal of field heat from freshly harvested commodities before storage. It involves faster cooling of the commodities to a desired temperature (the temperature at which the commodity will be further handled/ transported or stored in a cold chain) soon after harvest. Precooling is done to reduce the produce temperature, as high temperatures are detrimental to the keeping quality of fresh fruits. General aim is to slow down the respiration, reduce the water loss and minimize the susceptibility to microorganisms.

Precooling is done commercially by forced air cooling or hydro-cooling. The precooling method is selected depend upon the type of produce to be precooled, rate of cooling and cost involved. Forced air cooling is suitable for most of the fruits as hydrocooling cannot be used for some fruits like grapes, figs, etc where the fruits are water sensitive.

Low temperature storage: Low temperature is the best method for long term storage of fruits and vegetables. The storage life can be further extended by using other post harvest treatments supplemented with low temperature storage. Optimum temperature and humidity requirements vary with different kinds of fruits and even with variety. For most of the fruits the relative humidity in cold storage should be kept in the range of 85 to 95%. When fruits and vegetables (especially tropical) are stored at lower than their optimum temperature, they are susceptible to a physiological disorder known as chilling injury. Fruits such as mango, banana, papaya, sapota, fig, custard and vegetables beans, cucumber, okra, brinjal, pepper and tomato are affected commonly. The symptoms are:

- surface pitting
- discolouration- browning or blackening of the external or/and internal tissues.
- appearance of water soaked areas
- development of necrotic areas
- failure of mature fruits to ripen or loss of characteristic flavour
- increased susceptibility to decay

Storing at optimum temperature or above the critical temperature for particular commodity is the safest method to avoid chilling injury. As a thumb of rule temperate fruits like apple, pear, peach, grapes, etc and vegetables like carrot, cabbage, cauliflower etc. can be stored near 0°C whereas those in tropical in nature like, mango, banana, papaya, cucumber, okra, brinjal, tomato etc should be stored above 12°C and others like citrus, pomegranate, peppers, beans, etc can be stored at 6-8°C.

Controlled atmosphere storage (CA storage): CA storage is a system for holding produce in an atmosphere that differs substantially from normal air in respect of the proportions of Oxygen (O_2) and carbon dioxide (CO_2). This method, if combined with refrigeration, markedly retards respiration and delays softening, yellowing and other quality changes. This method is commercially followed for large-scale and long term storage of apples and other temperate fruits.

8. Ripening

During ripening an inedible mature fruit will turn into edible soft fruit with optimum taste and characteristic flavour. Fruits start ripening after reaching maturity by release of a ripening hormone known as ethylene from the fruit. Majority of fruits like mango, banana, papaya, sapota, guava and custard apple are harvested in a mature but unripe condition and allowed to ripen by natural release of ethylene from the fruit. But natural ripening is a slow process leading to high weight loss and desiccation of fruits. Sometimes natural ripening results in uneven ripening in some fruits. Hence, ethylene is externally applied to enhance the ripening process of fruits. Commercially ethylene gas is sourced either from compressed ethylene gas cylinders or ethylene gas generators or alternatively this ethylene gas can be produced from a growth regulator, 2-chloroethyl phosphonic acid (Ethrel or ethephon) by adding alkali to it. Use of properly ripened fruits is very important to manufacture the processed products of desired quality and flavor.

9. Transport

Transportation is an important link in the handling, storage and distribution of fruits and vegetables. Transport starts from field till they reach consumers or the processing industry. During transportation, produce may be exposed to unfavourable conditions like:

- rough handling during loading and unloading.
- compression from the overhead weight of other containers of products.
- impact and vibration during transportation.
- loss of moisture to the surrounding air.
- Higher/lower than recommended temperatures.
- ethylene gas from vehicle exhaust or product ripening.

The mechanical damage caused due to compression, vibration and impact during transportation will significantly increase the spoilage after reaching the industries before it is processed.

Points to be considered in transport:

1. Timely and speedy delivery of produce
2. Proper packaging and traveling conditions to avoid damage
3. The transported commodities should be of optimum maturity and with no injuries.
4. No produce should be considered as 'Hard wares' & should be handled with utmost care. Never drop containers/never toss light ones as effect of rough handling is cumulative.
5. Temperature and relative humidity control are vital if refrigerated carriages are used for long distance transport of fruits.

10 Hygienic measures during post-harvest operations

- The pack house or other premises where harvested material is assembled, graded or held must be maintained in a clean and hygienic conditions.
- There should be adequate facilities for the removal of waste material on a regular basis.
- All equipments and containers used should be thoroughly washed at the end of each day's work to ensure its cleanliness and safety. Water used for washing crates, scissors and work surfaces must be of potable quality.

- The produce must be packed in clean and dry containers and the packs must be held in a clean hygienic area free from the risk of contamination during storage period.
- The produce must be transported under clean conditions and must be protected adequately during transit.

Fermentation of Fruits and Vegetables

Dr. Ranjitha K. Senior Scientist, ICAR-Indian Institute of Horticultural Research Bengaluru, Mobile No. 9740179937

Topic 1: BRINING AND LACTIC FERMENTATION OF VEGETABLES

Brining of vegetables is one of the oldest preservation methods practiced by man. Traditionally, these products form a regular component of Korean, Chinese, Japanese and Central European cuisines. The brined and fermented vegetables find value as salad items, base materials for various kinds of pickles and ingredient in several culinary preparations. The better shelf life of such products is partly due to the salt and the organic acids either added or produced by lactic acid bacteria growing in such environments. Today, we recognize that this method still offers very good possibilities both for commercial and home preservation of many foods. High cost of packaging material, storage, transportation and high energy requirement are some limiting factors of canning, freezing which motivate us to develop low cost technologies like salting, steeping and curing. Apart from this, the nutritional value and the palatability of the vegetables are also increased by the metabolism of the naturally occurring or the added lactic acid bacteria in them. Lactic acid bacteria are known to secrete various vitamins and flavour compounds. A wide variety of vegetables such as cabbage, cauliflower, cucumber, turnip, kale, carrot, bamboo shoots, onion etc., are preserved by this method. 'Kimchi', 'Atchara' and 'Saurkraut' are examples for traditionally produced popular lactic fermented products.

The pre- processing steps include washing, peeling, size reduction, seed removal, blanching etc and vary slightly according to the vegetable to be preserved. Blanching is a mild heat treatment to inactivate the softening and undesirable microflora.

In general, there are two methods of preservation of vegetables involving the use of salt. By one method, 8-10% solid salt is added directly to the vegetable material (dry salting). In the second method, the fresh vegetable material is covered either with high salt concentrations of brine (Salt stock vegetables) or 2-2.5 per cent salt brine and an acidifier (steeping). Direct salting method would be most advantageous in areas where labor, time or equipment do not permit the cutting or shelling operations of vegetables like beans and peas. If a large amount of solid salt or strong brine is used, little or no acid is produced by the fermentation. In this case, the preserving effect of the brine results mainly from the action of the salt. Salt causes the plasmolysis of the cells and inhibits the spoilage organisms. These vegetables receive a desalting treatment prior to manufacture into the finished pickle products .This is to reduce the salt level to 2-2.5 per cent which is optimal for our taste. Dry salting, using a small amount of salt (2.5 to 5 percent by weight), is usually employed for vegetables that are readily cut or shredded, that are high in water, and that contain enough readily fermentable sugar to support a vigorous fermentation. Cabbage, lettuce and turnips are typical examples of vegetables that are salted in this manner.

Indian Institute of Horticultural Research has developed technologies on the latic acid fermentation and preservation of various vegetables like cucumber, gherkins, babycorn, carrot, radish, French beans, cabbage, cauliflower, bell pepper, onion etc. suitable latic acid bacterial strains for vegetable fermentation are also been identified. Cucumbers are preserved by direct acidification or fermentation. Salt stock cucumbers are obtained by brining initially at 5% sadium chloride, brine strength is increased gradually during the course of 6-7 weeks until it reaches 15-17%. In direct acidification process, fresh, non fermented cucumbers are covered with a brine containing spices and 0.1 per cent sodium benzoate and stored at 4–70 C. In controlled fermentations, cucumbers in 6% brine containing acetic acid and sodium acetate is fermented using Pediocococcus cervisiae and lactobacillus plantarum for 2-3 weeks. To control spoilage, maintance of proper brine strength, clean fermentation, correct acidification, pasteurization and anaerobiosis during storage are essential. At IIHR, Bangalore, Gherkin varietysuitable for brine stock preservation of pickling cucumber is developed. A similar process for French beans involve packing the vegetable in brine (1:1) containing 2.5% equilibrated salt other additives followed by fermentation using lactobacillus plantarum. In modified brining process developed at IIHR enables the long term

preservation of peeled as well as unpeeled raw mango slices for subsequent use in pickling was also developed and commercialized.

Nutritional importance of brined vegetables

Unlike other rigorous processing methods, salt preservation retains most of the nutrients in the vegetables. A portion of soluble minerals may be lost during the blanching, brining, or desalting operations. The calcium and iron content in brine preserved food are distinctly greater than that of the fresh vegetables. The sweet corn preserved in brine acidified with vinegar and containing a low salt concentration possessed twice the vitamin A content of the raw or frozen corn taken as basis of comparison. Further more, many B- vitamins are synthesised during fermentation by the lactic acid bacteria. The sugars and ascorbic acid are generally lost during the fermentation period and during brine storage. When desalting is practised in the preparation of brined foods for table use, somewhat greater losses in protein and mineral may be encountered.

Shelf life of brined vegetables

Addition of salt results in prevention of softening, browning and other spoilage. The brined vegetables having 0.6-1.0% acidity with a pH 3.0-3.2 are shelf stable, provided all fermentable sugars are removed and oxygen are excluded from the product to prevent surface growth of yeasts. Besides microbiological spoilage , quality retention in terms of colour, texture and flavour are important criteria during long term storage of these products. High temperature pasteurization can also lead to softening of the products Blanching, addition of calcium acetate and sorbic acid and low temperature process and storage can eliminate such storage problems.

In conclusion, although brine preservation can result in shelf stable product with improved quality, flavour and nutrition, these kinds of products are yet to penetrate Indian market and dietary component in our food system. In recent years, brining coupled with lactic fermentation has gained importance in the vegetable preservation through out the world. India, a major producer and exporter of vegetables, can generate better revenue by fermentation of these highly perishable produces.

Topic 2: PRODUCTION OF QUALITY WINES FROM GRAPES

Wine is the alcoholic beverage derived by the fermentation of grape juice. Wine has been a part of human diet since the beginning of recorded history; and still occupies a unique position among beverages due to its nutritional, cultural and religious importance in many societies. In ancient Indian literature, wine has been referred as “Somarasa” or The Drink of Gods”, and its use in several Ayurvedic medicines is cited. Wine represents a safe, non-toxic healthful beverage and provides calories, vitamins and minerals. Wine is rich in antioxidants , moderate consumption helps to reduce hypertension and stimulates gastric secretion. Wines are classified based on colour, sugar content, alcohol, presence of CO_2 and time of consumption. White table wines are produced from grape juice and are characterised by golden colour, delicate fresh fruity flavour. Red table wines are relatively more astringent and intensely flavoured owing to fermentation with skin. Rose wines are prepared by light colured grapes or brief fermentation of the grapes along with berry skin. All these table wines contain 9-12% alcohol and usually dry with less than 0.5 % residual sugar. Semi dry and sweet table wines contain 2-5 % sugar.

Traditionally, wine making process was considered as an art, but now has developed into a science involving precise control of operations, assuring high predictability on the quality of the finished beverage. Use of suitable variety, fermentation at low temperature, and close monitoring of SO_2 levels are prerequisites for assuring the wine quality. Good quality wines can be produced at small scale as a cottage industry. Liberalised taxation and farmer friendly wine policy adopted by Govt of Karnataka and Maharashtra has made licensing for the wineries easier.

It is well established that quality grapes are a prerequisite for the production of quality wines. Grapes with 20-22 per cent sugar, 0.5-0.7 per cent acidity and pH 3.2-3.5 is desirable for wine making. Characteristic flavours such as fruity, flowery, spicy, earthy etc., are inherent to the variety or resulting from agroclimatic factors provide distinctness to the wines. Many distinctive wine types require one or more specific varieties, which contribute to

the distinctiveness of the wine. French grapes vaieties like Chenin Blanc, Chardonnay, Sauvignon blanc, White Riesling and IIHR varieties like Arka Kanchan, Arkavati, Arka Soma etc suitable for white wine making. Good quality Red wines can be prepared from varieties like Cabernet Sauvignon, Pinot Noir, Rubi Red, Arka Shyam and Black Muscat.

Freshly harvested grapes are crushed in the presence of 100ppm sulphur dioxide. The resultant must or juice is ameliorated to 220Brix by the addition of cane sugar. This is then fermented using the special yeast strains of Saccharomyces cerevisiae at 180C for 10-12 days. The fermented juice is drawn off and placed in clean containers leaving the sediment behind. This process is called racking and may be repeated several times till clear wine is obtained. To make the wine crystal clear, clarifying agents like bentonite may be used at 0.05 per cent level. The wines are finally subjected to cold stabilization by storing at 0-20C for 2-3 weeks, filter sterilized and then bottled. They are stored at 10-120C for aging process, which provide a desirable level of maturity and complexity of flavours to wines.

The production of wine demands proper use of selected grapes, skill and attention but not necessarily large and extensive establishments. The equipments and facilities required for a winery includes grape crusher/ de-stemmer , press for juice extraction, fermentation tanks with cooling facility, mixing tanks, stainless steel storage tank, sterile filters, must and wine transfer pumps, controlled temperature rooms for cold stabilization and aging and bottling machines.

Wine research at IIHR, Bangalore was initiated during 1970, and the institute has come up with technologies for quality wine production. This include production of speciality wines, skin-juice contact technique for the enhanced flavour of white wines, thermovinification for improved wine colour and biological deacdification process of high acid must like “Bangalore Blue” grapes. Blending of wines were also standardised to improve the quality of wines from grape varieties which are deficient in colours and or chemical composition. Studies conducted at IIHR indicated that a blending proportion of 2:1 or 1:1 of light coloured Gulabi with deep coloured “Baily alicante” or” Rubi red” grapes produced superior quality wine with desirable colour. Similarly, blending of Thompson seedless with Rubi red or Anab e shahi improves the wine quality. A process was standardised at IIHR for the production of flavoured wine with the incorporation of various medicinal herbs was commercialised. Process for the preparation of wine coolers with tropical fruit flavours were developed using “ Thompson seedless” base wine and juice from fruits of mango, banana and guava.

Probiotic Fruit Beverages

ICAR-IIHR has developed and commercialized probiotic fruit beverages, which is a further value addition for the fruit beverages. These beverages are free from class II preservatives. Cold chain is compulsory for storage and marketing of the probiotic beverages.

MINIMAL PROCESSING OF FRUITS AND VEGETABLES

Introduction

In recent years, Ready -To -Use (RTU) food products are highly preferred by urban consumers due to the growing income levels and women employment. Minimally processed or fresh-cut fruits and vegetables are RTU foods in which fresh commodities are cut into small serving size portions and packed to retain the fresh like characteristics. Fresh cut market in India is so far limited to unorganized sector where street vendors sell raw mango slices, jack fruit bulbs, papaya, pineapple, peeled radish and cucumber especially during summer months. Nowadays supermarkets also sell products like peeled garlic and onion, cut vegetable mix etc., Most of these products have few hours to two days shelf life and are prepared under poor hygiene, contradicting the suitability of the term “ready-to-use’. Steps in fresh cut fruits and vegetable production Unit operations in preparation of minimally processed fruits and vegetables include washing, peeling, cutting, trimming, slicing, shredding, coring, dicing, etc., followed by pretreatment, draining, surface drying and suitably packing. Fresh-cut products are highly susceptible to water loss because of the exposure of internal tissues and lack of protective skin or cuticle.

Some fruits and vegetables such as pineapple, papaya, apples, oranges potatoes, and carrots, need peeling. Even though hand peeling gives best results, large scale peeling is achieved mechanically using rotated carborandum drums, chemically or in high pressure steam peelers.

Shelf life of minimally processed fruits and vegetables is greatly influenced by inherent nature of commodity, cut size and method of peeling and cutting. Pretreatments for extending shelf life Minimally processed fruits and vegetables intended for retailing are characterized by at least a shelf life of 4-7 days and preferably longer up to 21 days depending upon the market. Shelf life of minimally processed fruits and vegetables can be improved by use of sanitizers, anti-browning agents, and firmness improving chemicals and modified atmosphere packaging. Chlorine based chemicals such as liquid chlorine, hypochlorite, chlorine dioxide are widely used as sanitizers for fruits and vegetables. Apart from decontaminating the produce, chlorine compounds inhibit enzymatic browning. As there is a growing concern on the residual activity of chlorine compounds, alternative sanitizers like citric, lactic, acetic and tartaric acid in concentrations ranging from 0.5-2% have been proven to control bacteria in vegetables. Hydrogen peroxide at low concentration (0.5-1%) is a generally recommended safe chemical for removing pathogens and their spores from fruits and Minimally processed fruits and vegetables intended for retailing are characterized by at least a shelf life of 4-7 days and preferably longer up to 21 days depending upon the market. The freshly cut produce are highly physiologically active and are characterized by increased respiration rate. Therefore a suitable package ensuring proper gas exchange is a requisite for extending their shelf life.

Modified atmosphere packaging (MAP) is a preservation technique already in use by the fresh-cut industry. This technique involves packing the produce in semi permeable flexible films so as to create an appropriate gaseous atmosphere surrounding the commodity. Low levels of O2 and high levels of CO2 reduce the produce respiration rate, with the benefit of delaying senescence, thus extending the storage life of the fresh produce. The modified atmosphere can be achieved passively (the package is sealed under normal air conditions) or actively (the package is flushed with a gas mixture before closing). The atmosphere concentrations recommended for preservation depend on the product, with a gas composition ranging from 2-5% O2 and 2-5% CO2, and the rest being nitrogen. In general, fresh-cut products are more tolerant to higher CO2 concentrations than intact products. Excessively low levels of O2 favour fermentative processes which might cause the formation of acetaldehyde and the appearance of off- Minimally processed vegetables Browning of minimally processed fruits and vegetables is mainly due to the oxidation of phenolic compounds to quinones. Traditionally, sulfites had been used as anti browning agents in food industry. However, their use is restricted due to concerns about negative effects on human health. The present strategy is to use reducing agents like ascorbic acid and its derivatives, poly phenol oxidase inhibitors like hexyl resorcinol or chelating agents like ethylene diamine tetra acetic acid and cyclodextrins. vegetables.

Treatment with calcium salts is another approach for improvement of minimally processed fruits and vegetables. Calcium helps to extend the shelf life by maintaining firmness through cross linking of cell wall. Calcium chloride and calcium lactate are the common9 e-journal November 2013 KERALA KARSHAKAN flavours compounds. Obtaining above gas concentration is usually difficult as very few packaging materials are available in market with permeability matching with high respiration rate of cut fruits and vegetables. Micro perforations made in the packs can solve this problem to a great extent. Moderate vacuum packaging Another modified atmosphere packaging is moderate vacuum packaging. In this system, respiring produce is packed in a rigid, airtight container under reduced atmospheric pressure and stored at refrigerated temperatures. The initial gas composition is that of normal air, but at a reduced partial pressure. Lower oxygen content stabilizes the produce quality by slowing down the metabolism of the produce and growth of spoilage microorganisms. It is imperative to store the minimally processed horticultural products at cold temperatures ranging from 0-8°C depending on their susceptibility to chilling injury. Fluctuating temperatures cause in- pack water condensation, which stimulate spoilage.

Conclusion

Fresh–cut fruits and vegetable technology is a simple technology for value addition of horticultural produce. Shelf life varies with respect to commodity, cut size, in- pack atmosphere and storage temperature.

Technology for production of several fresh –cut fruits and vegetables have been standardized in research institutes like Indian Institute of Horticultural Research, Bangalore, Central Food Technological Research Institute, Mysore as well as Defence Food Research Laboratory, Mysore. With growing consumer demand and improvement in cold storage system, progressive farmers, small scale entrepreneurs and farmer's associations can profitably take up production and marketing of minimally processed Minimally processed capsicum fruits horticultural products.

Pickling

***C K Narayana**

Pickling is one of the oldest forms of food preservation, dating all the way back to 2400 BC, as a way to prevent spoilage before modern refrigeration. The process involves submerging fruits, vegetables, meat, or plant roots into either a salt brine or vinegar in order to control the fermentation process.

Pickled foods add a special touch to many snacks and meals. There are many varieties of pickled and fermented foods. The four general classes are: brined or fermented, fresh pack or quick-process, fruit and relishes. In India, pickles are of three basic types; those preserved in vinegar; those preserved in salt; and those preserved in oil. In **India**, oil is a popular medium used for **pickling**.

The practice of pickling have become popular as people slowly discovered its benefits. The Greek Philosopher Aristole (384-322 BC) is said to have praised pickles as it was believed to have some curative properties. Many centuries later, explorers like Christopher Columbus (1451-1506) used to stock their ships with pickles to prevent the outbreaks of scurvy caused in sailors due to lack of vitamin C. Many international travelers recorded the usage of mango and ginger pickle as an accompaniment to meal in India, in their travelogues. It is said that 'Lingapurana' written by Gurulinga Desika, describes no less than 50 kinds of pickles. These included pickles made from wild mangoes, lime, and vegetables.

Drying of salted fish is one of the oldest methods of preservation mankind learnt. The word **'Pickle'** comes from the Dutch word 'Pekel', meaning 'salt' or 'brine'. The Hindi word 'Achar' is derived from Persian, where it means 'salted meat or fruits, preserved in salt, vinegar, honey or syrup'. Sauerkraut (sour pickled cabbage) of Germans and 'Kimchi' of South Korea are some variants of shredded cabbage pickle. Over period of time, several variants got added as people relished.

Some regions have some special variants of same pickle. Mango pickle variant 'Avakkai' (high on mustard & chilli) is popular in Andhra Pradesh; 'Aam ka Chunda' (spicy & sweet mango pickle) in Gujarat; 'Vadu manga' (tender mango) pickle in Kerala; 'Appemidi' mango pickle in Karnataka are region specific variants of mango alone. Similar is the case with several other fruit and vegetable pickles. Of late mushroom is also being pickled and relished.

The following are some of the most popular and commercially widely manufactured pickles:

i. Traditional cut Mango Pickle (with and without oil)
ii. Grated mango pickle (thokku)
iii. Tender mango pickle / Appemidis
iv. Sweet mango pickle
v. Limen / Lemon pickle
vi. Citron pickle
vii. Amla Pickle
viii. Mango-Ginger pickle
ix. Ripe Tomato pickle
x. Green tomato pickle
xi. Garlic pickle
xii. Ginger pickle
xiii. Onion pickle
xiv. Green chili pickle
xv. Karela Pickle
xvi. Turnip Pickle
xvii. Green Tamarind pickle
xviii. Mixed vegetable pickle. Etc.
(list is only indicative)

Science of Pickling

Pickling is both an 'Art' and 'Science'. As an ancient art of cooking, several household developed their own recipes. Some of them were popular by their

How does a vegetable become a pickle?

All plant foods are covered with benign bacteria, mostly lactobacillus. During pickling, these bacteria grow while suppressing the development of other bacteria that cause spoilage and disease. They do this by being the first to metabolize the sugar in the vegetable (leaving none for harmful bacteria to grow on) and by producing lactic acid and other antibacterial substances (notably carbon dioxide and alcohol), all while leaving most of the plant's nutritional substances intact, such as fiber and vitamin C. This process is called lactic acid fermentation, because the production of lactic acid preserves the vegetable and gives fermented pickles their characteristic tartness. Meanwhile, the beneficial bacteria increase the amount of B vitamins and add to the vegetable's aroma and tang.

The fermented pickling process begins when vegetables are submerged in a salt brine-basically a mixture of salt and water, but it can include flavorings like spices, herbs, garlic, or chillies. Practically any fresh vegetable can be pickled (other than fragile leafy greens like spinach and lettuces), but the most common candidates are crisp and moist, such as cucumbers, peppers, and okra. The brine should cover the vegetables at all times to limit their exposure to oxygen, thereby inhibiting the growth of fungus and mold. To keep the vegetables submerged, they're weighted down or packed tightly into jars so that they can't float to the surface.

The brine's salinity level depends on what you're pickling and the results you're going for. Crisp leafy vegetables, such as cabbage, are fermented into sauerkraut or kimchi at 1% to 2% salinity, which allows different bacteria and a variety of flavors to develop as acidity increases. The most typical brine strength for home pickling is between 5% and 6% salinity.

Within a day or two of starting a batch of pickles, you'll see bubbles of carbon dioxide gas in the liquid surrounding the vegetables, indicating that the lactobacillus is thriving and the brine has started to acidify. To allow the gas to escape, pickling containers are usually left uncovered or covered with a porous fabric, like a kitchen towel or muslin cloth, to keep out debris. The amount of time you allow pickles to actively ferment depends on how sour you want them. Relishes and half-sour cucumbers usually ferment at cool room temperatures for about a week, but you can start tasting them to check on their progress after 4 days. Full-sour cucumbers ferment for about 2 weeks, and sauerkraut or kimchi for a month.

During home pickling, what can go wrong?

1. The brine gets cloudy: Mild cloudiness (caused by small floating bits of spices or vegetable) is nothing to worry about. You can keep your brine clearer, though, by avoiding table salt, which contains anticaking agents that don't dissolve and can make brine appear cloudy. Use pickling salt, kosher salt, or unrefined sea salt.

Also, the minerals in hard water can cause cloudiness. If you have very hard water, boil it for 5 minutes, let it cool undisturbed for 8 hours, then slowly pour off the top half of the water, leaving the cloudy layer of sediment at the bottom of the pan.

2. The pickles become discolored: Avoid aluminum, brass, iron, copper, and zinc cookware, containers, and utensils, which can react with the acids developed during fermentation, causing off colors ranging from blue to pink. Instead, use nonreactive plastic, ceramic, enamel, glass, or stainless steel. Discoloration may also be caused by spoilage microbes, mold, and yeast. Garlic that appears green or blue is safe to eat, but pink pickles may indicate yeast growth and should be discarded. When in doubt, throw it out.

3. Mold, yeast, and rotten smells develop: To remove undesirable microbes, rinse vegetables and containers in warm water. During fermentation, shield your pickles from microbes in the air by keeping them submerged in the brine. To ensure that the pickles stay submerged, you can weigh them down with a small glass jar filled with water, or use a small weighty object wrapped in plastic. These steps help prevent aerobic bacteria, yeasts, and molds from consuming the lactic acid in your pickles, which can reduce the brine's overall acidity, resulting in off aromas as unwanted bacteria break down proteins and fats in the pickles. You can also keep mold and yeast at bay by fermenting pickles at a cool room temperature of about 65°F, since warmer temperatures may increase the likelihood of spoilage.

4. The finished pickles are limp: Start with very fresh vegetables; less-than-fresh vegetables won't get any crisper after pickling. If you're pickling cucumbers, avoid seedless English ones, which are rich in an enzyme that makes pickles soften during fermentation. Be sure to trim the blossom ends from all cucumbers because that's where the softening enzymes reside. You can also add grape leaves, cherry leaves, or oak leaves to the brine, as these leaves contain astringent tannins that inhibit the softening enzymes.

5. If you're cooking the vegetables before pickling, don't overcook them: Cooking will help soften dense vegetables like beets, but as heat ruptures the cell walls in vegetables, liquids are released, causing vegetables to lose their turgidity. When pickling juicy vegetables like cucumbers, raw is the way to go for the crispest results. Using unrefined sea salt or pickling salt in your brine also encourages crispness. These salts contain calcium and magnesium, which reinforce naturally occurring pectins in the vegetables' cell walls, keeping the pickles nice and firm.

In India both fruit and vegetable pickles are popular. Important among them are Mango (different variants like whole mango, cut mango, grated mango, etc), lime and lemons, karonda, amla (Indian gooseberry), mixed vegetable, radish, turnip (shalgam), tomato, onion, garlic, ginger, etc. Let us see the recipe and process flow chart for a few of these.

RECIPE FOR MANGO PICKLE WITH MUSTARD		
S.No	**Ingredients**	**Ingredients per Kilo of mango**
1	Dry Roasted Fenugreen powder	50g
2	Dry Roasted Mustard powder	25g
3	Chilli powder	50g
4	Turmeric powder	8g
5	Hing (Asafoetida)	8g
6	Sea Salt	50g
7	Gingelly Oil	180 ml
8	Mustard for seasoning	12-15g
9	Garlic peeled and crushed	12g

Process flow Chart

Select right kind of mango with high acidity (sourness) and harvest when stone/ seed is not hardened

⇩

Wash mangoes and wipe dry using a clean cloth

⇩

Cut into pieces and put in a suitable container (jar or plastic bottle or plastic drum)

⇩

Add sea salt and mix thoroughly

⇩

Leave it for 3-4 days with intermittent mixing daily once or twice

⇩

When the liquid from pieces of mangoes largely oozes out, separate the liquid and pieces

⇩

Boil the salty liquid for 5 minutes and allow to cool to room temperature

⇩

Add all the spices, seasonings, peeled and crushed garlic to the salty liquid

⇩

Now add the separated mango pieces into this and mix thoroughly

⇩

Add half the quantity of oil (boiled and cooled) and fill it back into the container used for curing

⇩

Cover with cloth or fabric and allow for another 3-4 days for the spices to seep into the fruit pieces

⇩

Fill into the glass or plastic bottles or standy pouches.

⇩

Pour remaining half the quantity of oil over the pickle in bottle and seal

⇩

Paste label and store in cool and dry place.

Lime / Lemon Pickle (South Indian Style)

Ingredients

- 1 Kg Lemon / Lime
- 125 grams common salt
- 50 grams chili powder
- 8 grams Asafoetida
- 1 Table spoon turmeric powder
- ½ Cup Gingelly Oil

Preparation Flow Chart

Wash Lime / Lemon in clean water and wipe off the surface moisture with tissue

⇩

Cut the lime / lemon into quarter pieces using a clean knife

⇩

Heat Gingelly Oil (¼ cup) in a pan / kadai and put cut lime and saute for 10 minutes over low flame

⇩

Add Salt, Chili powder, asafoetida and turmeric powder and mix well.

⇩

Add the remaining half the quantity of oil and bring to boil on low flame

⇩

Take off the heat and allow to cool

⇩

Put in a clean, moisture free jar (glass/plastic/ceramic)

⇩

Allow it to cure for 10-15 days

⇩

Pack in bottles, label and store

S.No.	Ingredients	Quantity
1.	Chopped Carrots	100 g
2.	Chopped Cauliflower	50 g
3.	Shelled peas	50 g
4.	Chopped cucumber	50 g
5.	Red Chilli powder	50 g
6.	Lime juice	20 ml
7.	Crushed garlic	5 Cloves
8.	Mustard seeds	10 g
9.	Fenugreek Seeds	5 g
10.	Curry Leaves	7-8
11.	Rock Salt	40 g
12.	Gingelly Oil	100 ml

Mixed Vegetable Pickle

Preparation Flow Chart

Dry Roast Fenugreek and Mustard Seeds (separately) and powder

↓

Crush the Garlic Cloves

↓

Add Chopped Vegetables to a bowl

↓

Add Chilli powder + Salt + Lime Juice+ Fenugreek Powder + Mustard Powder + Crushed Garlic

↓

Mix all ingredients well

↓

Add one Half the quantity oil and mix

↓

Heat one quarter quantity of oil in a kadai & add mustard seeds, cumin seeds and chopped garlic and saute till brown

↓

Add little hing/asafoetida and curry leaves and saute

↓

Add the above tempering material to the pickle and mix well

↓

Fill into the bottle and cover with one quarter left over oil and seal

Tomato Pickle

S.No.	Ingredients	Quantity
1.	Tomatoes	1 kg
2.	Salt	100 g
3.	Red Chili powder	50 g
4.	Whole Red Chili	3-4
5.	Mustard Seeds	10 g
6.	Fenugreek seeds	5 g
7.	Garlic	1-15 cloves
8.	Split Bengal gram	5 g
9.	Split Black gram	5 g
10.	Tamarind	30 g
11.	Gingelly Oil	200 ml
12.	Curry leaves	7-8

Preparation Flow Chart

Wash, swipe dry and cut tomatoes

↓

Heat 100 ml oil in a Kadai

↓

Put cut tomato pieces in hot oil and cook till it becomes soft

↓

Add tamarind to the boiling tomatoes

↓

When done remove from flame and cool

↓

Dry Roast Fenugreek and Mustard Seeds (separately) and powder

↓

Grind the cooked tomatoes along with 7-8 garlic cloves, salt, chilli powder, fenugreek and mustard powder

↓

In a Kadai heat the remaining 100 ml oil, temper with mustard seeds, zeera seeds, crushed garlic, spilt black gram and Bengal gram, curry leaves and whole red chillies

↓

Add the ground tomato paste (made above) to the seasoned material and mix well. Allow to cool

↓

Fill in the clean bottles or pouches or ceramic pots and seal

Sweet Mango Chutney

S.No.	Ingredients	Quantity
1.	Peeled and Grated green mango	400 g
2.	Fennel / Saunf	5 g
3.	Fenugreek seeds	5 g
4.	Azwain	5 g
5.	Mustard seeds	5 g
6.	Sugar	400 g
7.	Salt	5 g
8.	Turmeric Powder	3 g
9.	Red Chilli powder	5 g
10.	Cashew	5-6 Kernels
11.	Raisins	10 g

Preparation Flow Chart

Take raw green mango, wash, dry and peel the skin

↓

Grate it into shreds using a carrot shredder

↓

Dry roast Saunf, Methi, Azwain and mustard seeds

↓

Grind coarsely using pestel and mortar or mixi jar

↓

Heat a frying pan and put shredded mango and sugar and keep mixing till it melts and shreds cook in sugar syrup

↓

Add red chilli powder, Salt and Turmeric and mix well. Continue cooking on low to medium flame

↓

Add ground speices (as above) and mix well . Continue cooking.

↓

Add a few broken kernels of cashew nut and a few raisins

↓

Allow to cool to ambient temperature and fill in bottles and seal

****

Packages for processed products

*S. Bhuvaneswari

Packaging

The aim of packaging is to protect the product during handling, transportation and storage until the customer finally uses it. The type of packaging is determined by the nature of the product. It is function of the product, the package and environment through which the product is transported, stored and sold. The shelf life of a product is based on the protection required for the product under ideal packing and storage conditions.

Attributes of good package:

(1) It must attract attention
(2) It must tell the product story- what it is , what size , how much
(3) It must build confidence
(4) It must look clean and hygienic
(5) It must be convenient to handle and to carry
(6) It must look like good value
(7) It must deserve a preferred display
(8) It must prevent spoilage during the selling period
(9) It must resist soiling

Different forms of packages:

Food packages may be divided according to the primary constituent material into four groups such as 1)Paper and paper based packages
2)Glass packages
3)Metal packages
4) Plastic packages

Paper and Paper Based packages

The raw material of paper is mainly cellulose. Wood which is about 50% cellulose is the major raw material for paper.

Papers are broadly divided into coarse grade used in packaging and fine grades used for writing and books.

Natural or unbleached kraft is a light brown paper available in four grades such as grocer's bag,shipping sack, wrapping paper and gumming paper. These are strongest paper, relatively low cost and efficient production. By using special additives or treatments natural kraft can be given smooth surface, water repellency, higher tensile strength, lower transmission.

When good appearance features like whiteness,brightness and printability are needed bleached papers are used. They have a smooth surface, but their mechanical properties are not as good as unbleached papers. They are used for special wrapping and labeling.Common denotation for finished bleached papers are MG(machine-glazed) glazed on one side and rough on other side and MF(machine- finished) where both sides are smooth.

Glassine is a transparent paper with high grease,air resistance and a glass like smooth surface. Waxed glassine, an excellent moisture barrier is used for wrapping and for bags were transparency and barrier properties are important. Grease papers are similar to glassine but without smooth surface. Parchment paper is translucent, sterile when made,greaseproof, strong when wet and printable. It is used for greasy foods such as butter.

Chip board is a paperboard made from recycled materials, mostly old paper with some scrap added for strength. It is often used for cereal boxes.

Paper bags:

There are 4 basic types of paper bags namely flat, square, sachet bottom and automatic or SOS (self opening style). The square and SOS bags have gussets which are reverse folds in their edges. Flat and square bags are similar in that they both are made from a tube with a single or double fold on the bottom.. Automatic and sachet type paper bags are able to stand up or lie flat for shelf display. They are used for consumer foods, flour, pet foods

The basic material for paper bags is kraft ,but kit is often combined with other materials, coatings, laminations or plies of reinforcing or barrier materials to obtain the properties required by the product and the packaging operations.

Corrugated Fibre Board(CFB):

CFB are mainly used for shipping containers. CFB consists of a sheet of corrugated paper, commonly called medium which is glued to one or two flat sheets of paperboard, called liners. Based on the number of mediums, there are single, double and triple walled corrugated board. Single wall board is known as single or double faced corrugated board, depending on the number of liners. The thickness of the corrugated medium is nearly constant, By varying the thickness of the liner different strength of corrugated board can be obtained. Based on the height of the corrugations and the number of corrugations per foot, there are 4 different flute styles designated as A,B,Cand E. Different types of boards are used for different purposes. A-flute gives good cushioning against shock and good compression resistance while B-flute has maximum crush resistance. The properties of C-flute is inbetween. E-Flute corrugated board has a very good printing surface.

Advantages:

Low Cost to strength and Weight Ratio
Smooth non abrasive surface
Good cushioning properties
Easy to set up and collapsible for storage
Reusable and recyclable
Easy handling and stacking
Can be turned quickly into highly precise and accurate sizes and can be punched for ventilation.

Disadvantages:

Stacking strength decreases with the duration of load and high humidity.
The corrugated board sometimes is coated for special purposes like water resistance, higher stacking strength under high humidity condition. Considering the sales value and volume corrugated fiberboard is the most commonly used packaging material.

Folding cartons:

The folding carton is one of the most important rigid packaging forms. It is a container which is made from bending paperboard. It is the cheapest type of rigid packages especially in large quantities. Folding cartons are shipped and stored in collapsed form. They are erected immediately before the filling operation. This results in very low shipping and storage costs. Using the right printing method an excellent appearance on the retail shelf is possible. With the use of adequate paperboard material and design features, the folding carton has relatively good strength properties.

Metal Containers:

Metal containers are one of the most important forms of food packaging. Rigid metal containers include cans, drum and pails. Semi rigid metal containers the collapsible tubes have become more common in food packaging.

Advantages of metal containers:

1) They are hermetically sealed so they are able to prevent any material transfer (microorganism, insects, moisture, oxygen and flavour) between environment and the packaged product.
2) Their strength provides easy stacking material handling and transportation
3) They can be stored on the retail shelf easily.
4) They are convenient for customer use.

Their use is well adopted to thermal processing of food products.

The most commonly used material for metal cans is called tinplate which is really steelplate with a layer of tin coated to it by electrolytic process. The conventional 3-piece can consist of a body and two ends. The body is made from blank plate, which is bent into a cylindrical shape. Then the two ends pf the plate are joined to each other, making the seam. Based on the plate and the expected product in the can, the seam can be made by 3 methods, soldering cementing and welding. The ends may be made of idfferfent materials, as when the bottom is steel and the top is aluminium with an easy open pull tab. Inside the can, protective organic coatings called enamels are used to prevent corrosion. The enamel must be formulated to suit the needs of each particular product.

Glass containers:

Glass as a packaging material is very popular in the food industry.

Advantages:

1) It is completely inert and its permeability to gases vapour and liquids is zero.
2) It can be produced at low cost.
3) They have a very high resistance to compression or internal pressure.

Disadvantages:

1) High weight and fragility.
2) If transparent, it is disadvantageous to the product which is sensitive to light.

Most commonly used glass containers in food industries are jars, mugs and tumblers.

Rigid Plastic Containers:

Plastic containers have replaced conventional glass, paper and metal containers in many areas of food packaging.

Advantages:

1)Weight and chances for breakage of plastic containers are less than for glass containers.
2) They show better corrosion resistance than metal containers.
3) The mechanical properties of plastic containers are not as affected by humidity as paper and their permeability to gases, vapour and liquids is much lower also.

Disadvantages:

1)Plastic containers are more temperature and time sensitive than other packaging materials.

Many different polymeric materials are introduced and used but there are really only four significant resins: Polyethylene(low and high), Polypropylene, PolyVinylchloride and Polystyrene

Flexible packages:

Flexible packages includeds plastic films and combinations of plastic films with paper other plastics or foil, known as laminates. These containers include bags,pouches,skin,blister and shrink packages. The flexible packages are among the least expensive packaging forms. The difference between bag and pouches is that bags are made first and later they are filled and closed at another plant. But pouches are made, filled and closed in one operation generally on a form fill and seal machine. Bags and pouches may be made of simple plastic films or they may be coated or used in laminations. In many cases there exists no single film which is able to satisfy all the requirements of clarity, sealability barrier properties, price, machinability compatibility.

To obtain a plastic film which is nearly ideal for such situations, different properties of different films are combined by coating or lamination. The coating is applied on one or both sides of the film and is very thin. Coatings are able to modify heat sealing behaviour,barrier properties, handling characteristics, scratch resistance etc. One of the best example is cellophane, which is not heat-sealable and is a very poor moisture barrier. With various coatings it is one of the most important packaging films.

Any combination of different plastic films or plastic and non plastic(aluminium,

paper)layers,where each ply is thicker than 0.25 micron is called laminate. The laminate should be designed for a given need. For example, a plastic with good printability may be used as an outside layer, the next layer can be a good barrier while another can give strength to the laminate and the inner one with no interaction with the product.Many times plastic films are laminated with paper where the paper gives strength or with aluminium foil where the foil gives excellent barrier properties and some strength.

Aseptic packaging:

New development of worldwide significance has been the composite paper carton which is capable of being sterilized and then aseptically filled with sterile liquid products. This process is called aseptic packaging even though it is both a packaging and processing technology. This technology allows foods such as milk to be packaged in relatively inexpensive flexible containers and which do not require refrigeration. This means that milk and juices can be distributed in parts of the world where refrigeration is not common. The packaging material is made from laminated roll stock consisting (from the outside inward) of polyethylene, paper, polyethylene, aluminium foil, polyethylene and a coating of ionomer resin. The roll stock enclosed in a cabinet at floor level is drawn upward as a continueous sheet through a hydrogen peroxide bath near the top of the machine. The sheet is passed through squeeze rollers to remove excess peroxide and the descending sheet is formed into a tube that is exposed to radiant heat to complete the sterilization and remove traces of peroxide. Next, the tube is further formed into a rectangular shape, end sealed at package-size intervals, filled with presterilized liquid food, top-sealed and separated into individual package units in a continueous operation. Commercially sterile liquids have a shelf life of several months at room temperature in the exceptionally light weight form-fill-seal package. Several form-fill-seal systems have been developed to take advantage of the rapidly growing aseptic package market.

Different packages for different processed products

The packaging should match the characteristics of the food which the package contained.

Poly propylene containers

For Vegetable salads dressing with mayonnaise

PP film and laminated bags,

For dried candied fruits, dried and fried mixed vegetables,

Easy-open cans

For fruit and vegetable juices

Long-neck glass bottles

For fruit juice concentrates

PP bags and metallized film-laminated bags
For snacks, dried cut flowers, potpourri, etc.

Filter paper, waxed paper and paper/foil/transparent film
For tea, herbal teas and coffee

Packaging of Processed Beverages

Plastic flexible film and semirigid packaging products are the major materials used.

Lighter and more compact packaging is being improved, with Polyethylene Terephthalate (PET) and High Density Polyethylene (HDPE) replacing other plastics, aluminum replacing steel and tinplate Glass, tinplate, aluminium playing a lesser role generally.

Rigid Containers

Rigid containers are made of plastic, glass, aluminum and heavily waxed cardboard and are suitable for all packs. These are often reusable. Straight or tapered sides on rigid containers make it much easier to remove frozen foods.

Glass jars used for freezing should be made for the purpose. Regular glass jars may not withstand the extremes in temperature. Do not use regular, narrow-mouth canning jars for freezing foods packed in liquid. Expansion of the liquid could cause the jar to break at the neck.

Cans, such as shortening and coffee cans, are good for packaging delicate foods. Line the can with a food-storage bag and seal the lid with freezer tape because they are not airtight.

Packaging not sufficiently moisture/vapor-resistant for long-time freezer storage includes ordinary waxed paper and paper cartons from ice cream and milk

Supply Chain Management of Horticultural crops

Vijay Rakesh Reddy S., Division of Post Harvest technology & Agril. Eng., ICAR-IIHR, Bangalore
Email: drrakesh.reddyiihr@gmail.com

The supply chain management is the management of a network of interconnected businesses involved in the ultimate provision of product and service required by the end customer (Mentzer, 2007). The horticultural supply chain includes entire vertical chain of activities from the supply of input (seed, fertiliser, chemicals) through production, postharvest operations, distribution and retail. Presently, not many details are available in the public domain related to the supply chain management of agricultural commodities in India. There is a need for a new revolution to bring down the prices of agricultural produce for consumers through an efficient supply chain management and incentivise farmers to increase their production (Roy, 2015). The supply chain for horticultural products in India is highly fragmented and skewed away from producers for its inherent features like small landholding, illiteracy, poor access to organised finance, markets and information (Singh 2009). A number of supply chains are operating in India for the movement of commodities from the farm gate to the ultimate consumer.

Several factors are driving an emphasis on supply chain management. First, the cost and availability of information resources between entities in the supply chain allow easy linkages that eliminate time delays in the network. Second, the level of competition in both domestic and international markets requires organizations to be fast, agile, and flexible. Third, customer expectations and requirements are becoming much more stringent. So to satisfy the consumers, SCM system should operate with the two main objectives timeliness and quality.

A large set of activities besides purchasing is part of supply chain management. Each of these seemingly diverse activities is part of a network that will define how efficiently and effectively goods and information flow across a supply chain. The activities include

i. *Purchasing*: Most organizations include purchasing as a major supply chain activity since purchasing is the central focus.

ii. *Quality control*: Almost all organizations recognize the importance of supplier quality and the need to prevent rather than simply detect quality problems. Progressive organizations work directly with suppliers to develop proper quality control procedures and processes.

iii. *Demand and supply planning*: Demand planning identifies forecasts of anticipated demand, inventory adjustments, orders taken but not filled and spare part and after-market requirements. Supply planning is the process of taking demand data and developing a supply, production, and logistics network capable of satisfying demand requirements.

iv. *Material or inventory control*: The material group is often responsible for determining the inventory level of finished goods required to support customer requirements, which emphasizes the physical distribution (*i.e*., outbound or downstream) side of the supply chain. The inventory control group is often responsible for determining the inventory level of finished goods required to support customer requirements, which emphasizes the physical distribution (i.e., outbound or downstream) side of the supply chain. v. Order processing: Order processing helps ensure that customer receive material when and where they require it. It represents a link between the producer and the external customer.

vi. *Production planning, scheduling and control*: Production planning, scheduling and control involve determining a time-phased schedule or production, developing short-term production schedules, and controlling work-in-process production. vii. Warehousing / distribution: Warehousing / distribution is particularly important for companies that produce according to a forecast in anticipation of future sales. viii. Customer service: Customer service includes a wide set of activities that attempt to keep a customer satisfied with a product or service.

Supply chain development (Figure 1) not only benefits the private sector but also creates spin-offs that stimulate social, economic and environmental sustainable development in the region (employment generation, added value, minimization of product losses etc.)

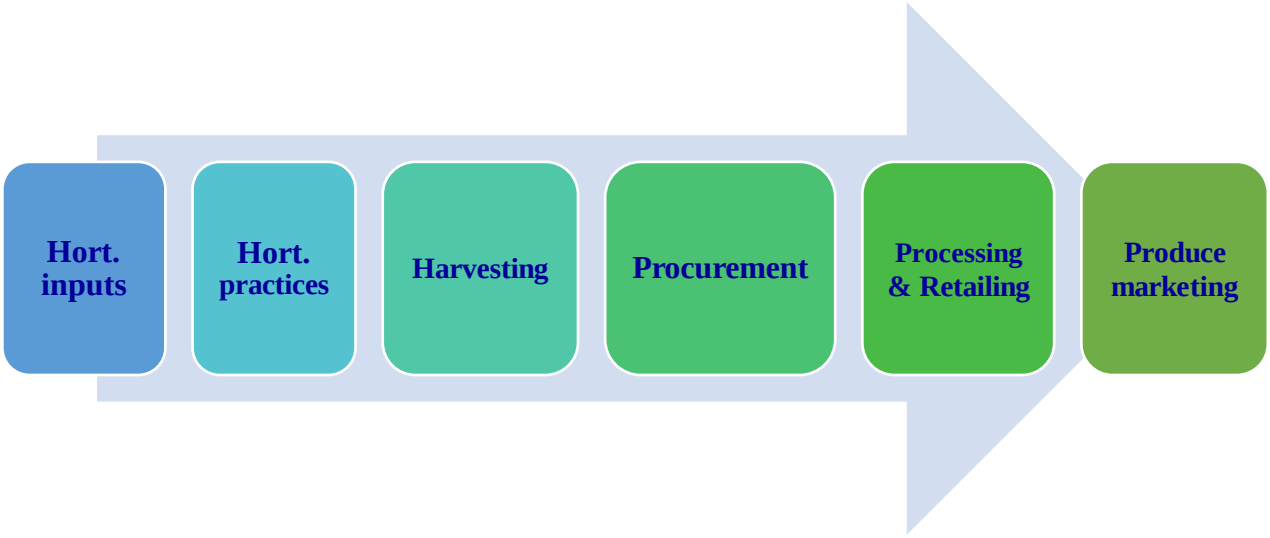


Fig.01. Illustration of a typical horticultural supply chain

Postharvest factors affecting the supply/value chain of perishable produce

There is high loss in the value chain of horticultural produce, due to high perishable nature and in the absence of adequate post-harvest and marketing infrastructure. The cost of transportation and ripening cost is also high although the facilities are conventional in nature leading to higher wastage. As there is negligible cold chain post-harvest infrastructure available in the country, by the time the produce reaches the retail level, wastages become very high adding to the selling cost. With modern ripening facilities and cold chain infrastructure, the present losses can be reduced to a great extent and value realization at each level of the value chain can be increased.

Inadequate post harvest management infrastructure: Non-availability post-harvest infrastructure at farm level is a major gap in the supply chain of the horticultural crops. Farm level collection centers are mostly absent; sorting, grading, washing, packaging and other crop specific post harvest activities are virtually absent at the farm proximate level. This leads to higher losses and lowers the value realization by the players along the value chains especially producers.

Poor packaging practices: Most of produce transportation to the mandi/units is done without proper packaging or insulation leading to high losses in the form of wastages. Typically, in the market yards the produce is dumped on the ground for weighing and price negotiation. Some sorting and grading is done manually in the market yards before dumping into the transporting vehicle again for further transportation. Such handling causes higher wastages.

Long and multi-layered supply chain: The large numbers of small farmers are unable to effectively bargain a better price in the wholesale markets both in the case of fresh market and processing industry. Inefficiencies in wholesale markets coupled with small farm size results in a long chain of intermediaries, multiple handling, losses in quality and increase in the gap between producer and consumer prices. Intermediaries and system inefficiencies consume a disproportionate share of consumer prices. Large number of small retailers, each handling small quantities, create high overheads is leading to high margins on produce making the consumer pay for the inefficiencies in the marketing chain.

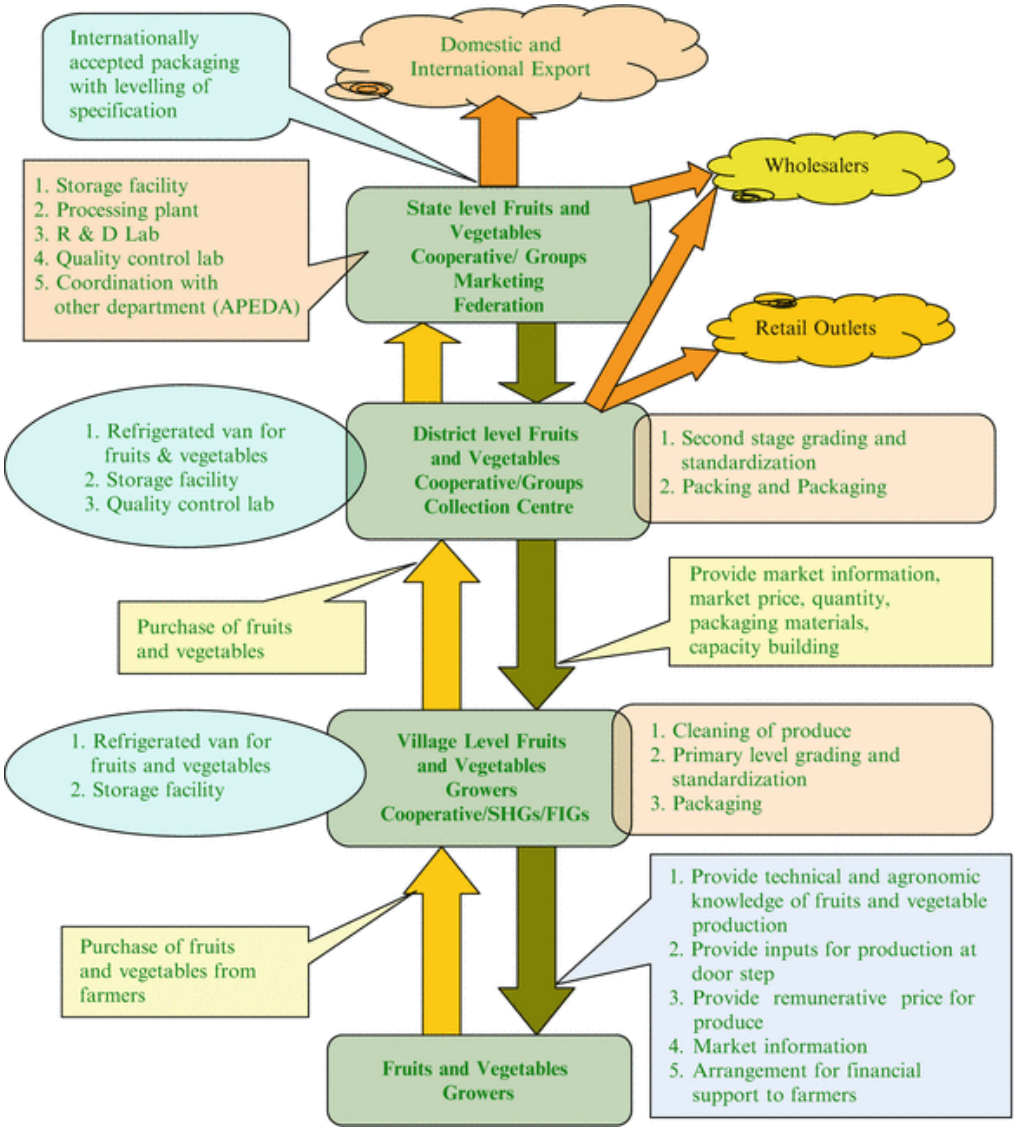


Fig.02. Supply chain management for small and marginal farmers (Singh, 2009)

Lack of cold chain facilities and scientific ripening chambers: Integrated cold chain infrastructure is low for horticulture produce in the country with very less use of refrigerated trucks even in case of highly perishable produce. There is need for more cold stores near the major consumption centres. Moreover, many of the existing cold stores have outdated technologies and hence have low energy efficiency. Further, availability of trained human resources for technical operations in cold stores is inadequate. There is need for new modern ripening facilities for different fruits at major consumption centers. The existing ripening chambers use out dated technologies. They can be upgraded with ethylene generators, automated temperature control, palletization facilities, *etc*. This will ensure better quality and longer life of the fruit ensuring higher price realizations for the producers and better quality product to the consumers.

The entire supply chain management process is a value chain where bottlenecks, value adding factors and liability factors are identified and addressed, thus enabling the retail organization to have an efficient supply chain. The supply is the part of retail operations that ensures that the right product is in the right place, at the right time and at the right cost.

Collaborative Refresher Training Program (RTP)
on
Opportunities for Value addition in Horticulture for established Agripreuners under ACABC
MANAGE- IIHR Bengaluru
14-16, July 2021
(online—link to be sent)
Coordinators: Dr V K Jayaraghavendra Rao , Dr C K Narayana ,Dr Venkattakumar, IIHR

Programme Schedule

Date	Time	Topic	Resource Person
Day 1 (Wednesday)			
14-07-2021 Wednesday	10.00- 10.45 Hrs.	Inauguration	Director(Dr B.N.S Murthy), Heads, Resource persons and all participants and Director MANAGE (Dr Shahaji Phand)
	10.45- 11.45 hrs.	Refresher orientation tips to ACABC incubates and trainees	MANAGE, Dr Sai Maheshwari
	11.45- 12.45 hrs.	Entrepreneurial dynamics and sustainability in Horticulture	Dr V K Jayaraghavendra Rao
	12.45-1330 hrs.	Lunch Break	
	13.30 - 14.45 Hrs.	Post-harvest management and value addition in fruits & Vegetables - A National perspective	Dr.C.K.Narayana
	1445-1600 hrs.	Advances in post-harvest management of fruits & vegetables	Dr.D.V.Sudhakar Rao
15.07.2021 Thursday	**Day 2 (Thursday)**		
	09.30 - 11.00 hrs.	Drying & dehydration of fruits & vegetables	Dr.R.B.Tiwari
	11.00 -12.45 hrs.	Fruits & vegetables beverages	Dr.C.K.Narayana & Mrs. Pushpa Chethan Kumar
	12.45 – 13.30	Lunch Break	
	13.30 – 14.30	Osmotic dehydration	Dr. R.B.Tiwari
	14.30- 16.00 hrs.	Pickles & Chutneys	Dr. C K Narayana

Day 3 (Friday)

16.07.2021 Friday	09.30 - 11.00 hrs.	Packaging of processed products	Dr.S.Bhuvaneswari
	11.00 hrs. 12.00Hrs	Fermentation of fruits & vegetables	Dr.K. Ranjitha
	12.00 – 13.00	Business planning and licensing procedures	Dr.C.K. Narayana Dr.Vijay Rajkesh Reddy
	13.00 -14.00	LUNCH	
	14.00 hrs. to 14.30 hrs.	Role of FPOs in tapping Value addition opportunities in Horticulture	Dr Venkattakumar
	14.40 – 15.40 hrs.	Valedictory, feedback and winding up	

2021

ICAR-INDIAN INSTITUTE OF HORTICULTURAL RESEARCH
HESSARAGHATTA,BENGALURU-560089
KARNATAKA
Ph : 080-23086100