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Formulation and Evaluation of Preserved Products Using an Under-Exploited Fruit [Kiwi Fruit (*Actinidia Deliciosa*)]

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Abstract—*The aim of study is to make preserved product using KIWI FRUIT (ACTINIDIA DELICIOSA). Kiwi fruit is highly nutritious fruit and it was decided to preserve for human consumption throughout the year. Kiwifruit is an excellent source of vitamin C as well as a very good source of dietary fiber. It is also a good source of the mineral potassium. This study is focused on preservation of kiwi fruit as a jam using different formulations. Using the kiwi fruit, jam is prepared for the production of a preserved product. Here, along with kiwi fruit, another fruit which is rich in pectin content is utilized i.e., apple. Apple is incorporated in the preparation of kiwi jam to set the product easily. Hence, the kiwi apple jam is developed and the quality parameters have been assessed. Sensory evaluation, nutritive analysis such as iron, potassium, calcium and vitamin C (ascorbic acid); and physicochemical properties such as titrable acidity and pH, total soluble solids, moisture content and ash values are determined according to the standard methods. The storage stability was good in jam with respect to flavor and consistency. The microbial load of Jam was under the limit during storage. Hence, the prepared Jam was safe and fit for consumption.*

1. INTRODUCTION

Food preservation has an important role in the conservation and better utilization of fruits and vegetables in order to avoid the glut and utilize the surplus during the off-season. It is necessary to employ modern methods to extend storage life for better distribution and also processing techniques to preserve them for utilization in the off-season in both large scale and small scale. Fruit plays an important role in the preparation of preserves, in cooking and in fermented beverage production.

The kiwifruit, often shortened to kiwi in many parts of the world, is the edible berry of a woody vine in the genus Actinidia. The most common cultivar group of kiwifruit is oval, about the size of a large hen's egg [5–8 centimeters (2.0–3.1 in) in length and 4.5–5.5 centimeters (1.8–2.2 in) in diameter]. It has a fibrous, dull greenish-brown skin and bright green or golden flesh with rows of tiny, black, edible seeds. The fruit has a soft texture and a sweet but unique flavor, and today is a commercial crop in several countries, such as Italy, New Zealand, Chile, Greece and France. Kiwifruit is native to southern China where it has been declared a National Fruit of China. Other species of *Actinidia* are native to India, Japan, and South Eastern Siberia. The genus *Actinidia* contains around 60 species. Though most kiwifruit are easily recognized as kiwifruit (due to basic shape) their fruit is quite variable. The skin of the fruit can vary in size, shape, hairiness, and color. The flesh can also vary in color, juiciness, texture, and taste. Some fruits are unpalatable while others taste considerably better than the majority of the commercial varieties. The most common kiwifruit is the Fuzzy Kiwifruit and comes from the species A.deliciosa.

Kiwifruit is a rich source of vitamin C (1.5 times the United States DRI per 100 grams) and vitamin K, and a good source of dietary fibre and vitamin E. Kiwifruit seed oil contains on average 62% alpha - linolenic acid, an omega 3- fatty acid. Usually a medium size kiwifruit provides about 46 calories, 0.3 g fat, 1 g protein, 11 g carbohydrates, and 2.6 g dietary fibre found partly in the edible skin. Kiwi fruit stands number one in nutrient content compared to 27 other fruits. It is packed with twice the amount of Vitamin C — compared to oranges (per 100 mg) — and has twice the amount of nutrients — compared to apples (per 100 mg). Kiwi fruit is an excellent source of Vitamin E, fibre, potassium, folic acid, carotenoids, antioxidants and trace minerals. The exotic Kiwi fruit jam, popular in New Zealand, is gaining popularity elsewhere in the world. Jam is made from crushed or ground fruit. The end product is less firm than jam, but still holds its shape.

2. MATERIALS AND METHODS

Selection of the Method of Preservation:
Food Preservation has an important role in the conservation and better utilization of fruits and vegetables. In order to avoid

glut and utilize the surplus during the season, it is necessary to employ methods to extend storage life, for better distribution, to preserve them for utilization in the off-season both in large scale and home scale. Jam is more or less a concentrated fruit processing which has fairly thick consistency and body. It is also rich in flavour, because ripe fruits which have developed full flavour are used in its preparation. A great advantage in its preparation is that it can be prepared in a single operation. For the preparation of good quality jam, the fruit should contain adequate amounts of pectin.

Pre-Preparation of the selected kiwi fruit:
Sorting and grading is essential to get suitable quality of fruit which was done by hand. The fruits were first washed to remove the dirt. Grading of fruit was done based on soundness, firmness, cleanliness, size, maturity, weight, colour, shape and freedom from foreign matters, insect damage and mechanical injury.

Fruit furnishes the flavor and part of the needed pectin and acid. Some irregular and imperfect fruit can be used. Do not use spoiled, mouldy or stale fruit.

Pectin (apple) is the actual gelling substance. The amount of pectin found naturally in fruits depends upon the kind of fruit and degree of ripeness. Underripe fruits have more pectin; as fruit ripens the pectin changes to a non-gelling form. Usually using 1⁄4 underripe fruit to 3⁄4 fully-ripe fruit makes the best product. Cooking brings out the pectin, but cooking too long destroys it. High pectin fruits are apples, crab-apples, quinces, red currants, gooseberries, Eastern Concord grapes, plums and cranberries. Fruits lower in natural pectin include blueberries, peaches, apricots, pears, raspberries, blackberries and figs. Here, kiwi fruit, which is low in pectin content, is combined with apple having high pectin. Through apple pectin is produced. Pectin acts as a carbohydrate that causes fruit to gel.

Acid is needed for gel formation and flavor. The amount of acid in fruits also varies with the fruit and degree of ripeness. When using low-acid fruits in recipes without commercial pectin, add 1 tablespoon lemon juice or 1/8 teaspoon citric acid for each cup of fruit.

Sugar helps form the gel, serves as a preserving agent, firms the fruit and adds flavor. Beet or cane sugar can be used. Brown sugar, sorghum and molasses are not recommended because of their strong flavor and varying degree of sweetness.

Formulation of different jam samples:
Different jam samples were prepared by varying the percentage (%) composition of kiwi pulp and apple pulp in that order. T_1(90-10%), T_2 (75-25%) and T_3 (50-50%).

Preparation of Jam:
Fruits are preserved in the form of jam, jelly, preserves and candies by relying upon the high solids-high acid principle. Jam is prepared by boiling the fruit pulp with sufficient quantity of sugar to a reasonably thick consistency, firm enough to hold fruit issues in position.

Selection and preparation of fruit
↓
Pulp was weighed
↓
Addition of sugar
↓
Cooking the pulp (slow cooking with occasional stirring for 15min)
↓
Addition of citric acid (1tsp) + salt (1pinch)
↓
Judging the end point (TSS-68.5% using refractometer ABBE)
↓
Packing (fill the hot jam into clean, dry sterilized glass container)
↓
Cooling
↓
Stored in refrigerator

Test for doneness:
A big challenge in making jam is to know when it is done.

Spoon or Sheet Test:
Dip a cool metal spoon in the boiling jam mixture. Lift the spoon above the kettle out of the steam. Turn the spoon so syrup runs off the side. If the syrup forms two drops that flow together and fall off the spoon as one sheet, the jam should be done.

3. PHYSICOCHEMICAL PROPERTIES OF JAM

Knowledge of the physicochemical properties of the food is fundamental in analyzing the characteristics of food during its processing. The study of these food properties and their responses to process conditions is necessary because they influence the treatment received during the processing and also because they are good indicators of other properties and qualities of food.

In the present investigation, certain physicochemical characteristics of the prepared kiwi apple jam such as total solids and soluble solids, acidity and pH value, moisture, and ash value are to be analyzed according to the standard methods to ensure the quality of the products.

PFA specifies that jam is a product obtained by processing fresh fruits, canned, dried, fruit pulp with water, sugar, dextrose, invert or liquid glucose either singly or in combination by boiling to a suitable consistency.

The analysis of jam for various properties was done using an aqueous solution of the sample. This was prepared by weighing 25gm of sample and dissolving it in 200ml of water. The aqueous solution was kept on boiling water bath for one hour. The solution was cooled and diluted to 250ml with distilled water, filtered and used for analysis.

- For the prepared jam, total solids and soluble solids are to be determined. The figure for soluble solids help in determining the fruit content of the jam and also helps to prevent the growth of mould and yeast.
- Acidity value is a measure of stability and shelf life of jam. It is due to the organic acids in fruits and those which are added while making the jam. The setting quality of jam is improved by adequate pH maintenance.
- The ash value is mainly due to potassium and phosphorous and the composition of it. It is the measure of fruits and fruit juice content. A low value indicates deficiency of fruit or excess of sugar.

Titrable Acidity and pH Value:
Acidity value is a measure of stability and shelf life of jam and fruit bar. It is due to the organic acids in fruits and those which are added while making the jam. The setting quality of jam is improved by adequate pH maintenance. Take one g blended jam and dissolve it in 20 ml distilled water, add two to three drops of phenoptheline indicator then titrate it with 0.1 N NaOH till pink colour appears. Titrable acidity can be calculated as in Equation.

$$T_a = \frac{B \times 0.1 \times 0.064 \times 100}{W}$$

Where T_a is titrable acidity; *B* is reading burette; *W* is weight of sample.
The pH value of the sample was measured with a digital glass electrode pH meter (CD 175 E) at room temperature, which was calibrated prior to sample pH measurement using buffer solutions of pH value 4.0 and 7.0.

Ash Value:
The ash value is mainly due to potassium and phosphorous and the composition of it. It is the measure of fruits and fruit juice content. A low value indicates deficiency of fruit or excess of sugar. About five grams of the sample was weighed accurately into a porcelain crucible. This was transferred into a muffle furnace set at 600^0C and left for about 4hours. About this time it had turned into white ash. The crucible and its content were cooled to about 1000C in air then to room temperature in desiccators and weighed (A.O.A.C., 1984).The percentage ash was calculated from the formula below

% Ash content = (weight of Ash / Original weight of sample)*100

Total sugars and Reducing sugars:
During jam making, sucrose is added. During boiling, the sucrose partly gets converted into invert sugar which prevents crystallization. Take 5 g of sample into a beaker and added 100 ml of warm water. The solution was stirred until all the soluble matters were dissolved and filtered through watt man filter paper into a 250ml volumetric flask. Pipette 100 ml of the solution prepared into a conical flask, added 10 ml diluted HCL and boiled for 5 min. On cooling, neutralize the solution to phenolphthalein with 10% NaOH and make up to volume in a 250 ml volumetric flask. This solution was used for titration against Fehling's solution and readings were calculated using the following equations:

$$T_t = (4.95 \times 250 \times 9.5 \times 100) / (T \times W \times 10)$$
$$R_s = (T \times W \times 10 \times 100) / 49.5 \times 250$$

Where, T_t is total sugar %; T is titre value; R_s is reducing sugar %.

Total Solids and Soluble Solids:
For jam total solids and soluble solids are calculated. The figure for soluble solids help in accessing the fruit content of jam and fruit bar and also helps to prevent the growth of mould and yeast.

4. SENSORY EVALUATION

Sensory evaluation on the basis of 9-point hedonic scale of all the prepared blended jam was done by taste panel. The tasting panel was consisting of 10 members. They were asked to evaluate the colour, flavour, consistency, taste and overall acceptability by a scoring rate, 9 means like extremely, 8 means like very much, 7 means like moderately, 6 means like slightly, 5 means neither like nor dislike, 4 means dislike slightly, 3 means dislike moderately, 2 means dislike very much and 1 means dislike extremely. The different preferences as indicated by scores were evaluated by statistical methods.

5. NUTRIENT ANALYSIS OF JAM

Kiwi fruit is rich in vitamins such as vitamin C, and also in dietary fibre. Some minerals like potassium, calcium and iron. These different nutrients can be analysed by using the standard methods available.

Ascorbic acid content:
The ascorbic acid content decreased during storage due to oxidation of ascorbic acid to dehydroascorbic acid. Ascorbic acid was determined by the 2, 6-dichlorophenol indophenol titration procedure. Ascorbic acid was extracted using an acetic acid and metaphosphoric acid solution. The extracts were transferred with distilled water into a 50 ml volumetric flask and made up to the mark with more water and filtered rapidly. The filtrate was run from a burette into a test tube containing one drop of dilute acetic acid and 1ml of the redox dye, 2, 6- dichlorophenol indophenol solution. The volume of extract required to decolorize the dye was noted. The titration was repeated using standard ascorbic acid solution (1 mg pure vitamin per 100 ml) in place of the jam and fruit extracts.

Ascorbic acid per 100g of jam or pulp is calculated as: **% ascorbic acid = (W x 100) / 100**

W is volume of dye.

Calcium and Potassium:
Kiwi fruit is rich in potassium, calcium and iron.

6. RESULTS AND DISCUSSIONS

Physicochemical analyses of kiwi apple jam:
The analyses of jams were made 1 day after processing. The averages of the duplicate measurements of the analyses of three different samples of jams are shown in table 1. Jams presented low moisture and had soluble solids mean values of 69.5, 68.00 and 69.00 °Brix for sample 1(10% apple), sample 2(25% apple), and sample 3(50% apple), respectively. Sugars in jams contribute to high content of soluble solids, an effect that is essential for the physical, chemical and microbiological stability and make gelation of pectin possible.

Total sugars and reducing sugars contents of jams ranged between 36.28–42.54 g.100 g-1and 12.38–21.40 g.100 g-1, respectively. Total sugars contents ranged between 35.00–54.55 g.100 g-1 and reducing sugars ranged between 10.50–15.50 g.100 g-1for different mixed fruit jams. The total acidity and the pH of the finished products ranged between 0.87 – 1.19 g.100 g-1 and 3.25-3.48, respectively. It is known that the acidity and pH of jams should be controlled. The low acidity (0.3-0.8 g.100 g-1) and low pH (3.2-3.4) contribute to pectin gelation and increase the stability of the formulated jams. However, the pH must not be too low (< 3.0) since it could induce deterioration of sensory quality: excessive acidic flavor, glucose crystallization; granular texture and exudation phenomenon.

Table: 1

Parameter	T_1(10% apple)	T_2(25% apple)	T_3(50% apple)
Moisture (%)	18 ± 0.37	20 ± 0.67	25 ± 0.33
Ash value (%)	0.57 ± 0.03	0.61 ± 0.02	0.55 ± 0.02
Acid insoluble ash (%)	0.15 ± 0.87	0.21 ± 0.56	0.24 ± 0.25
Titrable acidity (%)	0.92 ± 0.02	1.19 ± 0.01	0.87 ± 0.02
pH value	3.25 ± 0.07	3.48 ± 0.03	3.40 ± 0.05
Total soluble solids (^{0}Brix)	69.5 ± 0.11	68 ± 0.71	69 ± 0.54
Total sugar and reducing sugar (g/100g)	39.13 ± 0.18 21.40 ± 0.08	42.54 ± 0.04 19.33 ± 0.08	36.28 ± 0.11 12.38 ± 0.08

Nutritional Analysis of Different Samples of Kiwi Fruit Jam:

Iron, potassium, and calcium were recorded as 0.38, 2.98, and 0.87 for T_1, respectively; 0.45, 3.95, and 0.95 for T_2, respectively; 0.56, 4.79, and 1.54 for T_3, respectively. Results are presented in Table 2.

Table 2:

Nutrient (mg/100gm)	T_1 (10% apple)	T_2 (25% apple)	T_3 (50% apple)
Iron (Fe)	0.38 ± 0.02	0.45 ± 0.02	0.56 ± 0.04
Potassium (K)	2.98 ± 0.01	3.95 ± 0.03	4.79 ± 0.01
Calcium (Ca)	1.54 ± 0.01	0.95 ± 0.01	1.54 ± 0.01
Vitamin C (ascorbic acid)	18.95±0.05	15.68±0.15	13.98±0.08

Sensory Evaluation of Kiwi Apple Jam:
Mean scores of sensory evaluation are presented in Table 3. Kiwi apple jam had the highest mean scores for all attributes being compared. The differences in flavor and spreadability were not statistically significant at the (P > 0.05) 5% level. The differences in color, taste and overall acceptability were, however significant at (P < 0.05) 5% level.

Table 3

Sample	Appearance	Taste	Flavor	Texture	Color	Spread-ability	After taste	Overall Acceptability
T_1	7.0	8.0	7.67	8.0	7.0	8.0	6.33	7.0
T_2	6.17	7.67	7.17	7.35	7.5	8.33	8.0	7.33
T_3	7.67	7.0	7.0	6.67	7.17	7.0	7.5	7.5

Sensory evaluation indicated that kiwi apple jam with different formulations (i.e.; change in concentration of apple) was acceptable to consumers. The kiwi apple jam, however, had

the highest mean scores for all attributes being compared. The differences in flavor and spreadability were not statistically significant at the (P>0.05) 5% level. The differences in color, taste and overall acceptability were, however, significant at (P < 0.05) 5% level. Some assessors scored kiwi apple jam (T_1) higher for flavor, texture and spreadability. The texture of kiwi apple jam (T_2) had the lowest scores than other parameters or sensory attributes. Sufficient pectin content contributes to the spreadability of the kiwi apple jam (T_2). The color of the product has been improved with the change in concentration of apple.

7. CONCLUSIONS

Actinidia deliciosa can be used in making jam. The low gel strength of the jam can be improved by the addition of pectin during processing to attain the commercially acceptable gel strength or a combination of fruits rich in pectin (apple) can be used to make up for the deficiency. Optimum gel formation is reported at pH 3.4 and satisfactory gel formation in tropical fruits is achieved at lower pH range. The combination with other fruits could serve to improve the flavor and the color.

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