DEVELOPING BLENDED PRESERVED PRODUCT BASED ON SWEET POTATO

By

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THESIS

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2002

DECLARATION

I hereby declare that this thesis entitled ***"Developing preserved products based on sweet potato"*** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis *"Developing preserved products based on sweet potato"* is a record of research work done independently by **Miss. ROOPA G K**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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INTRODUCTION

1.INTRODUCTION

Mankind has witnessed tremendous development in the arena of science and technology over the last century; and we all hopefully expect the new millenium to prove itself as a more advanced one. However advanced the technology be, the prime concern of mankind still remains the same- food, cloth and shelter. Non-availability of adequate nutritious food for the fast growing population is a challenging problem faced by most of the developing countries.

Scientists have realized that it could be unwise to stick on to traditional food materials, inorder to serve the starving millions. This awareness has triggered numerous researches on developing alternative means of adequate food supply that would cater to the nutritive requirements of an ideal food.

Kumar and Pramod (1993) reported that considerable efforts are needed to make new product from under exploited fruits and vegetables competitive in the world market with respect to nutritional and microbial quality as well as zero level chemical residues.

Bhoumik and Epison (1992) has stated that there is a vast potential to tap the under exploited fruits, vegetables and tubers in the country. There is a need

to make new products from indigenous raw materials having nutritional values to open new channel for export market.

Due to urbanisation, changes in life style pattern and more working women, the consumption of processed foods are likely to increase in the future. Processed foods of high quality and a competitive price will break export quarantine barriers. Subrahmanyam (1993) has ascertained that exports based on the domestic capabilities are of large international demand.

Sweet potato (Ipomoea batatas) is among the world's most important versatile and under exploited food crops. With more than 133 million tons in annual production, sweet potato currently ranks as the fifth most important food crop on a fresh weight basis after rice, wheat, maize and cassava, in over 50 countries. Only in the last decade has the crop been the focus of an intense coordinated, global effort to realize its full potential as a source of food, feed processed products and income for millions of small farmers and low income consumers in many developing countries.

Sweet potato is a tuber crop, high in carbohydrates and vitamin A and can produce more edible energy per hectare per day than cereals (CIP, 2001). Sweet potato known as an environmentally friendly crop requires low amounts of fertilizers and other agricultural chemicals and is tolerant to stressful

environmental conditions. Hence it is necessary to invent new utilization system for sweet potato.

As reported by Mok (2000) there is a prosperous sight in sweet potato product consumption. If sweet potato could be processed into ready to eat products and preserved products, the consumption rate will increase.

Preservation of food had been practised since the good old days to store the perishable food materials for long duration. In today's fast mode of living preserved foods are gaining importance, as they are available in ready to serve forms. Sweet potato being a perishable tuber, preservation using various treatments, helps to convert them to more sustainable and attractive forms. In this context, an attempt is made to develop preserved products such as leather, wine and jam with sweet potato and fruit blends and to assess their acceptability and shelf life qualities. Attempt is also made to transfer the developed technologies to Self Help Groups.

2. REVIEW OF LITERATURE

The groundwork of any scientific enquiry is studies conducted in the past. The main objective of this section is to review the theoretical and the emperical information available from similar studies. The literature is reviewed under the following headings.

A. Sweet potato

2.1 Production and utilization

2.2 Nutritional significance

2.3 Processing potential

2.4 Shelf life qualities

B. Self Help Groups

A. Sweet potato

2.1 Production and utilization

Sweet potato (*Ipomoea batatas*) is a hardy and nutritious staple food crop, which is grown throughout the humid tropical and sub tropical regions of the world. Sweet potato belongs to the convolvulaceae or morning glory family and is a dicot. Sweet potatoes are native to Ecuador and Peru and are nutritious.

CIP (2000) reports that Asia is the world's largest sweet potato producing region and China occupies the first place in yield and production in the world with an annual production of 90 million tonnes (Upadhya, 1990).

In India sweet potato is grown in an area of 1,38,000 ha. with an annual production of 11,28,000 tones of raw tubers. Sweet potato is an important crop in Bihar, Orisa and Uttar Pradesh, which contributes about 80 to 90 % of total production (Thankappan and Nair, 1990).

In Kerala sweet potato is cultivated in an area of 1990 ha. and the total production is 21000 tonnes, yield 10t/ha. (FAO, 1993). Vimala (1990) pointed out that the production of sweet potato in India is almost 50% of the Asian average and this is much lower than the average world productivity.

Sweet potato has been regarded as one of the most important biomass crops because both cultivation and harvest are relatively easy (Kaoru and Katsuyshi, 1992). One of this crop's greatest assets as a food is that it can be harvested as needed, for home consumption or income generation (CIP, 2001).

Sweet potato is typically a small farmer crop and often grown on marginal soils with limited out put and hence, increasing sweet potato production and utilization is often considered as a means to improve income. Average yields in several countries are well below the current yield potential. Hence, rapid improvements in productivity are considered readily feasible with relatively less investment in research and extension than other crops such as rice.

In comparison with other popular crops, sweet potato is quick to mature, requiring only 4-5 months from planting to harvest. Sweet potato plays a very

important role as the survival food because of its high nutritive value and greater energy production (Dayal, 1990).

FAO food balance sheets has classified sweet potato as a main staple food crop in many African countries like Burndi, Kenya, Rwanda, Tanzania and Uganda (Johns *et al.*, 2001)

This hardy root crop has a long history of saving lives. The Japanese have repeatedly relied on it after typhoons have devastated rice crops. Sweet potato kept millions from starvation in famine played China in the early 1960's and in Uganda where a virus ravaged cassava crops in the 1990's, rural communities depended on the sweet potato to keep hunger at bay (CIP, 2000)

Versatility of the sweet potato storage roots offers various ways of utilizing it as foods which include fresh consumption and processed products.

2.2 Nutritional significance

Sweet potato resembles cereals due to its high starch content, resembles fruits due to its high carotene content. Thus among the tropical tuber crops, sweet potato is the most amenable one for processing into a number of value added products (Padmaja, 2000)

The USDA (1999) reported sweet potato as the healthiest vegetable due to reasons like:

One cup of cooked sweet potatoes provides 30 mg (50,000 IU) of beta-carotene (Vitamin A).

Sweet potatoes have four times the US RDA for beta-carotene when eaten with the skin on.

Sweet potatoes are a great source of vitamin E, and they are virtually, fat free which makes a real vitamin E stand out. Most vitamin E rich foods such as vegetable oils, nuts etc, contain a hefty dose of fat.

Sweet potato provides many other essential nutrients including vitamin B_6, potassium and iron.

Sweet potatoes are good source of dietary fibre, which helps to promote a healthy digestive tract.

Sweet potatoes are virtually fat free, cholestrol free and very low in sodium. A medium sweet potato has just 118 calories.

Sweet potato is a low cost food, rich in food energy, dietary fibre, minerals and vitamins. In addition to carbohydrates, proteins and phytoalexin, organic acid, vitamins, minerals, pigments and phytohormones are also present in the tuber (Lila, 1997).

Elizabeth (1999) reported that sweet potato could be considered as a natural health food. Sweet potato tuber is a storehouse of energy and contains

good quality proteins at a level comparable to other staples such as rice and potato.

Sweet potato is high in carbohydrates and vitamin A and can produce more edible energy per hectare per day than wheat, rice and cassava - reports CIP (2000).

According to Lila (1997), the tuber is rich in carbohydrates and generally low in fat and protein. Polysaccharides in sweet potato are composed of starch (70%), cellulose (20%), pectic substances (2.5%), hemicellulose (3-4%) and other minor substances.

The protein content of sweet potato varies from 0.5-3.5% (Ghosh *et al.*, 1988). Sweet potato contained the important amino acid lysine, in which commodities such as rice are deficient. Lila (1997) reported that protienase inhibitors (trypsin inhibitors) are present in the tuber. They are stable over a pH range of 2-11, but on cooking they are generally inactivated. She also reported that true digestibility of the protein ranged from 79-82% and the biological value of the protein was 72-74%; lipid content is low 0.1- 0.8 % on fresh weight basis in raw tuber.

The dark orange flesh colour of the tuber is associated with high carotene content (Jos *et al.*, 1990). The vitamin content with special reference to carotene of the tuber was discussed by Brad Bury (1990).

Carotene content of sweet potato ranges from 0.3-7.2 % in different genotypes. Depending on the variety, 100 grams of sweet potato can provide enough beta carotene to produce from 0-100% of suggested daily vitamin A requirement.

The orange flesh variety of sweet potato have been widely used as an excellent source of the provitamin beta-carotene. Hill *et al.* (1992) claimed that the presence of auto oxidant nutrient such as beta-carotene, ascorbic acid and tocopherol in sweet potato could be able to act against heart diseases and cancer in humans.

According to Lila *et al.* (1998), varieties of sweet potato with orange or yellow coloured tubers are excellent sources of beta-carotene, which, apart from being the precursor of vitamin A is ascribed with anticarcinogenic properties. Sweet potatoes are excellent sources of vitamin A and the darker the colour, the greater will be the vitamin content.

ICRW (2001) reported that orange fleshed sweet potatoes represent the least expensive year round source of vitamin A available to poor families. For infants and young children, this root will benefit by providing adequate amounts of calories and vitamin A, B, E and C as well as helpful amount of other micronutrients such as iron.

According to CIP (2001), sweet potato may be one of the best hopes for tens of thousands of African children whose eye sight and lives are threatened by

lack of vitamin A. They also have convinced that inclusion of even small amounts of sweet potato to family diets can eliminate vitamin A deficiency in both children and adults.

Sweet potato is a good source of vitamin C and iron. One hundred grams of fresh roots can supply from 25 - 50 % of the recommended daily allowance of vitamin C depending on methods of processing. Grant *et al.* (1992) detected phosphorous and potassium as the major minerals present in sweet potato tuber, with modest amount of iron, magnesium, calcium and copper.

Kay (1992) convinced that the fibre content in sweet potato is having the capacity to decrease the blood cholestrol level by daily use. Lila (1997) stated that the dietary fibre in sweet potato is superior, content and component wise, to cereals and other staples.

2.3 Processing potential

Sethi (1996) emphasized that all future thrust in research should be aimed at developing simple technologies which could be easily adopted to conserve and preserve perishable commodities and minimize both their qualitative and quantitative losses; so that the gap between the production and availability of horticultural crops is slowed down.

Nwankezi *et al.*(1994) pointed out that the search for alternative use of the perishable horticultural commodities to maximise their utilisation and reduce losses is virtually important. Rao (1991) felt that processing of foods can be

derived as adding value to conventional and innovative food items through various formation and combination providing protection, preservation, packing, convenience carriage and disposability.

Roy (1993) stated that surplus production of perishable fruits and vegetables during the seasonal glut could be converted into durable products in order to avoid wastage.

According to Walter *et al.* (1990), processing of sweet potato into forms, which combine the advantages of, diversity, nutritional value and convenience of use is a means of promoting sweet potato consumption among different strata of the society. He also stated that the processed sweet potato can make significant contribution to RDA's for several nutrients.

Sweet potato has abundance of uses ranging from consumption of fresh roots or leaves to processing into animal feed, starch, flour, candy and alcohol (Environment News Service, 2001).

Sweet potato can be used in diverse ways.

In United States, apart from its consumption as a fresh vegetable, sweet potato is canned, frozen or dehydrated. In Philippines sweet potato is used to

make ketchup, soft drinks, candies etc. A cheese like product made from sweet potato is a popular dish in Argentina.

Processing of noodles (China), flavoured dehydrated chips, ketchups and a hot cake mix (Philippines), solar-dried chips, strips and flour (India) and starch from different sweet potato varieties (Thailand). Possibility of the processing of noodles, macaroni, weaning foods and wafers was reported by Chellammal (1995).

According to Ghosh *et al.* (1988), yellow and orange types of sweet potato are canned in the USA in several styles of packing and among these canned sweet potato in sugar syrup is an important food item.

Motivating producers by developing a diversified port folio of value-added food products such as soup powder, dehydrated food and convenience foods using, sweet potato as the base raw material or as a component in the mixture will increase the demand for processed sweet potato products.

Sweet potato can be processed into the untiring daily foods and consumers are ready to consume such processed products. Jam, candies, sauce, jelly and juice could also be prepared from sweet potato.

Padmaja *et al.* (1990) developed different recipes from sweet potatoes, including fruit salad, sherbet, cake, jellies, gulab jamun, sukhiyan, pudding etc.

Wilson and Pichal (1991) developed a fruity food product from sweet potato which is considered as a new approach for improving the economic value of the crop. In Maharashtra state, boiled pulp of sweet potato is dried into shreds and used during feasts and festivals (Nanda, 1984).

Jam and jelly prepared from sweet potato - fruit blends were highly acceptable to consumers, reports Elizabeth (1999). Bouwkamp (1985) explained the use of sweet potato starch as a raw material for the preparation of candy drops, ice cream, jam, bread, biscuits, cake and juices.

The technology for the processing of dehydrated sweet potato cubes and its utilization in various preparations have been discussed by Troung *et al.* (1990). Data and Opario (1992) has developed successfully the technology for processing sweet potato chips. Sweet potato is believed to be employed in certain food industries as a thickener or to provide body smoothness and curdling effects to other food products.

The amazing sugar content (3-6%) of sweet potato, inspires additional uses in cakes, pies, breads, puddings, marmalades, cookies and muffins. Sweet potato is also utilized in the production of flakes and other products. In central and East Java, sweet potato is used for making cakes, cookies, candy, chips and ketchup (Widodo *et al.*, 1993).

A process of producing non-alcoholic beverage from sweet potato with taste and appearance, similar to those of commercial fruit drinks has been

reported by Troung *et al.* (1990). A different type of beverage, which is in the form of pre-cooked powder, was also developed from sweet potato by Walter *et al.* (1990). Artificial orange flavour enhanced aroma of the fruity sweet potato beverages reports Troung (1989).

At CTCRI, sweet potato starch is converted into alcohol on laboratory scale. Non-fermented product like sugar syrup and other derivatives, enzymes called beta-amylase modified starches such as anionic, cationic and phosphate stabilized starches are developed from sweet potato (Lila, 1997).

2.4 Shelf life qualities

The effectiveness of a storage method depends to some extent on the variety stored owing to varietal difference in susceptibility to a disease length of dormancy period and transpiration rate. Stability of the original quality of any product during storage is of paramount importance.

According to Padmaja (1990) storage of sweet potato beyond one month will adversely affect its nutritional quality. According to Chellammal (1995) analysis of the insect infestation and microbial assessment of the product developed from cassava and sweet potato revealed that there was no insect infestation in the products stored in glass and plastic container after a storage period of six months. Sowokinos *et al.* (1987) found that sucrose is the principal sugar showing most notable increase with storage. Padmaja (1990) reported 50%

loss in starch after six months storage and also a concomitant increase in glucose, fructose and sucrose content.

Siddappa *et al.*,.(1986) reported this storage of fruit bars based on banana, guava and mango without any detectable deterioration in organoleptic qualities for six months. Riji (1995) reported that osmotically dehydrated pineapple slices showed and increasing trend in reducing sugar and a decreasing trend in acidity, during four months of storage.

Jellinick (1985) observed that there was loss of ascorbic acid in the processed food products under the influence of atmospheric oxygen during storage.

Pearson (1973) found that citric acid retarded microbial growth during storage of mango jam. Thirumaran *et al.*, (1986) has standardised the formula of papaya jam and found that it had a good shelf life.

Bhatnagar (1991) conducted studies on the preparation of jam from watermelon rind and found that it was reasonably good under ambient conditions for a period of six months.

Jayaraman and Gupta (1991) convinced that the addition of ingredients like sugar, citric acid and KMS to pulp facilitates drying and improves the product quality.

B. Self Help Groups

A self help group is a homogeneous gathering of usually not more than 25 persons who join on voluntary basis in order to undertake some common activity through mutual trust and mutual help. It is mainly concerned with the poor and it is for the people and of the people. Apart from inculcating socially desirable habits and ethics among members, self help groups serve the purpose of a money lender, a development bank, a co-operative and a voluntary agency (Sreedhaya, 2000).

The Royal Tropical Institute (1987) defined Self Help Group as a membership organization or group which implies that its risks, course and benefits are shared among its members on an equitable basis and that its leadership and/ or managers are liable to be called to account by membership for their deeds.

Rao (1994) feels that Self Help Groups are means of raising the claim making capacity of the rural poor for the reaching out to such agencies as they are willing to work with and which can provide them with additional production resources.

Jayalakshmi and Hussain (1999) reported that in horticulture crop production and processing could be taken up with the help of Self Help Groups. Because of perishable nature of horticultural crops, processing units can be

opened by rural men and women. This helps the rural poor to become economically independent.

Singh (1995) conceptualized Self Help Groups as an informal association of individuals which come together voluntarily for the promotion of economic and/or social subjective. Basil and Paul (1999) reported that one of many group efforts initiated by Self Help Groups is participatory marketing.

Pathak (1992), observed that Self Help Groups being comprised of groups of persons, get empowered to solve most of their problems of non-functional nature, eg., raw materials and input supply, marketing, better adoption of technology, education and training for realizing the human potential for development. Sivaprasad (1997) found that economic motivation is an important character that persuaded people to adopt improved practices that are proven worthy.

The effective transfer of research result and technologies should be accomplished through training. Muller (1997) found out that due to increased training, the members of Self Help Group become more knowledgeable about ways and means to achieve group goals and hence an increased income and satisfaction was seen.

MATERIALS AND METHODS

3.MATERIALS AND METHODS

The present study,*"Developing blended preserved products based on sweet potato"* is comprised of the following sections:

3.1. Selection of tubers

3.2. Selection of products

3.3. Selection of blends

3.4. Detailed study on the sweet potato products

3.5. Shelf life assessment of products

3.6. Transfer of technology and

3.7. Statistical analysis of data

3.1 Selection of tuber

Sweet potato (Ipomoea batatas) is one of the most important tuber crop cultured all over the world. This tuber was selected for the present experiment based on the following aspects.

- Sweet potato is one of the most complete foods known (FAO, 2001)
- Sweet potato is a low cost food rich in food energy, dietary fibre, minerals and vitamins.
- Sweet potato can be harvested as needed for home consumption or income generation (CIP,2001)

- Sweet potato has a unique flavor and taste and can be baked, boiled or fried and can be served alone or in a combination with other ingredients to make superior dishes for breakfast, lunch, dinner or snacks.

Two sweet potato varieties, viz., Kanjanghad and Sri Bhadra were selected for the study considering their popularity, processing qualities and availability. Kanjanghad is the local variety and was procured (30 kg) from the Instructional farm of Kerala Agricultural University, Vellayani. Sri Bhadra variety was procured (30 kg) from Central Tuber Crop Research Institute, Sreekariyam.

3.2 Selection of products

Sweet potato is used in diverse ways in that the roots can be boiled, steamed, baked, fried or prepared as salad, jam, beverage, chips and other snacks or mixed with a flour to make breads, pan cakes, noodles etc.

Commercial fruit products like dried fruits, jams, juices and drinks could be processed from sweet potato (Christopher *et al.*, 1995)

In the present study, three preserved products were standardized from sweet potato, namely,

- Leather
- Jam
- Wine

- Leather

Leather is a familiar product for Indians. Various fruit leathers are common in South India. Preparation of fruit slabs or fruit leathers is one of the cheap methods of preservation of fruit pulp (CFTRI, 1978). Maini *et al.* (1982) reported that fruits preserved by drying than by any other methods have major advantages of greater concentration in dry form, production with minimal labour, less expensive and economic equipment for processing and storage.

A good market could be made for leather, depending on price, packaging, marketing and distribution. Hence leather was selected for the study.

- Jam

According to Siddappa *et al.* (1986), jam is a product prepared by boiling the fruit pulp, with a sufficient quantity of sugar to a reasonably thick consistency, firm enough to hold fruit juices in position. A jam is more or less a concentrated fruit pulp possessing a fairly thick consistency and body. It is a product, which is rich in flavour, and also it contains high concentrations of sugar, which helps to facilitate preservation.

Now a days, preserved products like jam are becoming increasingly popular due to marketing through media. Hence, jam was considered.

- Wine

Fruit wines are alcoholic beverages, which are nutritive, very tasty with mild stimulants (Joshi *et al.*, 1996). Wines are made from several types of

berries, and are named after the particular fruit employed for preparation (Sidappa *et al.*, 1986).

Wine is a natural, non-toxic, healthy fermented beverage from fruits rich in calories, vitamins and minerals (Adsule *et al.*, 1992). They serve as an important adjunct to the human diet, by increasing satisfaction and contribute to the relaxation necessary for proper digestion and absorption of food. (Delin and Lee,1992). With an aim to bring popularity to low cost alcoholic beverage, preparation of wine from sweet potato was considered.

3.3 Selection of blends

Kalra *et al.* (1991) opined that blending of fruits could be done to supplement appearance, nutrition or flavour of the products. In order to improve the nutritious and organoleptic qualities of sweet potato products blending with fruits were carried out. Considering the local availability and similarity in colour, mango and pineapple were selected for blending.

- **Mango**

Mango is one of the choicest and most appreciated fruit owing to its aromatic flavour, delicious taste, and attractive colour, besides being a good source of vitamins and minerals. (Trippesha, 1997). Mango is the richest natural source of beta-carotene, which is a precursor of vitamin A (Gowda and Ramanjaneya, 1994).

Pruthi (1992) pointed out that mango fruits can be blended well with other fruits. Hence more value-added products can be prepared out of it.

- **Pineapple**

Among the various fruit crops cultivated in our country, pineapple has become one of the most important commercial fruit crop (Sen *et al.*, 1980). Pineapple is a good source of vitamin A and B and is rich in vitamin C and calcium. In addition, it contains phosphorous, iron and an enzyme bromelin (Pawar *et al.*, 1985).

3.3.1. Standardization of blended and plain products of sweet potato

Standardization and the quality management systems play a major role in the assimilation of technology affecting economy in production and stimulating competitiveness. It encapsulates technological results and becomes a vehicle for technology transfer, while quality is the key for facilitating trade and satisfying customers. According to Tolule (1984), the procedure for recipe standardization begins with the process of recipe modification or adjustment.

Plain products of sweet potato viz. leather, jam and wine were first standardized at the laboratory by repeated trials and organoleptic assessments. Based on the recipes formulated and standardized for plain products, fruit (mango/ pineapple) blended sweet potato products were developed. To standardize sweet potato products at the laboratory, sweet potato and fruit pulp were mixed at three different proportions. The proportions experimented for

standardization of blended sweet potato products viz. leather, jam and wine were the same. The three proportions were:

- Sweet potato + fruit (Mango / Pineapple) → 50:50
- Sweet potato + fruit (Mango / Pineapple) → 60:40
- Sweet potato + fruit (Mango / Pineapple) → 70:30

Formulation of blended sweet potato leather

In the present study for the preparation of blended sweet potato leather, the sweet potato pulp and fruit pulp (mango/ pineapple) were mixed in three different proportions viz. 50:50, 60:40 and 70:30. To this pulp combination, other ingredients like sugar, citric acid and KMS were added and the mixture was sundried pouring into a tray; layer by layer. The flow chart for the preparation of blended sweet potato leather is given in figure 1.

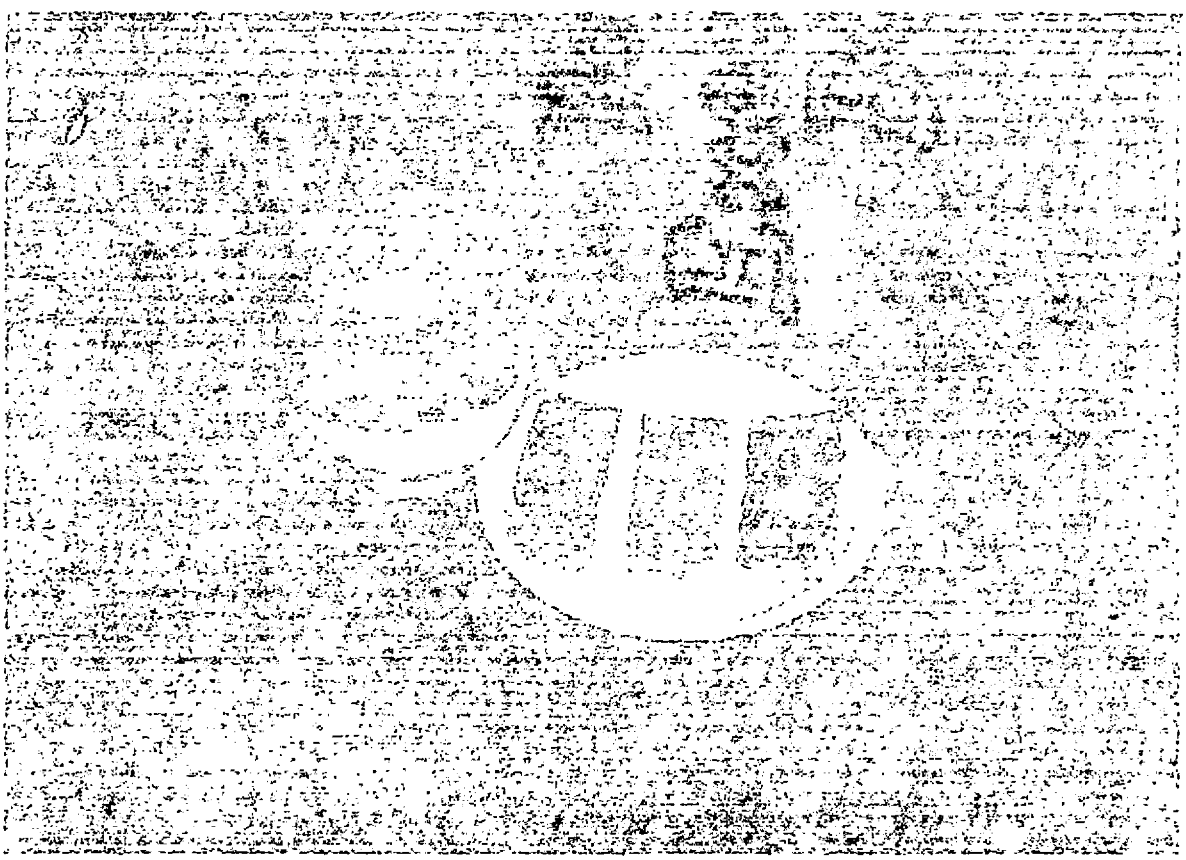


Plate No. 1 Location

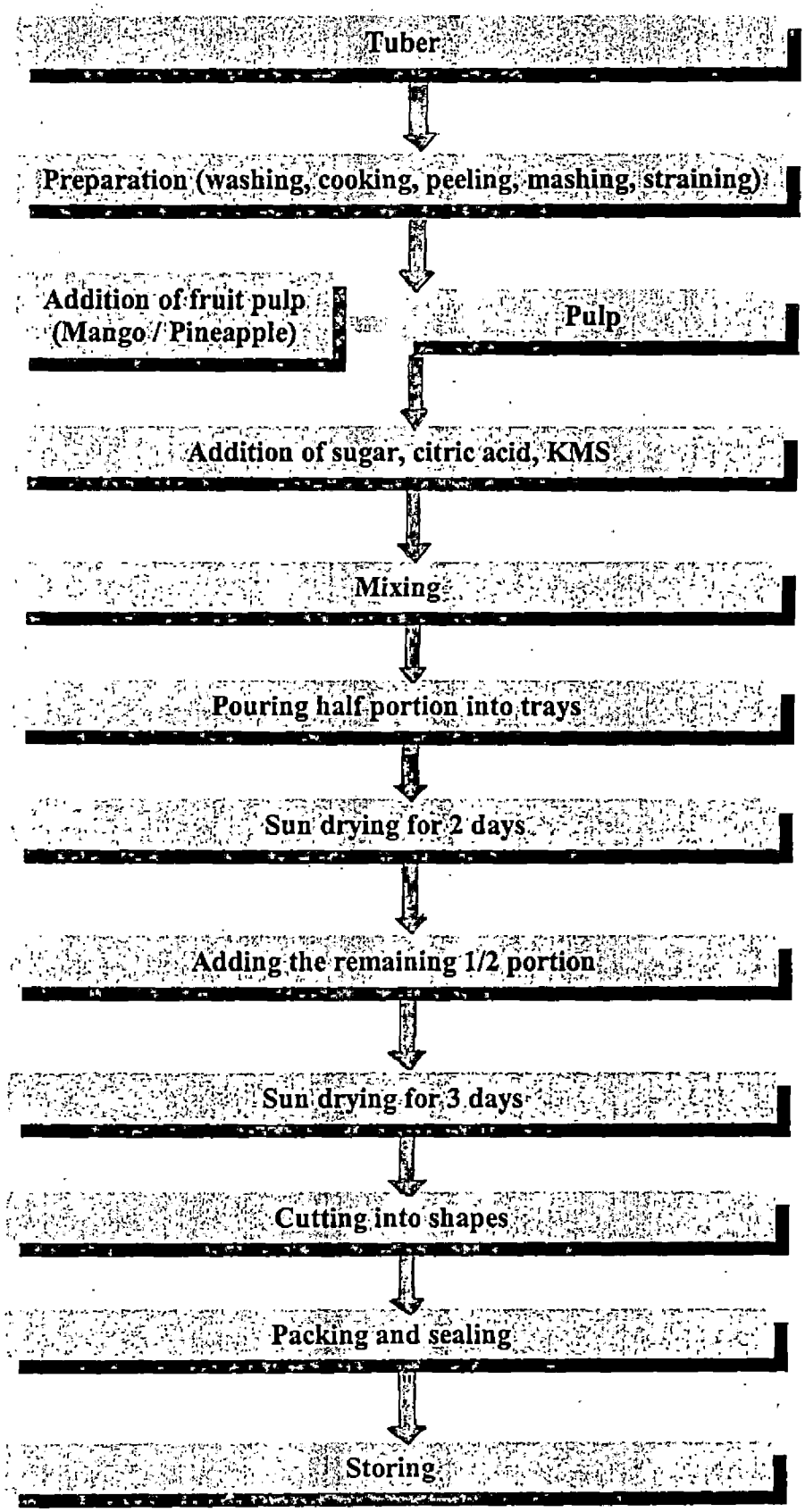


Fig. 1: Flow chart for the preparation of blended sweet potato leather

Formulation of blended sweet potato jam

For the preparation of blended sweet potato jam, sweet potato pulp and fruit pulp (mango/ pineapple) were mixed in three different proportions viz. 50:50, 60:40 and 70:30. Then sugar was added to this pulp combination and the mixture was boiled with occasional stirring until the required consistency was reached and then bottled. Flow chart for the preparation of blended sweet potato jam is given in figure 2.

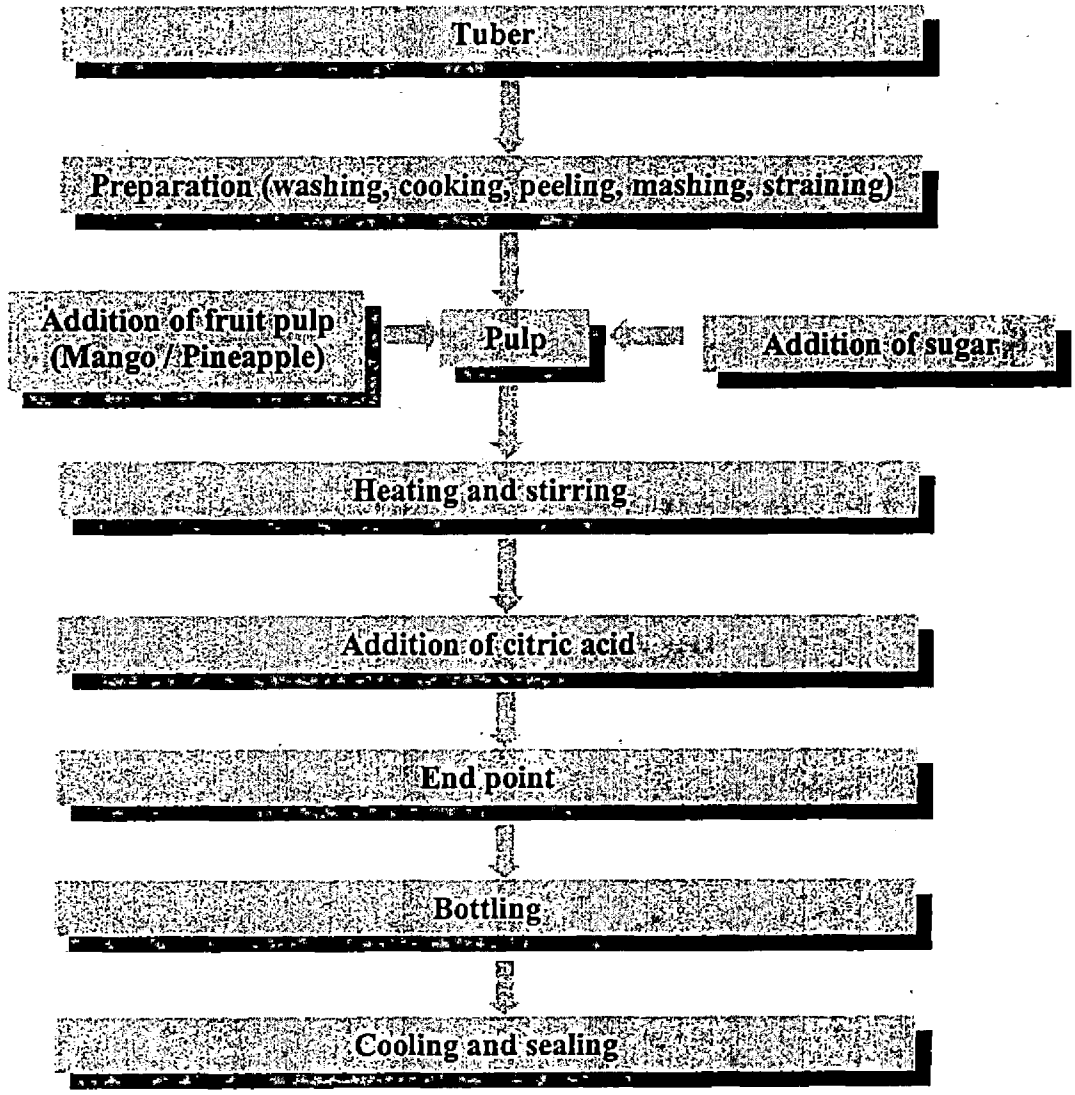


Fig. 2: Flow chart for the preparation of blended sweet potato jam

Formulation of blended sweet potato wine

For preparing blended sweet potato wine, the tuber and fruit (mango/ pineapple) were grated and mixed in 3 different proportions, viz. 50:50, 60:40 and 70:30. To this, sugar, water and starter were added and kept for fermentation for 21 days. Afterwards it was filtered, racked and bottled. Flow chart for the preparation of blended sweet potato wine is given in figure 3.

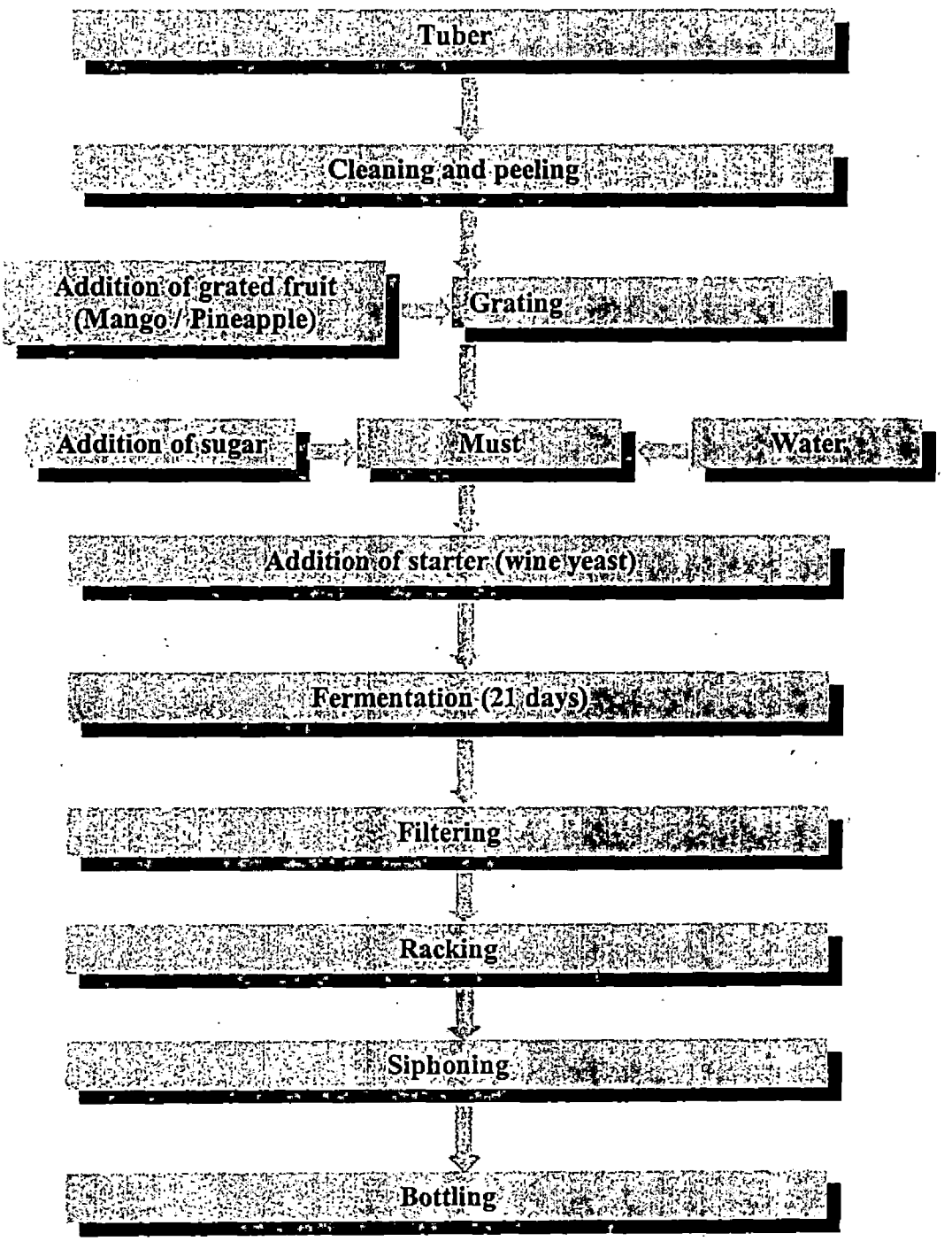


Fig. 3: Flow chart for the preparation of blended sweet potato wine

as possible on supply, demand and prices is essential for anyone directly involved in the business of marketing fruit products. Cost of the products in this study was analyzed, taking into account the expenditures incurred on food products namely sweet potato, fruit, sugar, citric acid and KMS, along with the over head charges.

3.4.4. Yield ratio, End point temperature and Drying time.

For ensuring the total output out of certain quantity of raw materials, information on product yield ratio is indispensable. This was analysed by taking into consideration the quantity of tuber used to produce a particular product. The end point temperature of the jam and the time required for drying of the leather was observed.

3.4.5. Overall acceptability of the product.

According to Thirumaran (1993) the product development and its acceptance by people depend on the overall acceptability and so its test was considered as of the important criterion for evaluating the acceptability of the newly developed products. The overall acceptability of the developed products were assessed by a group of judges using the method of Jellenick (1986). The score cards administered are given in Appendix –I.

3.4.6. Consumer acceptability and preference

According to Watt (1989) consumer awareness and preference decide the success of a food product. The acceptance tests are used to determine the degree

of consumer acceptance to a product. The developed products were subjected to acceptance testing by consumer groups of untrained persons.(Jellinick ,1986)

As reported by Watt (1989) preference tests allow consumers to express a choice between samples, one sample is preferred and chosen over another or thee is no preference. A preference test was also conducted where the consumers were asked to rank the three products in the sequence of their preference.

3.5. Shelf life assessment of the products.

The assessment of storage quality of the developed products was done by storing the products at ambient conditions. The shelf life of the developed products was assessed for a period of four to eight months. The storage qualities were assessed based on the changes in chemical characteristics, sensory characters and also on the basis of occurrence of microbial infestation in the products.

3.5.1. Assessment of changes in chemical qualities during storage.

The stored products were analysed for the chemical changes like pH, acidity, TSS, reducing sugar and total sugar (Ranganna, 1991). Periodical evaluations of chemical and nutritional qualities of the products were done on every month to observe the effects of storage and keeping quality.

3.5.2 Changes in sensory qualities

As reported by Jellinick (1986) chemical indices of deterioration alone will not decide the quality deterioration and it should be correlated with sensory

evaluation of the stored product. Organoleptic qualities of the stored products were assessed monthly to observe the changes in the sensory parameters.

3.5.3 Microbiological profile

The stored products were assessed for microbial contamination viz. bacteria, fungus and yeast. Nutrient agar, potato dextrose agar and maltose extract agar media were used for estimating bacterial and fungal count.

3.6 Transfer of technology

Transfer of technology from lab to land or from the point of origin to the hands of the actual consumers is one of the primary responsibility of all scientific / academic institutions. The technology developed in the present study was transferred to three self-help groups and the adoption rate was evaluated.

For measuring the rate of adoption of the technology transferred or the knowledge gain, a knowledge test, consisting of fifteen questions were constructed and administered to fifteen women each from three self-help groups. All questions had definite answers. A maximum of "one" for correct answer and "zero" for incorrect answers were assigned. Thus the maximum possible score was fifteen and minimum score was zero. The test was administered initially and after three months. The difference in knowledge scores of the women between pre-test and post-test were quantified as gain in knowledge

3.7 Statistical analysis of data.

The data generated during the study were compiled, analysed statistically and the results are presented and discussed.

RESULTS

4.RESULT

The results of the present study, ***"Developing blended preserved products based on sweet potato"*** are presented under the following headings.

4.1. Detailed study on sweet potato products

4.2. Shelf life assessment of the products

4.3. Transfer of technology

4.1. Detailed study on sweet potato products.

The developed sweet potato products from two varieties of sweet potato, viz. Kanjanghad (V_1) and Sri Bhadra (V_2), using standard methods as described in 3.3. were subjected to chemical analysis, confirmation with FPO, cost benefit analysis, product yield ratio, organoleptic analysis and consumer acceptance and preference.

4.1.1. Chemical components of standardised products

Chemical components provide information about the nature of the product, their quality, susceptibility and deterioration. The chemical composition of the developed products, viz. leather, jam and wine, are detailed below.

4.1.1.1 Assessment of chemical constituents in leather

Values on the chemical constituents of the fresh samples of leather analyzed are presented in the Table 1.

Table 1: Chemical constituents of fresh leather

Type of products	Parameters				
	pH	Acidity (%)	TSS (° brix)	Reducing Sugar (%)	Total Sugar (%)
V_1	4.45	0.43	66.20	34.96	40.59
V_2	4.44	0.43	66.13	34.85	40.54
V_1M_1	4.31	0.45	68.03	33.26	39.53
V_1M_2	4.30	0.46	67.91	33.18	39.48
V_1M_3	4.29	0.47	67.80	33.11	39.40
V_2M_1	4.31	0.45	67.98	33.24	39.50
V_2M_2	4.29	0.48	67.89	33.15	39.44
V_2M_3	4.28	0.48	67.79	33.08	39.38
V_1P_1	4.26	0.49	67.31	32.95	38.98
V_1P_2	4.23	0.50	67.21	32.82	38.91
V_1P_3	4.18	0.51	67.15	32.76	38.86
V_2P_1	4.26	0.49	67.28	32.94	38.95
V_2P_2	4.22	0.50	67.20	32.80	38.89
V_2P_3	4.19	0.52	67.12	32.72	38.82
CD	0.0093	0.0191	5.1224	5.0991	2.2113

V_1 → Sweet potato Kanjanghad variety

V_2 → Sweet potato Sri Bhadra variety

V_1M_1:Sweet potato + Mango → 50:50

V_1M_2:Sweet potato + Mango → 60:40

V_1M_3:Sweet potato + Mango → 70:30

V_1P_1:Sweet potato + Pineapple→50:50

V_1P_2:Sweet potato + Pineapple→60:40

V_1P_3:Sweet potato + Pineapple→70:30

V_2M_1:Sweet potato + Mango → 50:50

V_2M_2:Sweet potato + Mango → 60:40

V_2M_3:Sweet potato + Mango → 70:30

V_2P_1:Sweet potato + Pineapple→50:50

V_2P_2:Sweet potato + Pineapple→60:40

V_2P_3:Sweet potato + Pineapple→70:30

The compositional analysis of the leather samples revealed that the pH values varied between 4.18 and 4.45. The plain sweet potato leathers, V_1 and V_2 showed a slightly high value (0.45 and 0.44 respectively) compared to the other samples. Statistical analysis of the data conveyed the fact that the pH of the

blended leather samples varied significantly from the pH of plain leather samples.

The acidity of the samples seemed to vary from 0.43 to 0.51. The blended sweet potato–pineapple leather (70:30) prepared from Kanjanghad variety (V_1P_3) showed the highest acidity of 0.51 while the plain sweet potato leathers V_1 and V_2showed the lowest acidity of 0.43.

The Total soluble solids level ranged from 66.13 to 68.03. TSS level was highest for the blended leather V_1M_1 (Kanjanghad variety and mango (50:50)) with a value 68.03. The plain sweet potato leather of both the varieties V_1 and V_2 showed the lowest TSS level of 66.20 and 66.13.

Considering the reducing sugar levels of various combinations, the values showed a close association. Statistical analysis also showed that there was no significant difference between the reducing sugar levels of the samples. The blended product, V_2P_3 possessed the lowest value for reducing sugar i.e.32.72. The highest value for reducing sugsr was exhibited by the plain sweet potato leathers $V_1$and V_2 i.e. 34.96 and 34.85 respectively.

The total sugar level of the leather samples varied from 38.82 to 40.59. The plain sweet potato leather of Kanjanghad variety indicated the highest total sugar level of 40.59. The lowset total sugar content (38.82) was for the blended leather V_2P_3 (Sri Bhadra variety blended with pineapple in 70:30 proportion). The varietal difference was also not so prominent.

4.1.1.2 Assessment of chemical constituents in jam

Values on the chemical constituents of the fresh samples of jam analyzed are presented in the Table 2.

Table 2: Chemical constituents of fresh jam

Type of products	Parameters				
	pH	Acidity (%)	TSS (^{0} brix)	Reducing Sugar (%)	Total Sugar (%)
V_1	4.90	0.121	62.78	18.59	25.16
V_2	4.86	0.124	62.93	18.47	24.96
V_1M_1	4.77	0.136	67.21	22.01	25.22
V_1M_2	4.73	0.133	66.83	21.93	25.19
V_1M_3	4.69	0.131	66.51	21.88	25.17
V_2M_1	4.79	0.137	67.13	21.98	25.18
V_2M_2	4.75	0.135	66.91	21.86	25.06
V_2M_3	4.72	0.133	66.67	21.79	24.99
V_1P_1	4.43	0.133	66.01	21.39	24.86
V_1P_2	4.58	0.131	65.93	21.01	24.93
V_1P_3	4.63	0.129	65.84	20.78	25.01
V_2P_1	4.48	0.135	66.06	21.27	24.71
V_2P_2	4.53	0.133	65.95	20.97	24.79
V_2P_3	4.61	0.131	65.89	20.78	24.87
CD	0.0268	2.4391	11.698	3.3114	3.4851

V_1 → Sweet potato Kanjanghad variety

V_2 → Sweet potato Sri Bhadra variety

V_1M_1:Sweet potato + Mango → 50:50

V_1M_2:Sweet potato + Mango → 60:40

V_1M_3:Sweet potato + Mango → 70:30

V_1P_1:Sweet potato + Pineapple→50:50

V_1P_2:Sweet potato + Pineapple→60:40

V_1P_3:Sweet potato + Pineapple→70:30

V_2M_1:Sweet potato + Mango → 50:50

V_2M_2:Sweet potato + Mango → 60:40

V_2M_3:Sweet potato + Mango → 70:30

V_2P_1:Sweet potato + Pineapple→50:50

V_2P_2:Sweet potato + Pineapple→60:40

V_2P_3:Sweet potato + Pineapple→70:30

On analysing the pH values of fresh jam, it was seen that the pH values ranged between 4.43 and 4.90. V_1 showed highest value of 4.90, V_2 was near it with a pH value of 4.86. Blended sweet potato jam V_1P_1showed the lowest pH value of 4.43 and V_2P_1 was next to it with a value of 4.48. Statistical analysis showed that there was no significant difference between the values.

The acidity levels of the jam samples ranged between 0.121 and 0.137. V_2M_1 showed the highest acidity level of 0.137. No significant difference was found between the values while analysing statistically.

The TSS level was found to be highest for V_1M_1 (67.21).V_1 and V_2 showed the lowest values of 62.78 and 62.93 respectively. A significant difference was noted between the values.

On analysing the reducing sugar content, it was seen that V_1M_1 and V_2M_1 showed high values of 22.01 % and 21.98 % respectively. A comparatively lower level of 18.59 and 18.47 was noticed for V_1 and V_2 respectively. Through statistical analysis it was inferred that significant difference existed between the reducing sugar content of the samples.

The total sugar level of jam samples were between 24.71 and 25.22. V_1M_1 showed the highest total sugar percentage of 25.22 while the lowest percentage,24.71 was that of V_2P_1 .

4.1.1.3 Assessment of chemical constituents in wine

Results of the chemical analysis of the fresh samples of wine analyzed are presented in the Table 3.

Table 3 : Chemical constituents of fresh wine

Type of products	Parameters			
	pH	Acidity (%)	TSS (° brix)	Alcohol content (%)
V_1	3.59	0.45	22.78	10.65
V_2	3.55	0.45	22.76	10.72
V_1M_1	3.44	0.58	21.69	8.63
V_1M_2	3.46	0.57	21.67	8.50
V_1M_3	3.49	0.56	21.66	8.43
V_2M_1	3.45	0.58	21.69	8.69
V_2M_2	3.49	0.56	21.68	8.56
V_2M_3	3.47	0.56	21.67	8.50
V_1P_1	3.40	0.61	21.93	9.20
V_1P_2	3.45	0.59	21.92	9.15
V_1P_3	3.45	0.58	21.91	9.10
V_2P_1	3.40	0.61	21.93	9.32
V_2P_2	3.41	0.60	21.93	9.30
V_2P_3	3.44	0.58	21.92	9.30
CD	0.1863	2.7761	1.8354	0.1582

V_1 → Sweet potato Kanjanghad variety

V_2 → Sweet potato Sri Bhadra variety

V_1M_1:Sweet potato + Mango → 50:50

V_1M_2:Sweet potato + Mango → 60:40

V_1M_3:Sweet potato + Mango → 70:30

V_1P_1:Sweet potato + Pineapple→50:50

V_1P_2:Sweet potato + Pineapple→60:40

V_1P_3:Sweet potato + Pineapple→70:30

V_2M_1:Sweet potato + Mango → 50:50

V_2M_2:Sweet potato + Mango → 60:40

V_2M_3:Sweet potato + Mango → 70:30

V_2P_1:Sweet potato + Pineapple→50:50

V_2P_2:Sweet potato + Pineapple→60:40

V_2P_3:Sweet potato + Pineapple→70:30

The chemical analysis of wine prepared from sweet potato varieties, and their combinations with mango and pineapple displayed negligible difference in pH values. The values ranged between 3.40 and 3.59. The statistical analysis also confirmed the absence of significant difference between the values.

However a significant variation between the values was noted in the case of acidity levels of wine samples. The plain sweet potato wines of both the varieties, V_1 and V_2 , tend to show lower acidity level of 0.45. Pineapple blends showed a comparitively higher acidity level. The highest acidity level of 0.61was exibited by both V_1P_1 and V_2P_1 .

The TSS levels also tend to show a stable pattern. From statistical analysis it was confirmed that there was not any significant diversion of values. The plain sweet potato wines, V_1 and V_2, possessed very close values- 22.78 and 22.76 respectively.

Considering the alcohol content of wine, the values ranged from 8.43 to 10.72 percent. Among the wine samples prepared the highest alcohol percentage was for the plain sweet potato wines, of which the plain sweet potato wine prepared from Sri Bhadra variety had the highest alcohol content of 10.72. Blended wines also had compareble alcohol levels.

4.1.2. Confirmation with FPO requirements

The quality of preserved products is controlled by the Government through the Fruit Product Order (FPO, 1954).

The preserved products based on sweet potato developed during the study were analysed for FPO specifications and were found to satisfy the FPO requirements. The comparative values obtained gives the indication that the recipes were properly adjusted for its essential contents according to FPO.

Table 4: Confirmation with FPO requirements

Product	Quality Parameter	FPO Value	Observed Value
Jam	TSS	68%	62.78 – 67.21%
Wine	Alcohol content	9 – 16 %	8.43 – 10.72 %

4.1.3. Cost benefit analysis.

Cost of the prepared products was calculated. The cost benefit analysis was carried out based on the cost of various commodities needed for the preparation of products in this investigation, such as cost of tubers, fruits, sugar, chemicals, bottles and overhead charges including fuel.

Table 5 depicts the cost for the production of plain and fruit blended (mango and pineapple) sweet potato products. Since the cost of both the varieties, viz., Kanjanghad and Sri Bhadra were the same, the cost analysis of a single variety is depicted in the Table 5.

Table 5: Cost analysis of the products

Particulars	Cost per kg./litre (Rs.)
Leather	
Plain Sweet potato	22.00
Sweet potato + Mango (50:50)	52.00
Sweet potato + Mango (60:40)	46.00
Sweet potato + Mango (70:30)	40.00
Sweet potato + Pineapple (50:50)	40.00
Sweet potato + Pineapple (60:40)	37.00
Sweet potato + Pineapple (70:30)	33.00
Jam	
Plain Sweet potato	13.00
Sweet potato + Mango (50:50)	40.00
Sweet potato + Mango (60:40)	35.00
Sweet potato + Mango (70:30)	30.00
Sweet potato + Pineapple (50:50)	24.00
Sweet potato + Pineapple (60:40)	22.00
Sweet potato + Pineapple (70:30)	20.00
Wine	
Plain Sweet potato	16.00
Sweet potato + Mango (50:50)	40.00
Sweet potato + Mango (60:40)	35.00
Sweet potato + Mango (70:30)	31.00
Sweet potato + Pineapple (50:50)	24.00
Sweet potato + Pineapple (60:40)	22.00
Sweet potato + Pineapple (70:30)	20.00

The cost of one kilogram of leather varied from rupees twenty two to rupees fifty two. Plain sweet potato leather was found to be the cheapest

(Rs.22.00/kg), while the blended sweet potato – mango (50:50) leather came up with the highest cost of Rs.52.00/kg.

The cost analysis of jam samples in this experiment revealed much difference. The cost per kilogram of plain sweet potato jam was found to be Rs.13.00 and the same observed for blended sweet potato -pineapple jam (50:50) was Rs.24.00. The jam prepared from sweet potato and mango blend (50:50) was found to have a highest price of Rs.40.00/kg.

The cost of blended sweet potato – mango (50:50) wine was Rs.40.00/litre. The cost of plain sweet potato wine was observed to be the lowest (Rs.16.00/litre). The wine prepared by blending pineapple and sweet potato (50:50) was found to have a cost of Rs.24.00/litre.

4.1.4. Product yield ratio, End point temperature and Drying time

4.1.4.1. Product yield ratio

Product yield ratio gives an estimation of the amount of product obtained from known quantity of the raw material utilised. It also gives an idea about the amount of raw material that goes waste, which helps to ascertain the profit ratio, when a certain fruit is selected. The product yield ratio of tuber used to produce particular unit of each product was analysed.

Table 6 shows the product yield ratio of different sweet potato based products standardised in the present study.

Table 6 : Product yield ratio

Product	Tuber/ fruit weight	Quantity product yield (gm)	Ratio
Leather			
V_1	1 Kg	400	1 : 0.40
V_2	1 Kg	350	1 : 0.35
V_1M_1	1 Kg	312.5	1 : 0.31
V_1M_2	1 Kg	330	1 : 0.33
V_1M_3	1 Kg	347.5	1 : 0.35
V_2M_1	1 Kg	287.5	1 : 0.29
V_2M_2	1 Kg	300	1 : 0.30
V_2M_3	1 Kg	312.5	1 : 0.31
V_1P_1	1 Kg	325	1 : 0.33
V_1P_2	1 Kg	340	1 : 0.34
V_1P_3	1 Kg	355	1 : 0.36
V_2P_1	1 Kg	300	1 : 0.30
V_2P_2	1 Kg	310	1 : 0.31
V_2P_3	1 Kg	320	1 : 0.32
Jam			
V_1	1 Kg	450	1 : 0.45
V_2	1 Kg	400	1 : 0.40
V_1M_1	1 Kg	400.5	1 : 0.40
V_1M_2	1 Kg	410	1 : 0.41
V_1M_3	1 Kg	420	1 : 0.42
V_2M_1	1 Kg	375	1 : 0.38
V_2M_2	1 Kg	380	1 : 0.38
V_2M_3	1 Kg	385	1 : 0.39
V_1P_1	1 Kg	400.5	1 : 0.40
V_1P_2	1 Kg	410	1 : 0.41
V_1P_3	1 Kg	420	1 : 0.42
V_2P_1	1 Kg	375	1 : 0.38
V_2P_2	1 Kg	380	1 : 0.38
V_2P_3	1 Kg	385	1 : 0.39
Wine			
V_1	1 Kg	1700	1 : 1.70
V_2	1 Kg	1700	1 : 1.70
V_1M_1	1 Kg	1600	1 : 1.60
V_1M_2	1 Kg	1620	1 : 1.62
V_1M_3	1 Kg	1640	1 : 1.64
V_2M_1	1 Kg	1600	1 : 1.60
V_2M_2	1 Kg	1620	1 : 1.62
V_2M_3	1 Kg	1640	1 : 1.64
V_1P_1	1 Kg	1625	1 : 1.63
V_1P_2	1 Kg	1640	1 : 1.64
V_1P_3	1 Kg	1655	1 : 1.66
V_2P_1	1 Kg	1625	1 : 1.63
V_2P_2	1 Kg	1640	1 : 1.64
V_2P_3	1 Kg	1655	1 : 1.66

The product yield ratio of leather was observed for both the varieties of sweet potato alone and with fruit blends (mango and pineapple in various proportions). The best yield ratio was presented by plain sweet potato leather prepared from Kanjanghad variety (1:0.40).

The jam prepared from sweet potato (Kanjanghad variety) showed comparatively high yield than those prepared from Sri Bhadra variety as well as blends of both varieties with mango and pineapple.

No notable variation of product yield ratio was observed in the case of wine, for the two varieties of sweet potato. However the blends showed a comparatively lower yield ratio than the plain ones. A high yield ratio (1:70) was observed for wine prepared from sweet potato alone (both varieties).

4.1.4.2. End point temperature

The end point temperature of the product jam was observed and the results are shown in Table 7

Table 7: End point temperature

Particulars	End point temperature (^{0}c)
Sweet potato jam	102
Sweet potato – mango jam	101.77
Sweet potato – pineapple jam	103

The end point temperature of sweet potato jam was found to be 102° c, and that of sweet potato - pineapple jam was found to be the highest, i.e. 103° c. Sweet potato – mango jam showed the lowest temperature of 101.77° c.

4.1.4.3.Drying time

The drying time of different types of leathers developed during the study was noted and it was found that the drying time of the leathers were five to six days.

4.1.5.Organoleptic quality assessment.

The organoleptic qualities of the developed products were assessed and the results are as follows.

4.1.5.1.Organoleptic assessment of fresh leather

The data obtained on sensory parameters of fresh leather prepared from two varieties of sweet potato viz. Kanjanghad and Sri Bhadra and these varieties blended with mango and pineapple are summarized in Table 8.

Table 8 : Organoleptic characteristics of fresh leather

Leather	Quality Parameters					
	Appearance	Colour	Flavour	Taste	Texture	Overall Acceptability
V_1	4.2	3.8	4.2	4.2	4.2	4.1
V_2	4.0	3.4	4.0	3.9	4.0	3.9
V_1M_1	4.9	4.8	4.7	4.7	4.6	4.7
V_1M_2	4.7	4.7	4.6	4.5	4.3	4.5
V_1M_3	4.4	4.4	4.3	4.3	4.3	4.3
V_2M_1	4.6	4.6	4.4	4.4	4.4	4.5
V_2M_2	4.4	4.4	4.2	4.1	4.2	4.3
V_2M_3	4.1	4.2	4.1	4.0	4.1	4.1
V_1P_1	4.3	4.5	4.2	4.2	3.9	4.2
V_1P_2	4.0	4.3	4.1	4.1	3.9	4.1
V_1P_3	4.0	4.3	4.0	4.2	4.0	4.1
V_2P_1	4.1	3.9	4.0	4.0	3.7	3.9
V_2P_2	3.9	3.7	3.8	3.9	3.8	3.8
V_2P_3	3.8	3.6	3.8	3.9	3.7	3.8
CD	0.541	0.543	0.591	0.504	0.515	0.546

N= 10

V_1 → Sweet potato Kanjanghad variety

V_2 → Sweet potato Sri Bhadra variety

V_1M_1:Sweet potato + Mango → 50:50 V_2M_1:Sweet potato + Mango → 50:50

V_1M_2:Sweet potato + Mango → 60:40 V_2M_2:Sweet potato + Mango → 60:40

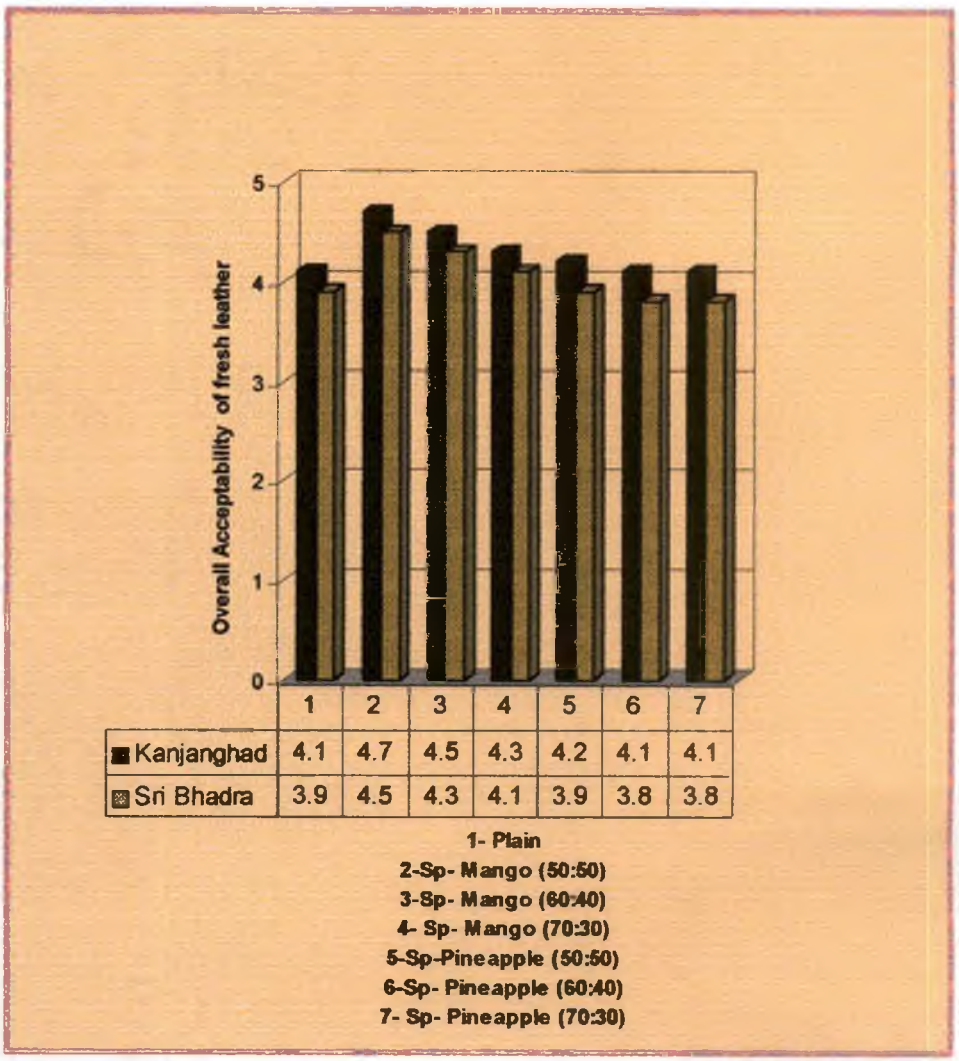
V_1M_3:Sweet potato + Mango → 70:30 V_2M_3:Sweet potato + Mango → 70:30

V_1P_1:Sweet potato + Pineapple→50:50 V_2P_1:Sweet potato + Pineapple→50:50

V_1P_2:Sweet potato + Pineapple→60:40 V_2P_2:Sweet potato + Pineapple→60:40

V_1P_3:Sweet potato + Pineapple→70:30 V_2P_3:Sweet potato + Pineapple→70:30

Table indicates that the appearance of leather samples made from the Kanjanghad variety of sweet potato blended with mango was superior with V_1M_1 (variety 1 sweet potato and mango blended in the proportion 50:50) securing the



	1	2	3	4	5	6	7
Kanjanghad	4.1	4.7	4.5	4.3	4.2	4.1	4.1
Sri Bhadra	3.9	4.5	4.3	4.1	3.9	3.8	3.8

Fig.4: Overall Acceptability of Leather

highest score of 4.9. Sri Bhadra variety of sweet potato blended with pineapple in the proportion 70:30 (V_2P_3) performed the lowest appearance quality i.e. 3.8. The pineapple blends were least appreciated for appearance quality.

In the case of colour, the blended leather of sweet potato (Kanjanghad variety) and mango in the proportion 50:50 (V_1M_1) performed high with a score of 4.8. The same variety blended with mango in the proportion 60:40 (V_1M_2) came next to it with a score of 4.7. The colour of Sri Bhadra variety and its blends were less appealing as per the results. The plain sweet potato leather made from Sri Bhadra variety secured the lowest score of 3.4.

Kanjanghad variety of sweet potato and mango when blended in the proportions 50:50 (V_1M_1) and 60:40 (V_1M_2), in the preparation of leather, exhibited high scores, i.e. 4.7 and 4.6 respectively, for flavour. The leather sample prepared by blending Sri Bhadra variety and pineapple in the proportions 60:40 (V_2P_2) and 70:30 (V_2P_3) both were very low in flavour and secured the least score of 3.8.

The taste attribute score of fresh leather ranged from 4.7 to 3.9. The blended leather made from Kanjanghad variety and mango in the proportion 50:50 (V_1M_1) was high in taste with a score of 4.7. Leather made from Kanjanghad variety and mango blended in the proportion 60:40 i.e. V_1M_2 was near the highest score with a score of 4.5. The lowest score for taste ,3.9, was secured by leather samples made from Sri Bhadra variety alone and also in combination with pineapple in the proportions 60:40 and 70:30.

Regarding texture also, the blended leather made from Kanjanghad variety and mango mixed in the proportion 50:50 (V_1M_1) secured the highest score of 4.6. The blended leather samples made from Sri Bhadra variety and pineapple combined in the proportions 50:50 (V_2P_1), 60:40 (V_2P_2) and 70:30 (V_2P_3) were considered lower in the case of texture with the scores 3.7, 3.8 and 3.7 respectively.

On comparison of various quality attributes to evaluate the overall acceptability, the results revealed that V_1M_1, i.e., blended leather made from Kanjanghad variety and Mango in the ratio 50:50 ranked high with a mean score of 4.7. Considering the overall acceptability, the blended leather, i.e., V_2P_2 (Sri Bhadra variety and Pineapple blended in the proportion 60:40) and V_2P_3 (Sri Bhadra variety and Pineapple blended in the ratio 70:30) were the least accepted ones with score 3.8.

4.1.5.2. Organoleptic assessment of fresh jam

Jam processed with the two varieties of sweet potato, viz., Kanjanghad and Sri Bhadra alone and its blends with mango and pineapple were evaluated for their sensory qualities and the mean scores obtained are depicted in the Table 9.

Table 9 : Organoleptic characteristics of fresh jam.

Jam	Quality Parameters						
	Appearance	Colour	Flavour	Taste	Texture	Consistency	Overall Acceptability
V_1	4.6	4.2	4.2	3.7	4.2	4.4	4.2
V_2	4.3	3.9	3.7	3.4	3.5	4.1	3.8
V_1M_1	4.3	3.5	4.4	4.5	4.6	4.6	4.3
V_1M_2	4.2	3.6	4.3	4.4	4.4	4.5	4.2
V_1M_3	4.2	3.7	4.2	4.2	4.3	4.5	4.2
V_2M_1	4.0	3.4	4.1	4.2	4.3	4.4	4.1
V_2M_2	3.9	3.4	4.0	4.1	4.1	4.3	4.0
V_2M_3	3.9	3.4	4.0	3.9	3.9	4.3	3.9
V_1P_1	4.9	4.7	4.6	4.6	4.6	4.6	4.7
V_1P_2	4.8	4.6	4.4	4.4	4.4	4.4	4.5
V_1P_3	4.6	4.5	4.3	4.2	4.4	4.4	4.4
V_2P_1	4.6	4.4	4.1	4.2	4.1	4.4	4.3
V_2P_2	4.5	4.3	4.0	4.0	3.9	4.3	4.2
V_2P_3	4.4	4.2	3.9	3.8	3.7	4.2	4.1
CD	0.682	0.532	0.661	0.678	0.618	0.620	0.643

N= 10

V_1 → Sweet potato Kanjanghad variety

V_2 → Sweet potato Sri Bhadra variety

V_1M_1:Sweet potato + Mango → 50:50 V_2M_1:Sweet potato + Mango → 50:50

V_1M_2:Sweet potato + Mango → 60:40 V_2M_2:Sweet potato + Mango → 60:40

V_1M_3:Sweet potato + Mango → 70:30 V_2M_3:Sweet potato + Mango → 70:30

V_1P_1:Sweet potato + Pineapple→50:50 V_2P_1:Sweet potato + Pineapple→50:50

V_1P_2:Sweet potato + Pineapple→60:40 V_2P_2:Sweet potato + Pineapple→60:40

V_1P_3:Sweet potato + Pineapple→70:30 V_2P_3:Sweet potato + Pineapple→70:30

The jam prepared by blending Kanjanghad variety and pineapple in the proportion 50:50 (V_1P_1) was highly appreciated for its appearance with a score of

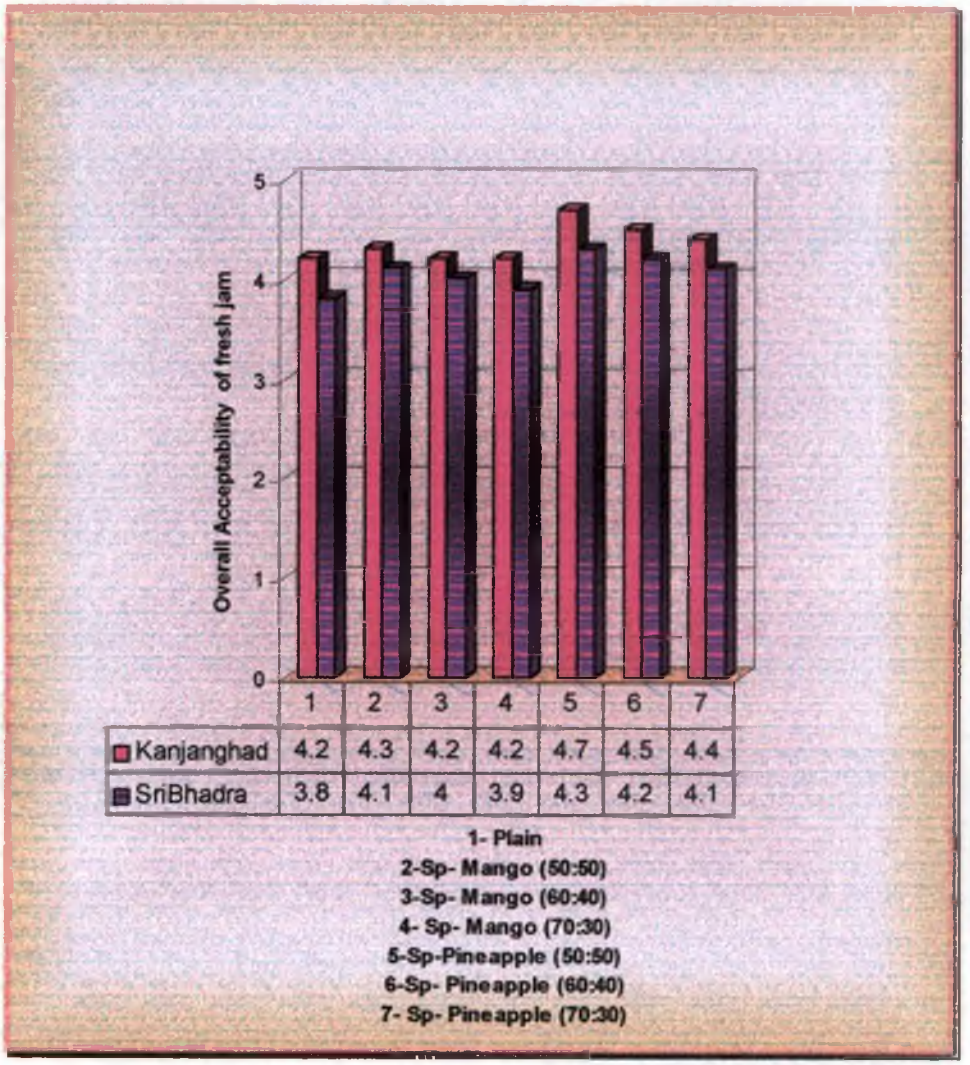


Fig.5: Overall Acceptability of Jam

4.9. The lowest score (3.9) was secured by the blends of Sri Bhadra variety and mango in the proportion 60:40 (V_2M_2) and 70:30 (V_2M_3).

The score for colour of jam samples ranged from 3.4 to 4.7 with the blended jam made from Kanjanghad variety and pineapple blended in the ratio 50:50 scoring the highest. It was observed that blending with mango made the colour of sweet potato jam less appreciable with the lowest scores ranging from 3.4 to 3.7.

Blended sweet potato (Kanjanghad variety and pineapple in the proportion 50:50) jam scored highest for flavour attribute, i.e., 4.6. The least score was for plain sweet potato (Sri Bhadra variety) jam i.e., 3.7.

Taking into account the taste ratings, the blended samples were found superior to the plain ones. The jam prepared by blending sweet potato of Kanjanghad variety and pineapple in 50:50 proportion (V_1P_1) was rated as the tastiest sample (4.6) in the evaluation. Next to it was the same variety (Kanjanghad) blended with mango in the proportion 50:50 (V_1M_1) having a score of 4.5. The taste of the plain jam from Sri Bhadra variety (V_1) was least accepted with a score of 3.4.

As per the result of sensory evaluation, the texture of mango blended samples were more appreciated in the case of Sri Bhadra variety; and for Kanjanghad variety both mango and pineapple blends were equally accepted. The highest of 4.6 was secured by both V_1M_1 (Kanjanghad variety and mango in the

proportion 50:50) and V_1P_1 (Kanjanghad variety and pineapple in the proportion 50:50)

Consistency of the jam samples ranged from 4.1 to 4.6. The highest score of 4.6 was scored by V_1M_1, i.e., the Kanjanghad variety and mango combined in the ratio 50:50 and V_1P_1., i.e., the same variety and pineapple in the proportion 50:50. The plain sweet potato jam made from Sri Bhadra variety scored 4.2, i.e., the lowest score.

The overall acceptability of V_1P_1 (Kanjanghad variety and pineapple in the proportion 50:50) was highest with 4.7. The least score for overall acceptability was obtained by the plain sweet potato jam from Sri Bhadra variety.

4.1.5.3. Organoleptic assessment of fresh wine

The result of the organoleptic assessment of freshly prepared blended and plain wine prepared from two varieties of sweet potato, viz., Kanjanghad variety and Sri Bhadra variety is summarised in the Table 10.

Table 10 : Organoleptic characteristics of fresh wine

Wine	Quality Parameters					
	Appearance	Colour	Flavour	Taste	Clarity	Overall Acceptability
V_1	4.7	4.5	4.2	4.3	4.4	4.4
V_2	4.6	4.5	4.1	4.4	4.2	4.3
V_1M_1	3.5	3.8	3.6	3.1	3.2	3.4
V_1M_2	3.6	3.9	3.8	3.2	3.4	3.6
V_1M_3	3.8	3.9	3.9	3.2	3.4	3.6
V_2M_1	3.4	3.8	3.7	3.2	3.2	3.4
V_2M_2	3.5	3.8	3.7	3.2	3.2	3.5
V_2M_3	3.7	3.9	3.8	3.2	3.3	3.6
V_1P_1	4.7	4.5	4.4	4.5	4.4	4.5
V_1P_2	4.6	4.5	4.5	4.6	4.5	4.6
V_1P_3	4.6	4.3	4.3	4.2	4.2	4.3
V_2P_1	4.6	4.5	4.4	4.4	4.3	4.4
V_2P_2	4.6	4.5	4.5	4.6	4.5	4.5
V_2P_3	4.6	4.3	4.2	4.3	4.3	4.3
CD	0.539	0.683	0.585	0.525	0.626	0.565

N= 10

V_1 → Sweet potato Kanjanghad variety

V_2 → Sweet potato Sri Bhadra variety

V_1M_1:Sweet potato + Mango → 50:50

V_1M_2:Sweet potato + Mango → 60:40

V_1M_3:Sweet potato + Mango → 70:30

V_1P_1:Sweet potato + Pineapple→50:50

V_1P_2:Sweet potato + Pineapple→60:40

V_1P_3:Sweet potato + Pineapple→70:30

V_2M_1:Sweet potato + Mango → 50:50

V_2M_2:Sweet potato + Mango → 60:40

V_2M_3:Sweet potato + Mango → 70:30

V_2P_1:Sweet potato + Pineapple→50:50

V_2P_2:Sweet potato + Pineapple→60:40

V_2P_3:Sweet potato + Pineapple→70:30

On analysing the organoleptic rating of wine samples, it can be seen that variety 1 (Kanjanghad) blended with pineapple (proportion 50:50, i.e., V_1P_1) as well as the same variety without any blend (V_1) have got the highest score of 4.7

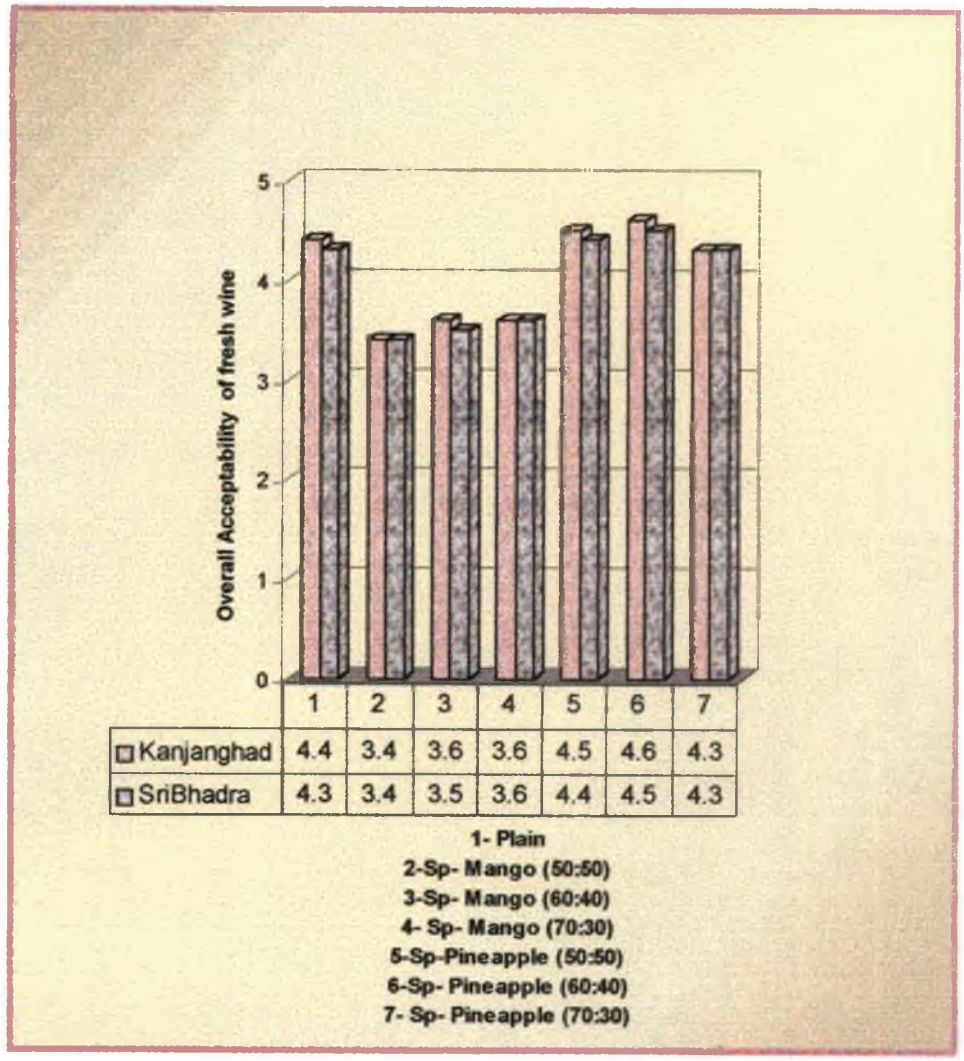


Fig.6: Overall Acceptability of Wine

for appearance. The least score for appearance(3.4) was obtained by variety 2 (Sri Bhadra), when compared with Mango blend in the proportion 50:50 (V_2M_1).

Scores for colour ranged from 3.8 to 4.5. It can be seen that plain sweet potato wines and its pineapple blends without any varietal difference were superior (4.3 to 4.5) to all the mango blended samples (3.8 to 3.9)

Blending with pineapple tends to increase the flavour of plain sweet potato wine. The highest score for flavour, i.e., 4.5 was obtained by the blended sweet potato wine of both the varieties (Kanjanghad and Sri Bhadra), where 40% pineapple was blended. Whereas, the least acceptable flavour was that of V_1M_1 (3.6), i.e., Kanjanghad variety and mango in the proportion 50:50.

The blends of both Kanjanghad and Sri Bhadra where the contribution of pineapple was 40%, i.e., V_1P_2 and V_2P_2 were rated as the tastiest samples with 4.6 as score. The taste of mango blends were found to be least acceptable.

The clarity of the samples ranged from 3.2 to 4.5, where the pineapple blends as well as plain sweet potato wines irrespective of much varietal difference, were superior to the mango blended wine.

Considering the overall acceptability, V_1P_2, i.e., the blend where 60% Kanjanghad variety was blended to 40% pineapple, came up with the highest score 4.6. As observed in almost all other qualities, in overall acceptability also. The mango blends were inferior to plain as well as pineapple blended sweet potato wines.

4.1.6. Consumer acceptability and preference

4.1.6.1.1. Consumer acceptance of leather

An analysis of the consumer acceptability statistics of leather samples revealed that the product prepared from the sweet potato (Kanjanghad variety) - mango blend (50:50), i.e., V_1M_1 gathered more acceptance among the consumers with an overall acceptability score of 4.8. In all quality attributes, the product V_1M_1 has par excelled the other samples. It can be seen that the over all acceptability of all other samples other than V_1M_1 ranged from 3.8 to 4.5, whereas, it came up to 4.8 for V_1M_1. The ratings for various quality parameters can be observed in the Table 11.

Table 11 : Consumer acceptance of leather

Leather	Quality Parameters					
	Appearance	Colour	Flavour	Taste	Texture	Overall Acceptability
V_1	4.1	4.1	4.2	4.4	4.1	4.2
V_2	3.9	3.5	3.9	4.0	3.9	3.8
V_1M_1	4.8	4.8	4.8	4.8	4.6	4.8
V_1M_2	4.6	4.5	4.6	4.6	4.4	4.5
V_1M_3	4.4	4.4	4.3	4.3	4.2	4.3
V_2M_1	4.5	4.4	4.4	4.4	4.3	4.4
V_2M_2	4.3	4.3	4.3	4.2	4.1	4.2
V_2M_3	4.1	4.1	4.2	4.1	4.0	4.1
V_1P_1	4.2	4.3	4.0	4.2	3.8	4.1
V_1P_2	4.0	4.0	4.0	4.0	3.6	3.9
V_1P_3	3.9	3.8	3.9	4.0	3.5	3.8
V_2P_1	4.1	3.8	4.0	3.9	3.6	3.9
V_2P_2	3.8	3.6	3.9	3.9	3.7	3.8
V_2P_3	3.7	3.6	3.9	3.9	3.7	3.8
CD	0.299	0.326	0.364	0.258	0.311	0.323

N= 25

V_1 → Sweet potato Kanjanghad variety

V_2 → Sweet potato Sri Bhadra variety

V_1M_1:Sweet potato + Mango → 50:50 V_2M_1:Sweet potato + Mango → 50:50

V_1M_2:Sweet potato + Mango → 60:40 V_2M_2:Sweet potato + Mango → 60:40

V_1M_3:Sweet potato + Mango → 70:30 V_2M_3:Sweet potato + Mango → 70:30

V_1P_1:Sweet potato + Pineapple→50:50 V_2P_1:Sweet potato + Pineapple→50:50

V_1P_2:Sweet potato + Pineapple→60:40 V_2P_2:Sweet potato + Pineapple→60:40

V_1P_3:Sweet potato + Pineapple→70:30 V_2P_3:Sweet potato + Pineapple→70:30

4.1.6.1.2. Consumer acceptance of jam.

The consumer acceptability statistics of jam favour the sample prepared from sweet potato (Kanjanghad variety) and pineapple blended in 50:50 proportion, i.e., V_1P_1, with an overall acceptability score of 4.7. For appearance and texture, V_1P_1 can claim a slight weightage over V_1P_1 whereas, for other qualities like colour, flavour, taste and consistency, V_1P_1 exceeded the score of V_1P_1. Table 12 summarizes the consumer acceptance ratings for jam.

Table 12 : Consumer acceptance of Jam

Jam	Mean Scores for Quality Attributes						
	Appearance	Colour	Flavour	Taste	Texture	Consistency	Overall Acceptability
V_1	4.4	4.0	4.2	3.7	4.3	4.5	4.2
V_2	4.1	3.8	3.7	3.5	3.5	4.2	3.8
V_1M_1	4.0	3.2	4.5	4.4	4.6	4.7	4.2
V_1M_2	4.1	3.2	4.4	4.2	4.5	4.7	4.2
V_1M_3	4.0	3.2	4.3	4.1	4.5	4.6	4.1
V_2M_1	3.8	3.0	4.2	4.2	4.4	4.4	4.0
V_2M_2	3.7	3.1	4.1	4.2	4.2	4.3	3.9
V_2M_3	3.7	3.2	4.0	4.0	3.9	4.3	3.5
V_1P_1	4.9	4.8	4.6	4.7	4.5	4.7	4.7
V_1P_2	4.9	4.6	4.3	4.6	4.6	4.5	4.6
V_1P_3	4.7	4.4	4.2	4.4	4.6	4.3	4.4
V_2P_1	4.5	4.5	4.3	4.1	4.3	4.3	4.3
V_2P_2	4.3	4.2	4.1	3.9	4.0	4.2	4.2
V_2P_3	4.3	4.2	4.0	3.7	4.0	4.0	4.0
CD	0.362	0.329	0.285	0.287	0.271	0.236	0.357

N= 25

V_1 → Sweet potato Kanjanghad variety

V_2 → Sweet potato Sri Bhadra variety

V_1M_1:Sweet potato + Mango → 50:50

V_1M_2:Sweet potato + Mango → 60:40

V_1M_3:Sweet potato + Mango → 70:30

V_1P_1:Sweet potato + Pineapple→50:50

V_1P_2:Sweet potato + Pineapple→60:40

V_1P_3:Sweet potato + Pineapple→70:30

V_2M_1:Sweet potato + Mango → 50:50

V_2M_2:Sweet potato + Mango → 60:40

V_2M_3:Sweet potato + Mango → 70:30

V_2P_1:Sweet potato + Pineapple→50:50

V_2P_2:Sweet potato + Pineapple→60:40

V_2P_3:Sweet potato + Pineapple→70:30

4.1.6.1.3. Consumer acceptance of wine.

In the case of wine, V_1P_2, the blended wine from sweet potato (Kanjanghad variety) and pineapple in the proportion 60:40 was noted to be the

most acceptable one by the consumers. The mango blended wine samples displayed a poor acceptability level with the mean overall acceptability score of 3.1, whereas, V_1P_2 topped the rating with a score of 4.6. The scores obtained by wine for the various quality parameters are available in the Table 13.

Table 13 : Consumer acceptance of wine

Wine	Quality Parameters					
	Appearance	Colour	Flavour	Taste	Clarity	Overall Acceptability
V_1	4.7	4.4	4.1	4.5	4.3	4.4
V_2	4.7	4.5	3.9	4.5	4.1	4.3
V_1M_1	3.2	3.5	3.2	2.9	3.1	3.2
V_1M_2	3.3	3.4	2.9	3.1	3.1	3.1
V_1M_3	3.3	3.4	2.9	3.0	3.0	3.1
V_2M_1	3.4	3.5	3.0	2.9	3.0	3.1
V_2M_2	3.3	3.5	3.0	3.0	3.0	3.1
V_2M_3	3.4	3.6	2.9	3.0	2.9	3.1
V_1P_1	4.8	4.4	4.1	4.6	4.4	4.5
V_1P_2	4.8	4.6	4.3	4.8	4.4	4.6
V_1P_3	4.7	4.5	4.2	4.7	4.4	4.5
V_2P_1	4.6	4.4	4.2	4.6	4.3	4.4
V_2P_2	4.7	4.5	4.2	4.7	4.3	4.5
V_2P_3	4.5	4.3	4.2	4.6	4.2	4.4
CD	0.236	0.254	0.251	0.312	0.291	0.273

N= 25

V_1 → Sweet potato Kanjanghad variety

V_2 → Sweet potato Sri Bhadra variety

V_1M_1:Sweet potato + Mango → 50:50 V_2M_1:Sweet potato + Mango → 50:50

V_1M_2:Sweet potato + Mango → 60:40 V_2M_2:Sweet potato + Mango → 60:40

V_1M_3:Sweet potato + Mango → 70:30 V_2M_3:Sweet potato + Mango → 70:30

V_1P_1:Sweet potato + Pineapple→50:50 V_2P_1:Sweet potato + Pineapple→50:50

V_1P_2:Sweet potato + Pineapple→60:40 V_2P_2:Sweet potato + Pineapple→60:40

V_1P_3:Sweet potato + Pineapple→70:30 V_2P_3:Sweet potato + Pineapple→70:30

4.1.6.2.Preference of the developed products among the members of Self Help Groups.

The best treatment of the three products developed using sweet potato were distributed to the self help group members. Samples of these developed products were tasted by the members of the Self Help Groups and their opinion on the degree of liking were recorded. Data were collected using a nine point rating scale ranging from, 'Like extremely' (9) to 'Dislike Extremely' (1). Later, during processing of the data, since none of the products were found to be rated as 'Dislike some what', 'Dislike very much' or 'Dislike extremely', these three rating were deleted. The score card used for preference test is presented in Appendix-II.

Percent scores of the developed products showed that 60 percent women voted Jam as the extremely liked product. Leather and Wine scored 40 and 20 percent respectively. Thirteen percent of women gave negative rating for wine. The degree of liking was obtained and is given in Table 14.

Table 14: Preference of women for the developed products

Sl. No	Product	Ratings (counts; percentage given in brackets)					
		Like Extremely	Like Very Much	Like Reasonably	Like Somewhat	Dislike	Dislike Somewhat
1	Leather	18 (40)	15 (33)	9 (20)	3 (7)	0	0
2	Jam	27 (60)	12 (27)	6 (13)	0	0	0
3	Wine	9 (20)	12 (27)	12 (27)	6 (13)	6 (13)	0

N= 45.

4.2. Shelf life assessment of the products.

The shelf life of the developed sweet potato products were assessed by analysing the changes in chemical constituents of the products during storage, changes in the sensory parameters of the products during storage and microbial quality of the stored products.

4.2.1 Assessment of changes in chemical constituents of the products

The following sections discuss about the variation of chemical constituents of the three products under study, viz., leather, jam and wine, on storage. The values of various chemical attributes of each of these products observed prior and after storage are included in tabular forms.

4.2.1.1. Assessment of changes in chemical constituents of leather with storage

Table 15 depicts the effect of storage in the chemical constituents of leathers developed during the investigation.

Table 15: Effect of storage on chemical constituents of leather

Product	Parameters									
	pH		Acidity (%)		TSS (^{0}brix)		Reducing sugar		Total sugar	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
V_1	4.45	4.36	0.43	0.58	66.20	66.61	34.96	43.61	40.59	44.22
V_2	4.44	4.35	0.43	0.58	66.13	66.56	34.85	43.58	40.54	44.20
V_1M_1	4.31	4.21	0.45	0.60	68.03	68.46	33.26	42.19	39.53	43.93
V_1M_2	4.30	4.19	0.46	0.61	67.91	68.36	33.18	42.07	39.48	43.73
V_1M_3	4.29	4.18	0.47	0.61	67.80	68.21	33.11	42.00	39.40	43.61
V_2M_1	4.31	4.22	0.45	0.59	67.98	68.33	33.24	42.16	39.50	43.88
V_2M_2	4.29	4.19	0.48	0.62	67.89	68.28	33.15	42.07	39.44	43.68
V_2M_3	4.28	4.17	0.48	0.62	67.79	68.20	33.08	41.98	39.38	43.60
V_1P_1	4.26	4.17	0.49	0.63	67.31	67.78	32.95	42.01	38.98	43.09
V_1P_2	4.23	4.12	0.50	0.63	67.21	67.62	32.82	41.95	38.91	42.99
V_1P_3	4.18	4.09	0.51	0.64	67.15	67.48	32.76	41.89	38.86	42.91
V_2P_1	4.26	4.16	0.49	0.62	67.28	67.56	32.94	41.99	38.95	43.03
V_2P_2	4.22	4.11	0.50	0.63	67.20	67.41	32.80	41.82	38.89	42.96
V_2P_3	4.19	4.08	0.52	0.65	67.12	67.46	32.72	41.76	38.82	42.89
CD	0.009	0.006	0.019	0.0028	5.122	0.003	5.099	0.1954	2.211	0.038

On storage, the pH values of leather samples followed a gradually decreasing pattern. The pH value of V_1,the plain sweet potato leather made from Kanjanghad variety, decreased to 4.36 from the highest initial value of 4.45. Statistical analysis also showed significant variation in the pH levels of the leather samples during storage.

The acidity levels of the leather showed an increasing pattern during storage over eight months. V_1M_1 and V_2M_1 had an initial value of 0.45 , that showed a gradual increase and the final acidity value for V_1M and V_2M were 0.60 and 0.59 respectively.

The TSS levels showed only a slight, but not significant increase, across storage during a period of 8 months. Considering the leather V_1M_1 as example, the initial TSS level was 68.03, which gradually increased and reached a value 68.46 by the 8th month. For other samples also, a similar pattern of increase was observed.

The leather samples were found to show a prominent increase in the reducing sugar content over the storage period. For e.g., V_1M_1, prior to storage had a reducing sugar percentage of 33.26. The final reducing sugar percentage for V_1M_1 was noted as 42.19.

When the total sugar percentage for various leather preparations were analysed, it was observed that the values gradually increased with the number of months of storage. Taking V_1M_1 as a representative case, it can be seen that the initial value was 39.53 and during the storage it changed to 43.93.

4.2.1.2 Assessment of changes in the chemical constituents of jam with storage

Effect of storage on the chemical constituents of jam was assessed and the value of chemical constituents before and after storage is depicted in Table16.

Table 16: Effect of storage on chemical constituents of jam

Product	Parameters									
	Ph		Acidity (%)		TSS (^{0}brix)		Reducing sugar		Total sugar	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
V_1	4.90	3.21	0.121	0.46	62.78	62.75	18.59	20.92	25.16	27.11
V_2	4.86	3.19	0.124	0.45	62.93	62.91	18.47	20.86	24.96	26.99
V_1M_1	4.77	3.06	0.136	0.44	67.21	67.19	22.01	25.03	25.22	27.28
V_1M_2	4.73	3.02	0.133	0.42	66.83	66.81	21.93	24.67	25.19	27.23
V_1M_3	4.69	2.98	0.131	0.41	66.51	66.49	21.88	24.78	25.17	27.20
V_2M_1	4.79	3.11	0.137	0.47	67.13	67.10	21.98	25.01	25.18	27.22
V_2M_2	4.75	3.09	0.135	0.44	66.91	66.88	21.86	24.79	25.06	27.01
V_2M_3	4.72	3.06	0.133	0.42	66.67	66.65	21.79	24.66	24.99	26.93
V_1P_1	4.43	2.88	0.133	0.41	66.01	65.98	21.39	24.53	24.86	25.96
V_1P_2	4.58	3.07	0.131	0.39	65.93	65.90	21.01	23.96	24.93	25.98
V_1P_3	4.63	3.09	0.129	0.41	65.84	65.82	20.78	23.58	25.01	26.02
V_2P_1	4.48	2.91	0.135	0.44	66.06	66.03	21.27	24.14	24.71	25.63
V_2P_2	4.53	3.09	0.133	0.45	65.95	65.92	20.97	23.61	24.79	25.71
V_2P_3	4.61	3.11	0.131	0.41	65.89	65.78	20.78	23.59	24.87	25.91
CD	0.024	0.461	2.439	0.005	11.698	0.020	3.311	0.074	3.485	0.1311

The pH value of jam displayed a decreasing tendency when analysed up to four months of storage. No much deviation was noted for the first month. But for the subsequent months, a drastic decrease was recorded. Considering V_1P_1 as an example, it can be seen that the initial pH value 4.43 changed to a lower value-2.88 by the fourth month of storage.

All samples of jam followed an increasing pattern of acidity, when stored for four months. Taking V_1P_1 as an example, the initial acidity level was 0.133 that increased to a value of 0.41 at the end of fourth month. The acidity levels and the variation over the months of storage for the other samples studied was very much same as that of V_1P_1.

TSS of jam showed a tendency to decrease when stored for a period of four months. A decrease by a factor of 0.01 and above was exhibited by the stored samples.

From the values shown in the table, it can be inferred that the reducing sugar level of stored jam tends to increase gradually, for all the combinations. The initial level was higher for V_1M_1, closely followed by V_2M_1. For V_1M_1 and V_2M_1 the initial value remained almost the same for the first month, which showed an increase in value afterwards. The final reducing sugar level attained by V_1M_1 at the end of fourth month was recorded as 25.03.

On analysing the total sugar percentage of jam during storage, an increasing pattern of total sugar level can be viewed. For all the combinations, the first 3 months did not indicate any noticeable change in the values. A slight increase in the percentage was observed for each months, thereafter. In the case of V_1P_1, the initial value was 21.39, which finally reached the value 24.53.

4.2.1.3. Assessment of changes in chemical constituents of wine with storage

The change in the chemical constituents of wine were assessed for a storage period of eight months and the values at the beginning and end of storage are presented in Table 17.

Table 17: Effect of storage on chemical constituents of wine

Product	Parameters							
	pH		Acidity (%)		TSS (^{0}brix)		Alcohol content	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
V_1	3.59	3.37	0.45	0.53	22.78	9.28	10.65	13.53
V_2	3.55	3.33	0.45	0.54	22.76	9.20	10.72	13.80
V_1M_1	3.44	3.26	0.58	0.66	21.69	7.13	8.63	11.78
V_1M_2	3.46	3.28	0.57	0.64	21.67	7.15	8.50	11.51
V_1M_3	3.49	3.31	0.56	0.64	21.66	7.15	8.43	11.50
V_2M_1	3.45	3.24	0.58	0.66	21.69	7.08	8.69	11.83
V_2M_2	3.49	3.27	0.56	0.64	21.68	7.04	8.56	11.76
V_2M_3	3.47	3.29	0.56	0.63	21.67	7.03	8.50	11.69
V_1P_1	3.40	3.23	0.61	0.70	21.93	7.56	9.20	12.87
V_1P_2	3.45	3.23	0.59	0.68	21.92	7.53	9.15	12.81
V_1P_3	3.45	3.24	0.58	0.67	21.91	7.53	9.10	12.81
V_2P_1	3.40	3.22	0.61	0.71	21.93	7.58	9.32	12.98
V_2P_2	3.41	3.23	0.60	0.70	21.93	7.56	9.30	12.94
V_2P_3	3.44	3.25	0.58	0.69	21.92	7.54	9.30	12.94
CD	0.186	0.0034	2.776	0.0010	1.835	0.767	0.682	0.019

A linear decrease in the pH levels was observed for wine during storage up to 8 months. However, the variation was not very prominent, considering the rate of decrease. V_1 initially had a value of 3.59, which decreased by an element of .01 for the first month of storage. By the eighth month the pH value lowered to 3.37.

The acidity level of wine was found to increase on storage. A stabilized acidity level was maintained by all the wine preparations under observation, during the first three months. Then a rapid linear increase in the acidity level was

recorded up to eighth month of storage. In the case of V_1P_2, the values ranged from 0.59 to 0.68.

A considerable decrease in the TSS content of wine was observed on storage for 8 months. Analysing the TSS level across the months, the first month denoted a TSS value almost same as the initial value. For e.g., V_1P_2 had an initial value 21.92 and the same value was observed on the first month also. In the subsequent months, the TSS level seemed to reduce to 7.53.

A considerable increase in the alcohol level of wines upon storage is evident from the table value. The alcohol levels of stored wine increased through the storage period of eight months and acquired high values like 13.80 (plain sweet potato wine- Sri Bhadra variety).

4.2.2.Assessment of changes in sensory qualities of the products

The following tables exhibit the values of the various sensory qualities of the three products, viz., leather, jam and wine, during initial and final month of storage.

4.2.2.1. Effect of storage on various sensory parameters of leather.

The effect of storage on various sensory parameters of leather was studied and the observations at the initial and final months of storage are given in Table 18.

Table 18: Effect of storage on various sensory parameters of leather

Product	Parameters											
	Appearance		Colour		Flavour		Taste		Texture		Overall acceptability	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
V_1	4.2	3.8	3.8	3.3	4.2	3.1	4.2	3.8	4.2	3.7	4.1	3.5
V_2	4.0	3.5	3.4	2.9	4.0	3.1	3.9	3.4	4.0	3.5	3.9	3.3
V_1M_1	4.9	4.4	4.8	3.9	4.7	4.1	4.7	4.1	4.6	4.2	4.7	4.1
V_1M_2	4.7	4.2	4.7	3.7	4.6	4.1	4.5	3.9	4.3	3.8	4.5	3.9
V_1M_3	4.4	3.9	4.4	3.6	4.3	3.9	4.3	3.7	4.3	3.7	4.3	3.8
V_2M_1	4.6	4.2	4.6	3.8	4.4	3.9	4.4	3.8	4.4	4.0	4.5	3.9
V_2M_2	4.4	4.0	4.4	3.6	4.2	3.7	4.1	3.6	4.2	3.8	4.3	3.7
V_2M_3	4.1	3.8	4.2	3.4	4.1	3.7	4.0	3.4	4.1	3.8	4.1	3.6
V_1P_1	4.3	3.8	4.5	4.1	4.2	3.5	4.2	3.8	3.9	3.4	4.2	3.7
V_1P_2	4.0	3.5	4.3	3.8	4.1	3.4	4.1	3.7	3.9	3.4	4.1	3.6
V_1P_3	4.0	3.5	4.3	3.7	4.0	3.2	4.2	3.7	4.0	3.5	4.1	3.5
V_2P_1	4.1	3.6	3.9	3.4	4.0	3.3	4.0	3.7	3.7	3.3	3.9	3.5
V_2P_2	3.9	3.5	3.7	3.3	3.8	3.1	3.9	3.6	3.8	3.2	3.8	3.3
V_2P_3	3.8	3.5	3.6	3.2	3.8	3.1	3.9	3.5	3.7	3.1	3.8	3.3
CD	0.54	0.25	0.54	0.25	0.59	0.23	0.50	0.26	0.51	0.27	0.50	0.12

Leather displayed a decrease in the score for appearance when stored for eight months. All the samples were found to lose their appearance quality through the period of storage. The statistical analysis also supported the existence of a significant variation in values. In the case of V_1M_1 the initial acceptability rating 4.9 declined to 4.4 after eight months of storage.

From observations of colour rating for eight months of storage, it was seen that storage had a negative effect on the colour of leather. The variation in the acceptability level was very prominent too. For V_1M_1, the final rating after

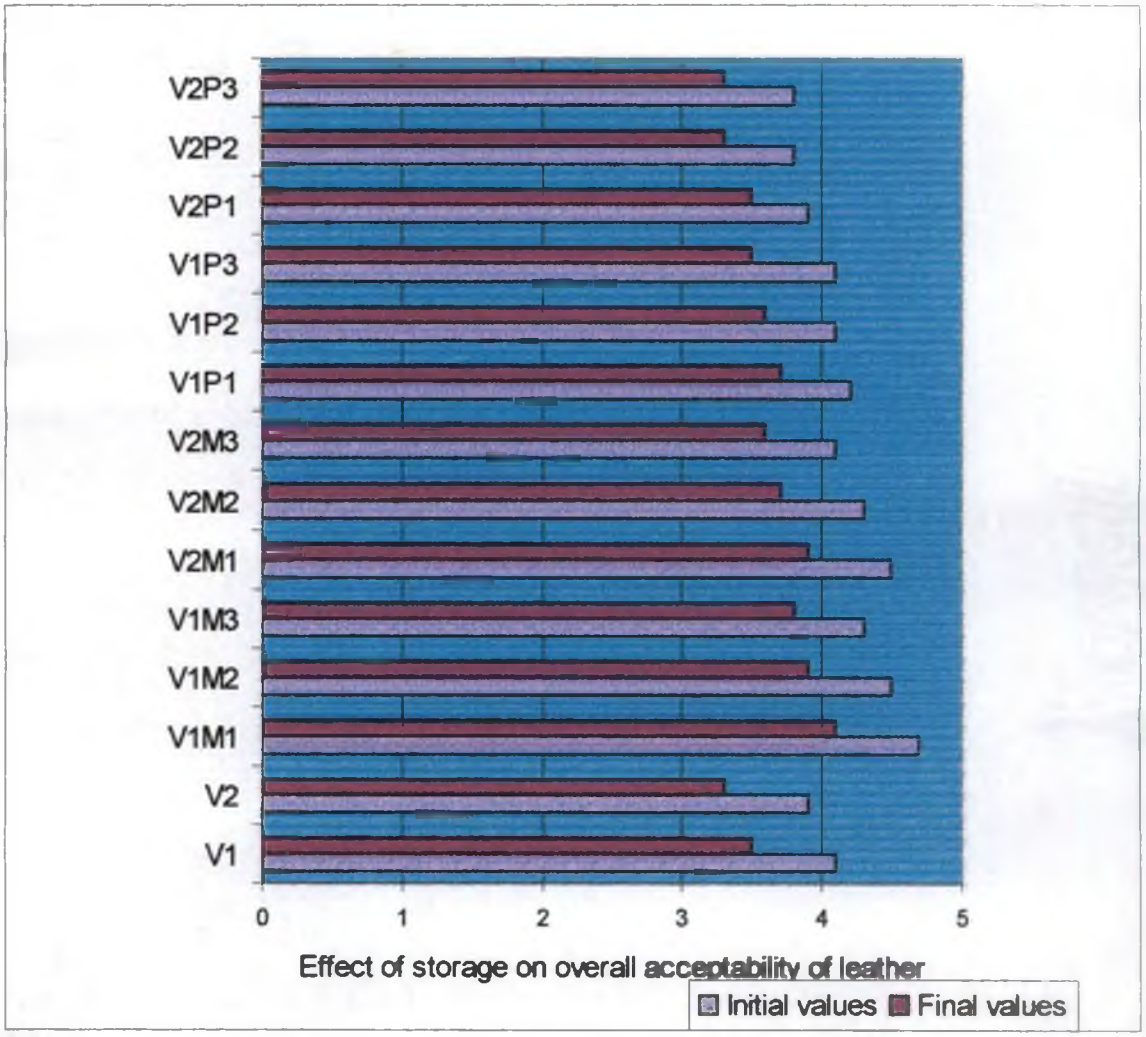


Fig 7: Effect of Storage on overall acceptability of leather

storing for 8 months was found to be 3.9, which was a considerably high variation from the initial value of 4.8.

As in the previous cases, the flavour of leather also was found to loose score during storage. A constant decrease in the flavour attribute was exhibited by all the samples studied.

On analysing the taste levels of leather, it can be seen that the storage badly affected the taste of leather. From the third month onwards, till the seventh month, a slow, gradual decrease in taste factor was observed for all the samples. But towards the eighth month, a drastic diminishing of taste was observed. V_1M_1 was found to be ahead of all other samples, when acceptability for each month was considered independently.

The texture of leather displayed a decrease in acceptability when stored for a long time. The decrease in texture rating was hardly noticeable during the first two months. Thereafter, a steady decrease in rating was observed till the eighth month.

Considering the overall rating of leather samples over 8 months, it can be seen that the samples had undergone degradation on storage. The product is well consumable during the first two months of storage, whereafter the quality attributes tend to decrease.

4.2.2.2.Effect of storage on various sensory parameters of jam

Table 19 depicts the effect of storage on the sensory parameters of jam at the end of the storage period.

Table 19: Effect of storage on various sensory parameters of jam.

Product	Parameters													
	Appearance		Colour		Flavour		Taste		Texture		Consistency		Over all acceptability	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
V_1	4.6	4.3	4.2	3.9	4.2	3.7	3.7	3.2	4.2	4.0	4.4	4.0	4.2	3.6
V_2	4.3	4.0	3.9	3.5	3.7	3.3	3.4	3.0	3.5	3.2	4.1	3.8	3.8	3.5
V_1M_1	4.3	3.9	3.5	3.1	4.4	3.9	4.5	4.2	4.6	4.2	4.6	4.2	4.3	3.9
V_1M_2	4.2	3.7	3.6	3.3	4.3	3.8	4.4	4.0	4.4	4.0	4.5	4.1	4.2	3.8
V_1M_3	4.2	3.7	3.7	3.3	4.2	3.7	4.2	3.7	4.3	4.0	4.5	4.1	4.2	3.8
V_2M_1	4.0	3.6	3.4	3.0	4.1	3.6	4.2	3.8	4.3	3.9	4.4	4.0	4.1	3.7
V_2M_2	3.9	3.5	3.4	3.0	4.0	3.4	4.1	3.5	4.1	3.7	4.3	3.9	4.0	3.6
V_2M_3	3.9	3.4	3.4	2.9	4.0	3.5	3.9	3.5	3.9	3.5	4.3	3.8	3.9	3.5
V_1P_1	4.9	4.6	4.7	4.5	4.6	4.2	4.6	4.2	4.6	4.4	4.6	4.3	4.7	4.4
V_1P_2	4.8	4.5	4.6	4.4	4.4	3.9	4.4	4.0	4.4	4.1	4.4	4.2	4.5	4.2
V_1P_3	4.6	4.2	4.5	4.3	4.3	3.7	4.2	3.8	4.4	4.1	4.4	4.2	4.4	4.1
V_2P_1	4.6	4.3	4.4	4.2	4.1	3.7	4.2	3.8	4.1	3.8	4.4	4.1	4.3	3.9
V_2P_2	4.5	4.2	4.3	4.0	4.0	3.5	4.0	3.6	3.9	3.6	4.3	4.0	4.2	3.8
V_2P_3	4.4	4.0	4.2	3.9	3.9	3.4	3.8	3.5	3.7	3.4	4.2	3.8	4.1	3.7
CD	0.68	0.21	0.53	0.21	0.66	0.32	0.67	0.26	0.61	0.29	0.62	0.17	0.54	0.11

Jam was seen to exhibit a reduction in score in the appearance aspects on storage. A noticeable decrease in the appearance rating was noted only from the second month of storage. Statistical analysis of the rating underlines the existence of a significant reduction in appearance aspects.

The colour attribute of jam tends to show a declining effect, when the ratings for four months of storage were analysed. However, on statistical analysis the decline was found to be of not much significance. V_1P_1 secured an initial score of 4.7, which on course of storage reduced to 4.5.

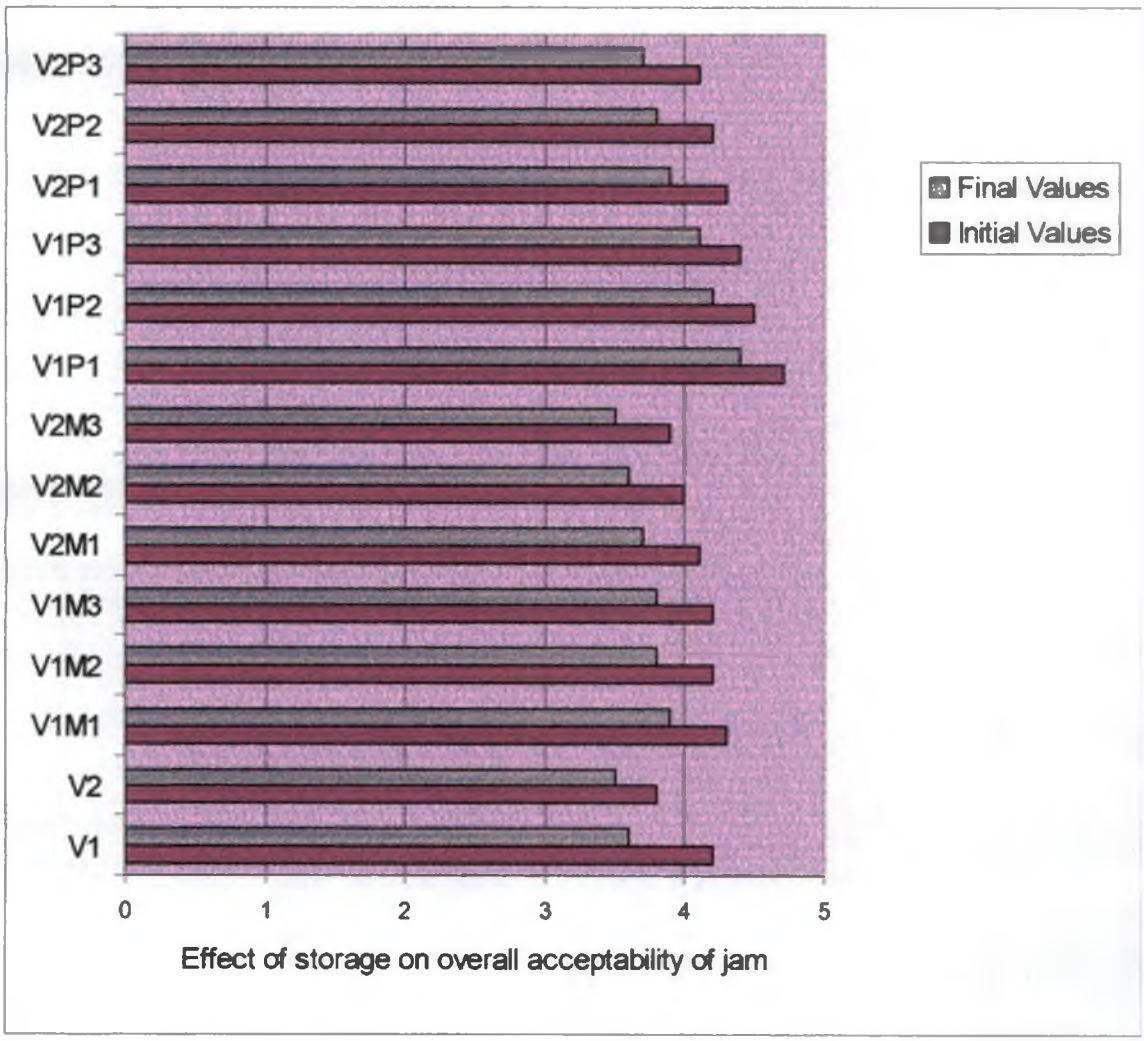


Fig 8: Effect of Storage on overall acceptability of jam

Flavour of jam was found to be negatively affected by storage. A notable decline in the flavour rating of jam was experienced on course of storage. Considering the case of V_2P_1 the rating lowered to 3.7 from the starting score of 4.1.

A descending effect was detected on the taste of jam, during storage for four months. For V_1P_1 and V_2P_1, a deduction by 0.4 was noticed on the initial score of 4.6 and 4.2 respectively. The statistical examination of rating figures strengthened the above observation.

The texture of jam was more acceptable during the initial months of storage than during later months, though the variation was not worth mentioning as per statistical norms.

Jam displayed a decrease in consistency with storage. For V_1P_1, the starting score was 4.6, which after four months of storage reduced to 4.3. Statistical examination reveals that the variation is not very much significant.

A significant difference was seen in the overall acceptability of jam during the storage period of four months. This difference was more pronounced in the case of plain sweet potato jam of both the varieties.

4.2.2.3. Effect of storage on various sensory parameters of wine

The change in sensory parameters of wine was studied for a period of eight months and the scores at the initial and final months of storage are presented in Table 20.

Table 20: Effect of storage on various sensory parameters of wine

Product	Parameters											
	Appearance		Colour		Flavour		Taste		Clarity		Overall acceptability	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
V_1	4.7	4.9	4.5	4.8	4.2	4.6	4.3	4.8	4.4	4.7	4.4	4.8
V_2	4.6	4.9	4.5	4.8	4.1	4.6	4.4	4.8	4.2	4.5	4.3	4.7
V_1M_1	3.5	4.0	3.8	4.1	3.6	4.0	3.1	3.6	3.2	3.5	3.4	3.8
V_1M_2	3.6	4.1	3.9	4.2	3.8	4.1	3.2	3.5	3.4	3.7	3.6	3.9
V_1M_3	3.8	4.2	3.9	4.3	3.9	4.2	3.2	3.7	3.4	3.8	3.6	4.0
V_2M_1	3.4	3.9	3.8	4.0	3.7	4.0	3.2	3.5	3.2	3.6	3.4	3.8
V_2M_2	3.5	4.0	3.8	4.0	3.7	4.1	3.2	3.4	3.2	3.6	3.5	3.8
V_2M_3	3.7	4.2	3.9	4.0	3.8	4.2	3.2	3.5	3.3	3.8	3.6	3.9
V_1P_1	4.7	4.9	4.5	4.8	4.4	4.6	4.5	4.8	4.4	4.7	4.5	4.8
V_1P_2	4.6	4.9	4.5	4.8	4.5	4.7	4.6	5.0	4.5	4.9	4.6	4.9
V_1P_3	4.6	4.8	4.3	4.6	4.3	4.5	4.2	4.5	4.2	4.5	4.3	4.6
V_2P_1	4.6	4.9	4.5	4.7	4.4	4.6	4.4	4.8	4.3	4.7	4.4	4.8
V_2P_2	4.6	4.9	4.5	4.8	4.5	4.8	4.6	5.0	4.5	4.9	4.5	4.8
V_2P_3	4.6	4.8	4.3	4.7	4.2	4.5	4.3	4.7	4.3	4.6	4.3	4.7
CD	0.53	0.12	0.68	0.13	0.58	0.21	0.52	0.21	0.62	0.19	0.52	8.99

From the ratings for appearance of wine, recorded up to 8 months of storage, it can be inferred that the appearance attribute progress with time. The rating of appearance was found to follow a slowly increasing pattern. From the ratings for the wine samples, it can be seen that appearance rating has varied up to a factor of 0.2 to 0.6.

Analysis of rating for the colour attribute highlights the fact that storage improves the colour of wine. An increase by a factor of 0.2 to 0.4 was noted from the ratings. This increase has been identified as notably significant, from statistical analysis.

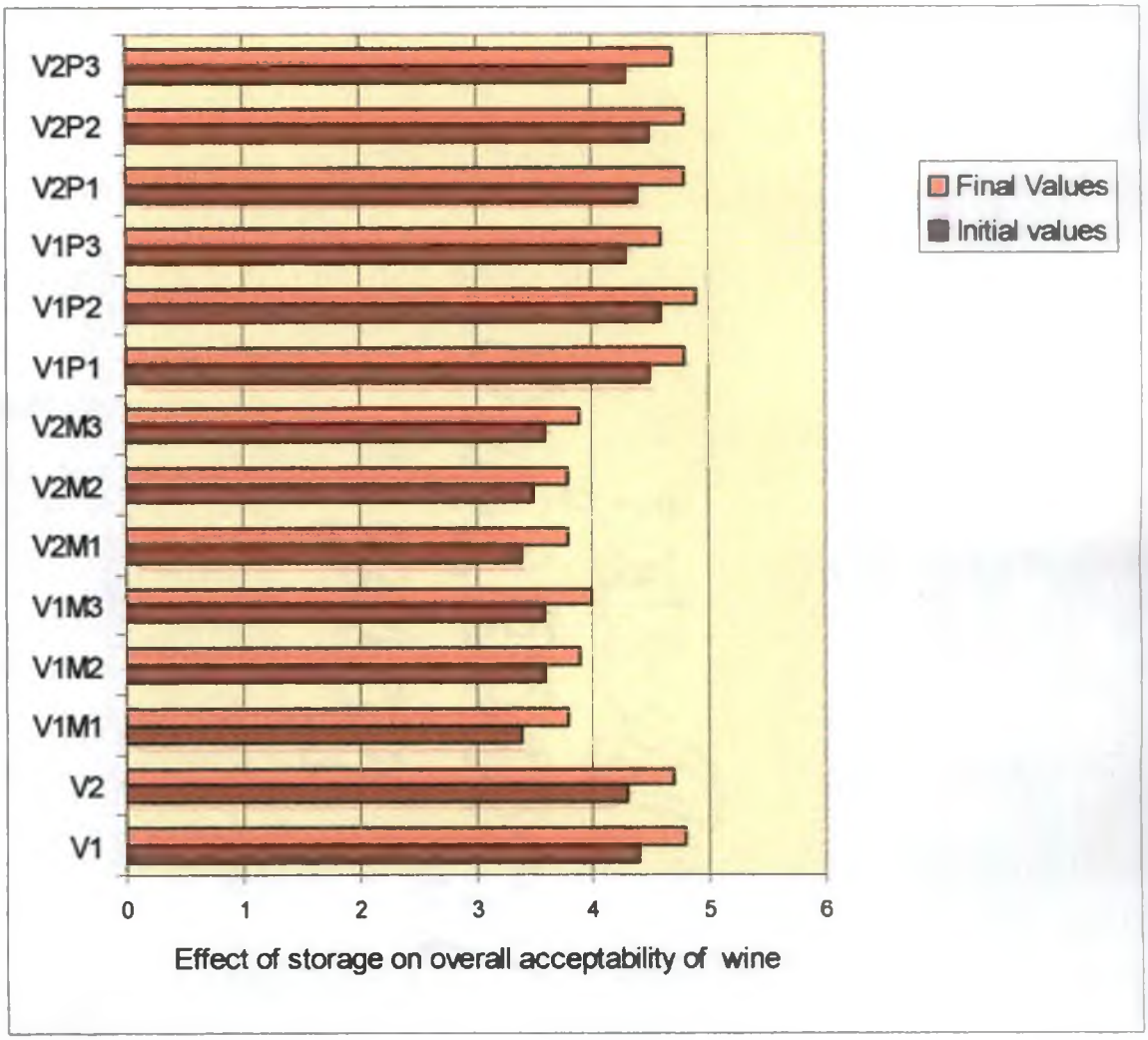


Fig.9: Effect of storage on overall acceptability of Wine

The flavour of wine tends to increase during storage. For plain sweet potato wines $V_1$and V_2 the increase was about a factor of 0.4 and 0.5 respectively.

From the rating of taste of wine, it can be seen that taste of wine can be increased through storage. The increase in rating by a factor of 0.2 to 0.5 was recorded. For V_1P the acceptability level increased from 4.6 to 5.0 and for V_2P_2 also the acceptability rating leaped to 5.0 from 4.6.

Based on the ratings of clarity of wine recorded in 8 months, it can be generalised that clarity of wine progresses as months elapse. For V_1P_2 and V_2P_2, the initial acceptability level was 4.5 that gradually increased to 4.9 at the end of eighth month.

The above Table serves as an evidence for the increase of overall acceptability of wine with storage. It can be seen that V_1P_2 has maintained a high level of acceptability on each month under consideration and has exhibited a steady increase in the acceptability rating with the progression of time of storage. A similar increasing pattern was displayed by the other samples also.

4.2.3. Assessment of microbial contamination of products during storage

Processed foods, which are stored and consumed after a period of storage is to be assessed for microbial contamination. Hence the blended sweet potato products viz. leather, jam and wine were examined for microbial infestation such as bacteria, yeast and fungi.

All the isolations were carried out following serial dilution technique by colony morphology and microscopic observations. The products were analysed as fresh and also at monthly intervals.

The periodical testing of sweet potato leather on storage showed complete absence of any microorganism up to eight months of storage. The presence of microorganisms was detected only from the ninth month in plain sweet potato. The blended sweet potato leather samples indicated no microbial contamination. The colonies of *Pencillium* and *Aspergillus* species were found in plain sweet potato leather.

Microbial infestations were detected in all the samples of jam developed only from the fifth month of storage. Colonies of *Pencillium* and *Aspergillus* were the species found in the jam samples.

None of the stored samples of wines showed presence of microorganism even after twelve months of storage. All the wine samples were pure even after fifteen months.

4.3. Transfer of technology.

One of the objectives of the present study was transferring the technologies developed to self-help groups. For this three self –help groups were selected and the method of preparation of the products from sweet potato viz leather, jam and wine were demonstrated to the members of the self-help groups.

The gain in knowledge was measured using a pre and post test, which revealed that gain in knowledge was about 70 percent.

Pre-test

Fifteen statements about processing were prepared. Main purpose was to test the awareness of the self help group members regarding processing. Knowledge of the self-help group members related to various aspects of processing is detailed in Table 21.

Table 21 : Knowledge of self-help group members related to various aspects of processing.

Sl No	Aspects	Number of statements	Maximum score to be obtained	Mean score
1.	Processing	3	3	1.05
2.	Processing techniques	4	4	0.52
3.	Sweet potato	4	4	0.4
4.	Processing of sweet potato	4	4	0.08

Gain in knowledge after pre-test.

	Mean score	Gain in knowledge
Pre exposure	2.05	
Post exposure	37.3	t = 73.8

It is evident that the transfer of technology was effective.

The rate of adoption was also satisfactory. These self help groups were evaluated after a period of three months. It was found that one group has started practicing processing of sweet potato in small scale.

DISCUSSION

5. DISCUSSION.

The results obtained during the present study entitled "Developing blended preserved products based on sweet potato" are discussed under the following headings.

5.1 Detailed study on the sweet potato products.

5.2 Storage studies on the sweet potato products.

5.3 Transfer of technology.

5.1. Detailed study on selected blended sweet potato products.

A detailed study was conducted on the developed sweet potato products and results are discussed below.

5.1.1. Assessment of chemical components of the products

The chemical components of the fresh products were analysed and it was observed that the values were within the satisfactory limits.

5.1.1.1. Assessment of chemical components of leather.

The pH of the leather samples ranged from 4.18 to 4.45. Jyothi (1997) had recorded a pH of 4.60 in mango-papaya bar (1:1). According to Tonāki et al. (1993) the pH level should be lowered for adequate presentation of dried fruit products.

The acidity level was highest for, V_1P_3, the blended sweet potato-pineapple jam made from Kanjanghad variety (70:30). The acidity level of sweet potato leather which was low could be increased by blending with mango or pineapple. Sheeja (1994) observed the acidity content of papaya candy to be 0.50

percent. According to Sheeja (1995) the acidity content of Karonda candy was 0.65 percent.

The highest TSS level was recorded for the blended sweet potato-mango leather (V_1M_1). The lowest was for the plain sweet potato leather prepared from Sri Bhadra variety. The high TSS levels recorded by blended leathers would be advantageous for its quality and storability.

The range of reducing sugar recorded was within satisfactory level. During drying the amount of reducing sugar increase and therefore the quantity of reducing sugar is more in dehydrated foods (Das,1986). Chauhan et.al (1993) reported a similar reducing sugar level for fruit bar prepared by dehydration of apricot pulp supplemented with soy slurry having 33 percent reducing sugar.

The total sugar content of the leather samples varied from 38.82 to 40.59. The highest total sugar content was noted for plain sweet potato leather, V_1. A similar total sugar content was noted for mango blended papaya leather developed by Beena (1998).

5.1.1.2. Assessment of chemical components of jam

Considering the chemical constituents in jams, the pH content of the jam samples ranged between 4.43 and 4.90. Sheeja (1994) reported that the pH of papaya jam ranged from 3.00 to 3.90. Irene (1997) mentioned that the pH of mango jam ranged from 4.42 to 5.42.

The acid content of the developed jams didnot vary much and there existed no significant difference between the samples. Irene(1997) observed that the pH of mango jam ranged from 0.13 to .0.14.

The TSS content of the developed plain sweet potato jams were around 63 percent and the TSS content of pineapple blends were about 66 percent. Blending with fruit significantly increased the TSS content of plain sweet potato jam.

The reducing sugar content of the plain sweet potato jam V_1 and V_2 were 18.59 and 18.47. While the reducing sugar content of the blended sweet potato leathers were found to be between 20.78 and 22.01. Blending with fruit could increase the reducing sugar content of plain sweet potato jam.

Blending with mango was found to increase the total sugar content of plain sweet potato jam while blending with pineapple decreased the total sugar content of plain sweet potato jam.

5.1.1.3. Assessment of chemical components of wine

A number of factors which include yeast strains, fermentation conditions, mineral contents, treatments adopted and composition of the must are known to influence the quality of wines as reported by Sandhu and Joshi (1995). On analysing the chemical constituents in wine it could be seen that the pH level observed for wine in this experiment agrees with the data reported by other workers. Vyas and Joshi (1992) observed that the plum wine showed a pH of 3.9. Wine from Golden apple showed a pH of 4.5 (Vyas and Kochar, 1993). The variation in pH of wine observed in this investigation was in accordance with the acidity level of the products.

The acid content of the wines in this experiment ranged from 0.45 to 0.61 with the highest values for the sweet potato-pineapple blended wines, V_1P_1 and V_2P_1. As reported by Sandhu and Joshi, (1995) wine contain acids which are dependant on the type of fruit used. Hence blending with pineapple increased the acid content of sweet potato wine. Hema (1997) recorded an acid content of 0.38 for jamun wine and 0.45 for its blend with West Indian cherry.

The TSS values observed in this experiment agree with the findings reported in other studies. Vyas and Joshi (1992) recorded a TSS of 18.00 in plum wine. Hema (1997) reported a TSS content of 20.10 for jamun wine.

5.1.2 Confirmation with FPO requirements

Kalia and Sood (1996) stated that the development of grades and standards of quality depends upon the definition of the quality characteristic to be measured. The food products developed during the study were analysed for FPO requirements and were found satisfactory.

The FPO requirement for TSS of jam is 68 percent, the result obtained in the present study for plain and blended sweet potato jam is between 62.78 and 67.21 percent. Thus the sweet potato jam standardised were in tune with the standard level.

FPO requirement for wine is the presence of alcohol between 9and 16 per cent. The alcohol content of the wines prepared in this experiment ranged from 8.43 to 10.72.

The three products standardised in this study satisfy the FPO standards and present a comparable status with standard products of similar category.

5.1.3. Cost benefit analysis of the products.

According to How (1990), information as accurate and upto date as possible on supply, demand and prices is essential for anyone directly involved in the business of marketing fruit products. Hence the cost of each item was worked out.

The results of the cost benefit analysis indicate that among the three products prepared utilising plain sweet potato and also the tuber blended with mango as well as pineapple, it was found that the cost of sweet potato products were very low. While comparing the different products it may be stated that blending with low cost tuber could considerably cutdown the cost of plain fruit products. However all the three blended sweet potato products were found to be acceptable, nutritious as well as economical when compared with the similar products in the market.

5.1.4.1. Product yield ratio

Analysis of the product yield ratio clearly indicate that sweet potato can yield products in higher quantity compared to fruits like mango and pine apple with relevant to all the products studied. Hence maximum effort should be given to exploit this under exploited tuber crop.

5.1.4.2.End point temperature

The results of the analysis of the end point temperature of the jam shows that end point of blended sweet potato-mango jam was the lowest. This is due to

the high pectin content of sweet potato and mango. The end point increased while blended with pineapple.

5.1.4.3.Drying time

It was found that blending had no prominent effect on the drying time of the leathers. The leather samples took five to six days to get dehydrated.

5.1.5. Organoleptic assessment of the products.

The quality of a food is a combination of the attributes that determine the degree of acceptability of the product. For an average consumer, the concept of food quality consists in those related to the sensory characteristics which may be classified in accordance with human senses of perception as appearance, kinethetics (texture), odour and taste (Sethi, 1989)

Any product that is new has to be tasted in small quantities before being used in regular production. Scientific methods of sensory analysis of food are becoming increasingly important in assessing the acceptability of food products. As mentioned by Jellenick (1986) sensory quality is one of the criterions for acceptability of any products by the consumer. Rajalakshmi (1993) described sensory analysis as a scientific discipline used to evoke, measure, analysis and interrupt reaction to those characteristic on food and materials as perceived by the sense of sight, smell, taste, touch and hearing.

Quality parameters such as appearance colour, flavour, texture and taste are assessed by means of human sensory organs The evaluation is then said to be sensory evaluation.

The developed sweet potato products viz. leather, jam and wine were subjected to sensory evaluation.

5.1.5.1. Organoleptic assessment of leather.

Quality parameter such as appearance, flavour, colour, taste, texture and overall acceptability were analysed for various samples of leather.

Appearance is a composite of all information about the product and its environment, which reaches the eye (Birch et al, 1988). Appearance of the leather samples were assessed and the result indicated that the leather made from the blend of Kanjanghad variety sweet potato and mango in the proportion 50:50 (V_1M_1) gained the highest score. Considering the plain leathers, the one made from Kanjanghad variety performed rather well than Sri Bhadra variety. Blending with mango enhanced the appearance of plain sweet potato leather, while blending with pineapple was less appreciated for appearance.

As reported by Clydesdale (1989), colour affected perception of other sensory characteristic is such as taste and flavour. Regarding colour, the sweet potato leather made from Kanjanghad variety blended with mango in the proportion 50:50 (V_1M_1) secured the highest mean score. Leather samples made from Sri Bhadra variety failed to give appealing colour in the case of plain leather and also when blended with pineapple. It was observed that blending with mango enhanced the colour of plain sweet potato leather, irrespective of varietal difference.

For flavour also, the leather made from Kanjanghad variety blended with mango in the proportion 50:50 (V_1M_1), secured the highest score.Blending was

found to be acceptable for highlighting the flavour of sweet potato leather. Beena (1998) has reported that blended papaya-mango leather was found to have more flavour than plain papaya leather.

The blended leather with main ingredients as sweet potato (Kanjanghad variety) and mango in the proportion 50:50 (V_1M_1) was the sample with highest score for taste. But the taste of blended leathers from sweet potato and pineapple was not so appreciating.

Beena (1998) reported that texture of leather could be improved considerably when the product was prepared with a mixed pulp of papaya and mango. The result of the present study was also in line with this report where blending with mango improved the texture of sweet potato leather for both varieties, viz., Kanjanghad and Sri Bhadra.

When the overall acceptability was computed based on the sensory qualities, the leather made from blended sweet potato (Kanjanghad variety) and mango in the proportion 50:50 was found to be the most accepted product. From the results of sensory evaluation, it could be concluded that blending with mango could enhance the acceptability of sweet potato leather and that the Kanjanghad variety of sweet potato is the best for blending with mango for preparing leather. Studies conducted by Jyothi (1997) revealed that fruit bar prepared from mango and papaya blend was organoleptically more acceptable than plain papaya bar. Nanjundaswamy et al (1976) reported that mango bar prepared from different varieties of the fruit had high organoleptic qualities than the product prepared from only one variety fruit.

5.1.5.2. Organoleptic assessment of jam.

Quality parameter such as appearance, flavour, colour, taste, texture and overall acceptability were analysed for various samples of jam.

Regarding the appearance of jam, blending with pineapple was highly accepted. The appearance of jam prepared from Kanjanghad variety was more acceptable in both plain and blended forms, when compared to the plain and blended jams from Sri Bhadra variety. Blending with mango was less appreciated, considering the appearance.

Blending with pineapple highly enhanced the colour of plain sweet potato jam. Whereas blending with mango was not at all acceptable considering the colour attribute, as it resulted in a dark yellowish brown coloured jam, which was not attractive. In colour attribute also Kanjanghad variety was a step forward than Sri Bhadra variety for preparing plain and blended jam.

A significant difference was noted in the flavour of blended sweet potato jam and plain sweet potato jam. Blending with pineapple, in 50:50 proportion, improved the flavour of plain sweet potato jam from a mean score of 4.2 to 4.6.

Considering the taste and consistency the blended sweet potato (Kanjanghad variety)–pineapple (50:50) jam scored highest. The consistency of jam made from Kanjanghad variety with mango as well as pineapple scored high. Texture of blended sweet potato (Kanjanghad variety)-pineapple (50:50) jam as well as Kanjanghad and mango (50:50) jam were equally accepted.

The overall acceptability of the blended jams revealed its superiority on the plain sweet potato jam and plain pineapple jam. Appearance, colour, flavour,

texture and consistency of blended sweet potato (Kanjanghad variety)- pineapple (50:50) jam were preferable than plain sweet potato jam.

5.1.5.3. Organoleptic assessment of wine.

Quality parameter such as appearance, flavour, colour, taste, texture and overall acceptability were analysed for various samples of wine.

According to Singleton and Ough (1969) appearance is the important feature of wine and the colour, along with its clarity is a good indicator of its past, present and future quality. Appearance of pineapple blended sweet potato wine and plain sweet potato wine was highest for the Kanjanghad variety. The score for plain sweet potato wine made of Sri Bhadra variety was also nearer to the highest score but the score for sweet potato –mango blended wines were poor.

The colour attribute was also in line with appearance score with the blended sweet potato wines and plain sweet potato wines highly superior to mango blended sweet potato wines.

According to Gayon (1978) taste and aroma of wines are very complex and are independent upon a number of factors such as variety of fruit, practices adopted, fermentation and maturation. The flavour of pineapple blended sweet potato wine (60:40) of both varieties were highly appreciated. The flavour of mango blended sweet potato jam was not so appreciating.

Taste of pineapple blended sweet potato (60:40) wines prepared from Kanjanghad variety as well as Sri Bhadra variety scored high when compared to

other wines. Blending had significantly increased the taste of sweet potato wine. Hema (1997) reports that taste of Jamun wine increased by blending with grapes.

The wine prepared from Kanjanghad variety par excelled the wine from Sri Bhadra variety in its clarity. The clarity of pineapple blended sweet potato wine of both the varieties were also more or less equal in clarity score, to plain sweet potato wine.

On comparison various quality attribute to evaluate the overall acceptability, the results revealed that the V_1P_2 i.e. the blended sweet potato (Kanjanghad variety)-pineapple wine (60:40) was highly appreciated.

5.1.6. Consumer acceptability and preference.

According to Lundahal (1983) most consumers have fairly fixed ideas and know what to expect in terms of sensory quality of a given processed food. Clement and Kubena, (1989) stated that sensory evaluation can be used to predict consumer acceptance.

The developed products were subjected to consumer acceptance and preference studies.

In consumer scaling V_1M_1 the mango blended sweet potato (Kanjanghad variety) leather sample gained more acceptance. Quality parameters like colour, flavour, taste and texture of the sweet potato – mango blended leather, V_1M_1, was more preferable compared to other leather samples. While considering the colour, flavour and texture of the plain sweet potato leathers V_1 and V_2 a less

favourable consumer appeal was noticed. It could be remarked that the consumers relished the sweet potato – mango blended leather V_1M_1 with much preference to plain leathers of sweet potato and blended sweet potato-pineapple leather. The results are in conformity with the reports of CFTRI (1978) which stated that mixed fruit slabs were found to be quite delicious than plain fruit slabs.

While considering the consumer acceptability of jam, a remarkably high rating was observed for the sweet potato – pineapple blends, especially for V_1P_1 from Kanjanghad variety. The pineapple blended jam samples made from Kanjanghad variety owes to its ,taste for the relatively high rating than the blended jam samples made from Sri Bhadra variety. It could be summarised that sweet potato – pineapple blends are more acceptable rather than the jams made from plain sweet potato and pineapple and also from sweet potato- mango blends.

Analysing the acceptability aspects of wine, the preparation from sweet potato – pineapple blends as well as from plain sweet potato were found to be almost equally acceptable. A slightly high rating among these items was observed for V_1P_2. The appearance attribute was the main factor that most of the consumers found as most highlighting. However for blended wine prepared from mango and sweet potato the acceptability was very poor.

Preference studies are designed to determine consumer's subjective reactions to external phenomena and their reasons for having them. Guitamanian

(1987) stated that consumer food preference is changing rapidly. The preference scores of the members of three self help groups evidently showed that most of the women rated jam as the 'like extremely well' product and leather was also scored positively but a small percentage of women rated wine negatively. The sweetish taste and attractive colour of the jam is the reason for the high preference of jam. Attractive colour and appearance and also the sweetish taste of sweet potato leather maybe the reason for the good score of leather. While unfamiliar alcoholic taste of wine could be the reason for the low preference for the product.

5.2. Assessment of shelf life qualities.

The shelf life of the developed products were assessed by studying the effect of storage on the chemical constituents of the products, effect of storage on the sensory parameters of the products and microbial quality during storage and the results are discussed.

5.2.1. Effect of storage on the chemical constituents of the products.

This section discuss about the changes in chemical constituents of the products during storage.

5.2.1.1. Effect of storage on the chemical constituents of leather.

A gradual decrease was noted in the pH levels of the leather samples on advancement of storage period. Sheeja(1994) reported a similar decrease in the pH level of blended papaya leather on storage.

The acidity of the leather samples increased over a storage of eight months. Kahtani (1990) has reported an increase in acidity in dried pomegranate

during storage. Jyothi (1997) observed an increase in the acidity of mango-papaya blended leather with storage.

The TSS levels showed only a slight increase during storage for eight months. Sagar and Khurdiya (1996) stated that the increase in TSS may be due to the decrease in moisture content. Mahajan and Chopra (1994) observed that the TSS of dried apple increased as the storage period advanced.

A prominent increase was noted in the reducing sugar content of the leather samples during storage. Mir and Nath (1993) reported that the reducing sugar of mango bars increased significantly during storage of seventy days. Saini and Dharmpal (1997) opined that the increase in reducing sugar was due to the inversion of mono sugars.

Similarly the total sugar level of the leather samples also increased with storage. Mohammed et al (1993) reported that the total sugar of pineapple candy increased during storage. Similar increase in total sugar was observed by Chavan (1991) for ber candy.

5.2.1.2. Effect of storage on the chemical constituents of jam.

The pH of stored jam samples were found to decrease gradually during storage over four months. This results is in par with results reported by Sheeja (1994) in which the pH of papaya jam decreased with storage.

An increasing pattern was observed for acidity by the stored jam samples. This result was in line with the findings of Kalra and Revathi (1981) where a rise in acidity was observed during storage in guava jam.

Only a negligible increase was detected in the TSS content of jam during orage. Irene (1997) reported that the TSS of papaya jam remained unaltered luring a storage period of four months.

The reducing sugar content of the jam samples stored for a period of four months was found to increase gradually.

An increasing pattern was veiwed on analysing the total sugar percentage of the jam samples during storage.

5.2.1.3. Effect of storage on the chemical constituents of wine.

Mohini and Surjeet (1993) stated that aesthetic appeal of wine depends upon the balance of chemical components that arise from extraction, fermentation and ageing. According to Amerine et al. (1980) a typical wine contains ethyl alcohol, sugars, acids, higher alcohols, tannins, aldehydes, anthocyanins and minor constituents like flavouring compounds etc. Fermented products undergo more changes in chemical constituents during storage.

A discussion on the effect of storage on the chemical constituents of wine is followed. A slight decrease in the pH levels of the stored wine was noted during the study. This descending pattern in the pH levels of the stored wines could be subscribed to the consequent increase in the acidity observed in wines. Shukla et al (1992) and Hema (1997) observed that the pH value of jamun wine decreased after a storage period of six months.

The wine contains acids, which are dependent upon the type of fruit used (Sandhu and Joshi,1995). The acidity of the wine samples tend to increase with advancement of storage period. This increase in acidity is an indication of the

increase in alcohol content during storage. Adsule et al (1992) found that acidity of pomegranate wine increased from 0.71 to 0.75 during storage. Hema (1997) reported that the acid content of jamun wine increased with storage. The findings on acidity variations of wine, in the present investigation is in tune with the above reports.

A tangible decrease in the TSS value of the wine samples was noted during storage. The cause of this decrease could be substantiated by the commensurated increase in alcohol content. Vyas and Kochhar (1993) reported such a downward trend in the TSS of wine.

The alcohol content of wine samples tends to increase with storage. Ageing is a process which the wine undergoes after the completion of fermentation and during this process the unfermented sugar gets converted to alcohol which accounts for increased alcohol content as observed in the present investigation during storage. Ber wine also observed the same trend during storage as reported by Kadam etal (1991).

5.2.2. Effect of storage on sensory qualities of the products.

The effect of changes in the sensory qualities of the products during storage are discussed bellow.

5.2.2.1. Effect of storage on sensory qualities of leather.

The effect of storage on the sensory qualities of leather was assessed for a period of eight months. The appearance value decreased after a stability of three months. This degradation of appearance was more pronounced during the later

stages of storage. Kerterz (1980) from his studies concluded that appearance of the pear candy decreased as the storage period advanced.

A gradual decreasing fluctuation in colour attribute was observed during storage of the developed leathers. This observation could be supported by the findings of Karim and Taufik (1992) that reduction in colour was noted in colour of chikku leather. A significant decrease was noted in the flavour of the leather samples with storage.

The taste and texture of the stored leathers were observed to be diminishing with storage. Beena (1998) reported a declining pattern in the taste and texture of stored papaya leather.

A considerable decrease was noted in the over all acceptability of the stored leather samples. Tripathi et al., (1988) reported that storage decreased the over all acceptability of amla candy. Karim and Taufik (1992) observed a decrease in the acceptability of chikku leather during storage. A better storage quality was noted for the blended sweet potato-mango leathers, considering all the sensory parameters.

5.2.2.2. Effect of storage on sensory qualities of jam.

Appearance is composite of all information about the product its environment which reaches the eye (Birch et al., 1988). The appearance of the stored jam samples showed a decreasing pattern with increase in storage time. This could be supported by the report of Irene (1997) that the appearance of mango jam stored for a period of four months decreased with time.

The colour of the jam samples tends to reduce through storage period of four months. According to Potter (1986) complex colour changes occur when many organic chemicals present in food come in contact with air. The results obtained are in line with Bhatnagar (1991), who had reported that the colour of watermelon jam decreased with storage.

Flavour is an important factor which enriches the consumer preference to a particular product (Ranganna, 1991). The flavour attribute of the stored jam reduced during storage.

The taste of the jam samples diminished over the storage period of four months. Bhatia et al., (1983) reported such a decrease in taste attribute in culled apple jelly during storage.

Significant difference existed in the texture and consistency of the stored jams through the storage period. This finding was in line with Bhatnagar (1991) who reported that the texture of water melon jam decreased with increase in storage time. Irene (1997) reported a similar decrease in the taste and consistency attribute of stored mango jam.

Assessment of overall acceptability of jam samples indicated that, there was a steady decrease in the overall acceptability scores during the storage period. Mir and Nath (1993) had reported that storage decreases the overall acceptability of fruit products.

5.2.2.3. Effect of storage on sensory qualities of wine.

According to Joshi et al (1996) effect of maturation in relation to the sensory qualities of wine is profound. The result of the periodical sensory

evaluation of the wine samples during storage was also in this line. The appearance of the stored wine samples varied progressively. According to Vyas and Kochar (1993) appearance improved in ciders and wines during storage.

Improvement was noted in the colour aspect also in the stored wine samples. Hema (1997) reported that jamun wine showed change in colour as it aged.

A considerable increase was noted in the flavour and taste of the blended and plain sweet potato wine during storage. Flavour is the most important factor influencing the acceptability of wine (Sandhu and Joshi, 1995).

The clarity of the stored wine improved with storage. This result could be supported by the report of Khurdiya and Roy (1984) that unheated and chemically preserved wine become clearer in little time.

The over all acceptability showed fine increase with storage.This is in line with the findings of Patel (1978) who states that ageing increases over all acceptability.

5.2.3.Assessment of microbial contamination of the products during storage.

According to Sankaran (1993) several factors such as raw material quality, storage temperature, storage containers, process employed, the environment in which it is processed etc. will have an effect on the microbiological quality of the processed food. The shelf life of any product is dependent on the absence of harmful microorganisms.

Assessment of microbial quality revealed that the leather samples on storage up to eight months showed the complete absence of any microorganism. The absence of moisture in this dried product is the reason for such a long shelf life. Only in the ninth month of storage colonies of *Pencillium* and *Aspergillus* species were found in the plain sweet potato leather. A similar microbial quality was reported for stored mango-papaya bar by Beena (1998).

Stored jam samples had a safe shelf life of only four months. Colonies of *Pencillium* and *Aspergillus* species were found in all the jam samples by the fifth month. Change in the pH of the jam samples with storage may be the reason for the presence of microorganisms in the stored samples. Irene (1997) reported that stored mango jam showed the presence of microorganisms by the fifth month of storage.

Complete absence of microorganisms were noted in the stored wine samples even after eight months of storage. A similar purity was reported for stored blended jamun – grape wine by Hema (1997).

5.3.Transfer of technology

A knowledge that is never conveyed to the needy will never be appreciated. The worth of the information that was attained from this study could be ultimately evaluated only when it was passed over to people whom it could prove useful. Hence transferring of the output of the study to selected self-help groups was one of the major objectives of the work.

As a part of the work, it was decided to select three self-help groups and make the members aware of the importance and the use of such an endeavor. The awareness of the members in this arena was assessed through a test comprising of fifteen statements and the result of the test was noted down. As the first step towards training the members of the self-help groups, they were introduced to the various preserved products that can be prepared from sweet potato. The methods of preparing leather, jam and wine using sweet potato and the fruit blends were demonstrated to the members. The extent of knowledge gained was evaluated by carrying out a second test, of the same pattern. The variation in the score by the members were analysed and it was found that a positive deviation resulted.

SUMMARY

6. SUMMARY

The present study entitled " Developing blended preserved products based on sweet potato" was taken up for the value addition of sweet potato. The investigation included standardisation of raw materials, formulation of recipes for the products, assessing chemical, organoleptic and shelf life qualities of the products and finally transferring the developed technology to self help groups.

Sweet potato is a vital part of the food security equation in some of the world's poorest nations. The crop should be exploited more efficiently for industrial purposes. In Kerala, sweet potato preparation for consumption is limited to boiling, roasting in an open fire or other methods. Easily preparable, easily marketable, ready to use products should be developed from sweet potato through small scale industries.

In the present investigation two varieties of sweet potato were selected viz. Kanjanghad and Sri Bhadra. The products selected were leather, jam and wine. For the preparation of fruit blended preserved products, sweet potato was combined with mango and pineapple in three different proportions viz.50:50, 60:40 and 70:30. The products leather, jam and wine were prepared with the two varieties of sweet potato in the plain form and also blended with mango and pineapple in the three different combinations.

The chemical parameters like pH, acidity, TSS, reducing sugar and total sugar of the fresh products were assessed. A better balancing of the various constituents favouring the acceptability of sweet potato leather was attained by

blending with mango in 50:50 proportion. While analysing the chemical parameters of jam, the sweet potato – pineapple jam blended in 50:50 was found to be highly satisfactory in the chemical composition. The results of the analysis of chemical qualities of wine was worthy enough to state that blending sweet potato and pineapple, in 60:40 proportion, in wine making, could profitably be utilised for the distribution of nutrients rich in this fruit and tubers at a fairer balance in blended wine.

The products developed were studied for FPO requirements and the products were found to have quality standards in agreement with FPO.

Cost benefit analysis of the products revealed that the production expense of plain sweet potato products were low due to availability of sweet potato tuber at a low cost. However the blended sweet potato products had comparatively lower price than other products available in the market.

The organoleptic qualities of the developed products were evaluated. Best result for appearance, colour, flavour, taste, texture and overall acceptability was exhibited by the blended leather of sweet potato (Kanjanghad variety) and mango in 50:50 proportion.

In sensory assessment of jam, the overall acceptability performance of the blended jam of sweet potato (Kanjanghad variety) and pineapple in 50:50 proportion was the best.

Results of organoleptic evaluation of wine samples clearly indicated that sweet potato of both Kanjanghad and Sri Bhadra variety has a potential for processing into blended wine. Pineapple was considered to be superior to mango

for blending with sweet potato for the preparation of wine. Plain sweet potato wines of both the varieties were also organoleptically high scoring.

The consumer acceptability assessment of the products revealed that the mango blended sweet potato leathers were more accepted by the consumers. In the case of jam the combination of sweet potato with pineapple was more liked by the consumers. For wine also the combination with pineapple was more accepted.

In the preference tests of the developed products conducted among members of self-help groups it was found that jam and leather rated high and wine was less preferred.

The developed products were stored at ambient conditions and were assessed periodically for its shelf life performance on chemical, organoleptic and microbial changes.

The shelf life qualities of the developed products revealed that the blended sweet potato products had more or less similar storage life as that of the well established fruit products.

The evaluation of the chemical parameters of leather showed only tangible changes upon eight months of storage. The blended leathers exhibited a minimum compositional deviation. The changes in sensory quality parameter of the leather on storage were also low. The leather samples also confirmed microbial safety up to eight months. The plain sweet potato leather showed the presence of *Pencillium* and *Aspergilles* species only during the ninth month of storage.

In the case of blended sweet potato jam the lesser variation in most of the chemical constituents was observed compared to plain sweet potato jam. Only nominal changes were noted in sensory quality parameters. The presence of *Pencillium* and *Aspergillus* were detected in the blended jam only on sixth month.

The chemical balance of wine enhanced as the storage period proceeded. The aesthetic appeal and over all acceptability of wine improved with ageing. The wine was cent percent pure even after the storage period of eight months.

The technology of the developed products was transferred to three self-help groups. On evaluation of the rate of technology adoption satisfactory results were obtained.

The study highlighted the workability of developing preserved products based on sweet potato. The introduction of such processed products can offer variety to consumers and the developed technologies could be taken up as income generation activities.

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APPENDICES

APPENDIX – I

SCORE CARD FOR LEATHER

Product: **Tested By:**
Date: **Age:**

Sl.	Property	1	2	3	4	5	6	7
1	**Taste** *Excellent (5)* *Very Good (4)* *Good (3)* *Fair (2)* *Poor (1)*							
2	**Flavour** *Very Pleasant (5)* *Pleasant (4)* *Moderately Pleasant (3)* *Unpleasant (2)* *Not at all Pleasant (1)*							
3	**Appearance** *Very Good (5)* *Good (4)* *Fair (3)* *Poor (2)* *Very Poor (1)*							
4	**Texture** Soft (5) *Neither hard nor Soft (4)* *Hard (3)* *Very hard (2)* *Brittle (1)*							
5	**Colour** *Very Good (5)* *Good (4)* *Fair (3)* *Poor (2)* *Very Poor (1)*							

APPENDIX – II

SCORE CARD FOR PREFERENCE TEST

Product	Like Extremely	Like Very Much	Like reasonably	Like some what	Do not like or dislike	Dislike some what	Relatively dislike	Dislike very much	Dislike extremely
Leather									
Jam									
Wine									

DEVELOPING BLENDED PRESERVED PRODUCT SED ON SWEET POTATO

By

ROOPA G K

THESIS

IN PARTIAL FULFILMENT OF
EMENT FOR THE DEGREE OF
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IENCE AND NUTRITION)
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ABSTRACT

A study on 'Developing blended preserved products based on sweet potato' was conducted with the major objective to develop value added preserved products based on sweet potato and to transfer the technology to self help groups. The study comprised of selection of tubers, selection of products, selection of blends, standardization of blended and plain sweet potato products, formulation of recipes for the products, assessing chemical, organoleptic and shelf life qualities of the products and finally transferring the developed technology to self help groups.

Three preserved products, viz., leather, jam and wine were prepared using two varieties of sweet potato, viz., Kanjanghad and Sri Bhadra in plain forms and also in combination with mango and pineapple in three different proportions.

The chemical composition of developed products with reference to pH, acidity, TSS, reducing sugar and total sugar were determined through suitable laboratory techniques. An acceptable balancing of the various chemical constituents were seen in the products.

The developed products, when studied for FPO requirements were found to satisfy the quality standards. Cost benefit analysis of the products was also favourable with low production expense and so low cost of the product.

Organoleptic qualities of the developed preserved products were assessed by a judging panel. The parameters tested were appearance, colour, flavour,

taste, texture, consistency and clarity. The analysis revealed that both the plain and blended products got acceptable scores.

The results of consumer acceptability was also satisfactory as it indicates that the sweet potato mango blends were more acceptable for leather while for jam and leather, combination of sweet potato with pineapple was more accepted.

A preference test of the developed products was conducted among members of self-help groups where the rating was high for jam and leather and wine was less preferred.

The shelf life assessment of the developed products showed satisfactory results. The evaluation of chemical parameters showed only small variation in most of the chemical constituents was there for leather and jam. While for wine, an enhancement in chemical balance was observed as the storage period proceeded.

Tangible changes were noted for the sensory qualities of leather and jam during storage. Storing was found to improve the sensory qualities of wine. The assessment of microbial quality revealed that the products were microbially safe. Evaluation of rate technology adoption, after transferring the technology to self help groups, reveled satisfactory results.