

V SUMMARY AND CONCLUSION

India being the leading production in fruits and vegetables it is imperative for food security to meet up the growing food demands and it can be attained by meeting the four main elements of availability, stability, utilization and access. India with its current production of around 32 million MT of fruit accounts for about eight per cent of the world's fruit production. Banana contributes 37 per cent to total fruit production in India. Guava is the fourth most widely cultivated crop in India with a production of more than 1.80 million tonnes in 0.15 million hectares. India also leads the world in papaya production with an annual output of about three million tonnes. Majority of 60 to 70 per cent of fruits produced in India are consumed domestically and two per cent of fruits are being processed. Out of the total production only one per cent is being exported and post-harvest losses account to 20 to 30 per cent of the stored fruits. Processing of fruit crops not only aids in minimizing the postharvest losses but also increases the shelf life to make it available for a long period. Food processing can be a good source of income for small community based production groups as well as to community based women empowerment groups. Education and training on fruit processing helps to motivate the farmers for more production, facilitates the consumer to use the fruits during off season and offers an opportunity to raise the economy of independent entrepreneur with increasing market avenues for value added fruit products.

Hence the present study entitled "Processing and Packing of Selected Major Cropped Fruits and Their Promotion through Capacity Building Programme 'was undertaken with the objectives to formulate value added products from major cultivated fruits namely banana, guava and papaya, evaluate the acceptability of formulated fruit products, analyse the nutrient content and identify the best packaging material for the formulated fruit product, study the shelf life of formulated value added products and promote the developed fruit products through Self Help Group women and farmers for entrepreneurship. The production scenario of banana, guava and papaya was collected from secondary sources and market survey on the availability of processed fruit products and consumer preference towards fruit product were collected by questionnaire and the fruits were processed by dehydration, pulping and pickling

techniques by purposive sampling method and quality analysis of the formulated products packed in various materials was carried out and capacity building programme on fruit processing to Self Help Group women and Farmers was conducted and women who became a successful entrepreneur was observed by a case study.

The salient findings of the study are summarized below:

- India is the top banana producing country in the world with the production of 26.2 Million Metric Tonnes (MMT)..
- The top guava producing country is India with the production of 163.37 MMT
- Papaya production in India is 39 Million Metric Tonnes
- Tamil Nadu is the top producer of banana with the production of 8.25 Metric tonnes.
- With the production of 92 Metric tonnes Tamil Nadu ranks 10th position in Nationwide.
- Andhra Pradesh is leading state in papaya production with 11.38 Metric tonnes.
- It is observed from market survey that none of the fruit products were available more than 43 percent of the departmental and small store outlets.
- Whole seller played a small role in marketing fruit products.
- It is identified that 52 percent children and 42 percent adolescents preferred fruit jelly and jam respectively.
- It is noted that 83 and 79 percent of consumers were satisfied with the product packing and product labeling which is available in the market.
- Consumer surveyed revealed that 69 percent of the consumer showed interest to buy an innovative product of locally available fruits.
- It is observed that 44 and 24 percent of children and adolescents expressed the availability of fruit products were very less.
- Irrespective of the varieties the edible portion of banana found to be 70 to 78 percent which was due to the skin thickness.

- The colour of red, glucose, nendran and rasthali varieties of banana changed to deep yellow on osmotic dehydration .
- Country and Hill guava and red and yellow papaya took 36 and 48 hours on sun drying respectively.
- The wastage of peel in banana ranged from 20-30 percent which was maximum when compared to guava and papaya.
- The yield of guava and papaya pulp was ranged between 83-96 percent with a minimum wastage of four and 17 percent of peel and seed.
- Addition of high amount of oil used as one of the main ingredients to increase the shelf life of the fruit pickle.
- Though the total mean score ranged between 13- 14 on 90 days storage the acceptability was satisfactory in sun dried banana.
- The mean organoleptic score of the microwave dried banana stored for three months showed slight differences. The mean score for flavor and texture was ranged between 2.5 to 2.9 in 90 days of storage.
- In the case of cabinet drying the maximum acceptability score of guava and papaya was reduced from 22.7 to 12.
- All the selected varieties of banana processed by osmotic dehydration method stored till 90 days found to possess maximum acceptability scores.
- Among the drying methods the antioxidant activity in microwave dried fruits was maximum.
- Although losses have occurred during the process, the vitamin C content of guava retained in all four drying methods.
- The carbohydrate and vitamin A content of dried papaya dices was found to be maximum when compared to papaya fruit.
- The potassium content of dehydrated banana increased maximum in microwave drying.

- This study also proved that the per cent of moisture and fat was very low for dried papaya dices than papaya fruit which accounted for 15 per cent and 0.5 g respectively.
- Air tight plastic container found to be more suitable for the storage of dried fruits dehydrated by microwave method up to 90 days.
- The increase in microbial count in red banana, poovan rasthali, robusta, neypoovan and nendran were found to be between 03(10^3 CFU) and 04(10^3 CFU) on 90th day which was at accepted safe level of 10^3 CFU.
- Osmotic dehydration was found to be the best method for the long shelf life of dehydrated fruits since the total plate count was negative till 60th day of storage.
- The total required and desirable attributes of banana candy were accepted by the panel members.
- The mean hedonic scale of banana candy also showed the variation 1 had 7.56 score and it was acceptable by the panel list.
- Rank correlation also proved that variation I was highly correlated when compared with other variations in terms of appearance, colour, flavour, taste and texture.
- Banana candy with the addition of jaggery and fat improved the value of energy, carbohydrate and fat as against banana alone.
- Shelf life study revealed that even after 60 days of storage there was no change in the sensory attributes and the banana candy was acceptable.
- The mean hedonic scale between 7 and 7.5 for banana candy indicated that the value added products of banana candy was acceptable for consumption even after 60 days.
- During the two months period of storage there was not much change in the nutrient content of the banana candy.
- Guava candy with five grams of guava pulp was found to be highly satisfied and correlated at high level based on five point score card and hedonic scoring.

- Besides increasing the shelf life of guava, the energy, protein, fat, carbohydrate and iron values were increased and considered as value added guava candy.
- The shelf life study by hedonic scale and score card revealed that the attributes like appearance, colour, taste and texture were highly acceptable and the mean score on 60th day was 18.6 which were found to be at desirable level.
- Except carbohydrates and ash content, there was no change in the nutrient content of guava candy after 60th day storage.
- The mean score for all attributes for the variation I of papaya sauce was between 3.5 and 4 and the hedonic score also showed that variation I of papaya sauce was liked extremely well followed by other variations.
- Among the six variations 'r' value also indicated that papaya sauce with variation I was highly acceptable and positively correlated.
- It is proved by the rank correlation analysis that the candies with the addition of five grams each of banana, guava and papaya were positively and highly correlated and acceptable.
- It is ascertained that the health benefits for consumers are achieved with the enhancement of nutritive value of papaya candy as against fresh papaya fruit.
- The mean score and hedonic rating scale for papaya candy on 60th day obtained the overall acceptability scale at the highest level. Thus it was highly acceptable and shelf life of papaya candy was very good.
- Though some differences in the nutritive value of the papaya candy were noted it did not affect the major nutritional quality of the papaya candy after 60th day of storage period.
- Among the candies, papaya candy had maximum moisture on 60th day followed by guava and banana candy. However, they were at safety level.
- Though the microbial count was observed on 30th day and 60th day of storage all the candies were at safety limit and the attributes like taste, flavour and appearance were found to be desirable.

- It is obvious that among the variations minimum amount of five grams of pulp was only suitable to get a standard candy. Thus the variation I possessed required and desirable attribute and statistically proved that it is highly accepted by the panel members.
- The wastage of fruits like banana, guava and papaya ranged between 25 and 35 per cent while the edible portion of fruits ranged between 65-75 per cent. Among the three fruits, papaya had maximum pulp.
- Food cost of candies varied but the number of portions of papaya was maximum (216 portions) followed by guava and banana since papaya had minimum wastage while banana had maximum wastage.
- It can be inferred that the mean score of variation 1 for appearance, colour, flavour, taste and texture was between 3 and 3.5. Variation 1 with 100g of banana pulp was found to be highly acceptable and contains the desired attributes.
- There is an increment in the energy value of banana sauce mainly with the inclusion of sugar.
- Up to 30th day the mean score obtained was 15-17 for banana sauce which was desirable.
- There is an increment of antioxidant activity, total sugar and total fibre where as there is meager changes in energy and carbohydrates content during storage.
- It is observed that variation 1 has scored as highly acceptable, based on mean attribute which fall between the value of 3.5 and 4.5.
- Variation 1 has got the highest degree of correlation since all the attribute was highly acceptable.
- Besides raising the value of the guava sauce the study ascertained that the shelf life was improved and made available throughout the year especially during off season.

- Guava sauce was very good up to 30th day with the mean score of 18.2 while on 60th day; the mean score was only 12.2.
- Guava sauce was liked moderately by 60 per cent on 60th day storage.
- The study indicated that the nutrient content of guava sauce was increased in small amount of most nutrients such as total fibre, total sugar, antioxidant activity, iron and sodium content but energy and protein content of the sauce during 60 days shelf life was decreased.
- Among the three variations of papaya sauce Variation 1 with 100 g of papaya pulp was highly acceptable due to highly desirable and satisfaction by the panelist.
- Papaya sauce with Variation 1 was highly and positively correlated because all the attributes like appearance, colour, flavour, texture were scored at the highest level.
- Value of papaya sauce also enriched by the addition of ingredients like sugar, salt and fruit pulp in the preparation of papaya sauce.
- The mean score value of papaya sauce was in the ratio of 4.4-4.5 which comes under the upper limit of acceptability.
- Though 70 percent like moderately, 30 percent mentioned that papaya sauce was liked very much on 60th day of storage it was at safety level. However, 40 percent liked papaya sauce extremely on 30th day of storage.
- There is no change in the nutrient content of papaya sauce on the 60th day when compared to that of the 30th day storage.
- The moisture content of guava and banana sauce was increased except papaya sauce. In spite of this change, it was highly desirable and acceptable.
- Even though the microbial count was observed on 60th day shelf life it was found that the acceptability of all the sauces was scored at the highest level by the panelist.

- Variation 1 with 100 g of pulp was selected as the standard portion by the panel list because variation I got the maximum score for appearance, colour, taste, flavour and texture.
- As observed in candy, papaya sauce had maximum edible portion followed by guava and banana.
- As there is difference in cost of fruits, the cost varied among the sauces prepared using banana, guava and papaya.
- Capacity building programme increased the knowledge of self help group women and farmers in the aspects of prerequisites for fruit processing, financial planning, processing and marketing of fruits
- The capacity building programme facilitated women to become a successful entrepreneur which is obvious from the case study report.

Conclusion

Thus the study revealed that sun drying, microwave drying, cabinet drying and osmotic dehydration are best suitable for processing the locally available fruits namely banana, guava and papaya. The formulated products such as fruit candies and fruit sauces are one of the nutritious and health benefit food. The shelf life study of these products also showed that these products can be stored for three months at room temperature without having any defect or deterioration. But the suitable packaging material for candies is aluminium foil. As a result of capacity building programme on fruit processing the self help group women can able to generate a new source of income which improves the standard of living.

Implications of the Study

- The dehydrated papaya can be consumed 100-300g to meet the daily requirements of vitamin A.
- The daily requirement of potassium met with 100g of dehydrated banana which can be source of potassium for hypokalemia.
- Dehydrated fruits can be taken regularly to boost the antioxidant levels.

- The post-harvest losses of abundant production of guava and papaya candy minimized by simple and cost effective processing methods and dehydrated guava and papaya can be used at non seasonal period.
- The dehydration methods facilitate organic processing of banana, guava and papaya can minimize the risk of adverse health effects of using processed foods.

Recommendations for Future Study

- Supplementation of dehydrated banana, guava and papaya to the protein energy malnutrition among children can be studied.
- A processing method to minimize the carbohydrate content and glycemic index of banana can be observed.
- Guava pectin a rich source of dietary fibre can be separated and incorporated in regular recipes for maintaining healthy life style.
- Therapeutic value of dehydrated banana, guava and papaya can be studied
- Chemical and biochemical changes of dehydrated fruits in various packing can be identified.

Limitations of the Study

- In depth study of physical, chemical and biochemical qualities of the dehydrated fruits was not done due to the larger sample size of fruits.
- The calculations for rehydration ratio and mass transfer during dehydration were not done since the moisture content was analyzed.
- The quality of banana, guava and papaya fruit powders obtained from selected dehydration methods and pulp was not analysed due the time constraints.
- In depth study of various packing material was not carried out in order to maintain the focus of the study only to keep longer shelf life of the products.