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Standardization of sugar levels on Physico-chemical properties of peel candy of Karna Khatta (*Citrus karna*) during storage

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Abstract
Karna khatta, peel candy was prepared under ten different treatment comprising the different sugar concentrations (45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%) with the addition of the standard recommended dosage of citric acid and approved food colours. The peel candy samples were tested for the physicochemical changes after preparation, and sensory evaluation was done based on the 9-point hedonic scale tested on a panel of 7 experts. These candies were stored for about 90 days and the effect of storage on the physicochemical and the organoleptic characteristics were also observed.

Keywords: Karna Khatta peel, *Citrus. karna* peel, Peel candy, Sadaphal, citrus, sugar syrup

1. Introduction
Fruits are among the most important foods of mankind as they are both nutritive and indispensable for the maintenance of health. Being a rich source of carbohydrates, minerals, vitamins and dietary fibres, these constitute an important part of our daily diet. Moreover, they add flavour and diversity to diet [19].
Citrus. karna is also known as karna khatta, sadaphal. India's main sour orange variant is karna. Sadaphal is a native of India. It grows all over India up to an elevation of 1000m. Some botanists believe sadaphal to be hybrid between sour orange and lemon. Like amlas, lemons, and limes, a sour orange cannot be eaten in their raw form, it's extremely acidic, bitter, and, as its name suggests, sour. Drinking the juice requires adding copious amounts of water and sweetener. The best oranges have incredibly oily, zesty peels that practically burst with a citrusy aroma. Look for fruits that feel heavy for their size, and avoid those with hard, brown skin and small pores. Of the vast amount of worldwide citrus production, only one-third is processed. They consist of peels (albedo and flavedo), which are almost one-fourth of the whole fruit mass, seeds and fruit pulp, remaining after juice and essential oil extraction. The peel of the fruit, which is generally considered a waste, is more nutritious than juice; which can be processed into candies. This does not necessitate complicated equipment and technology. Hence, the citrus processing.
industry can easily opt for making candied peel which finds a ready market in confection way.
Candy is a sweet food prepared from fruits or vegetables by impregnating them with sugar syrup followed by draining of excessive syrup and then drying the product to a shelf-stable state. Fruits and vegetables like apples, ginger, mangoes, guava, carrots and citrus peels have been used to prepare candies [3-6]. Candied products available these days are descended from the simplest confections first made more than 4,000 years ago. Candy making is a fairly simple process. In traditional candy production, a mixture of sugar, water and possibly corn syrup are mixed and boiled until sufficient water has been boiled out of the candy mass. With this view, the study was undertaken to develop consumer-friendly candies from peels of *C. karna*, fruits to standardise different levels of sugar for product development for peel candy and to study the effect of storage on quality and stability of the product.

2. Materials and Methods
2.1 Raw material
Fresh Karna khatta fruits were collected from our research field and the peels and the juicy segments were separated. The juicy segments were given to the juice processors where the peel is a waste material. Peels of almost the same size were selected for processing. The graded peels were washed

thoroughly under running tap water to remove dust and dirt from the surface. Extra white part rags that were attached to the inner surface were removed manually. Cleaned peels were then dried to remove adhering moisture. Then the peels were cut in the desired shape and size.

2.2 Pre-treatment

After cutting the peels were blanched for 10 minutes in 100OC temperature. Blanching was taken up two times since the *C. karna* peels were more bitter, the blanched peels were washed with several changes of freshwater

2.3 Preparation of Candy

C. karna peel candy was prepared with different sugar concentrations in the sugar syrup *i.e.* 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85% and 90%. The different concentrations in sugar syrup is prepared by dissolving the respective amounts (400g, 450g, 500g, 550g, 600g, 650g, 700g, 750g, 800g, 850g, & 900g) in 1000ml (1 litre) of water giving the desired sugar solution concentration.

After washing blanched peels, sugar syrup of different concentrations was prepared. After preparation of sugar syrup, peels were steeped in sugar syrup and boiled for 3-5 minutes and then allowed to cool and steeped it for 15- 20 minutes irrespective of the treatment. After completion of steeping time, sugar syrup was drained and the desired colour was added to the peels, after which the peels were spread out on trays for drying. Then peels in the tray were kept for drying under the sun for around 8-12 hours. After drying the samples were collected and packed in LDPE bags for storage purposes. Candies were stored at ambient temperature (room temperature) for 3 months and evaluated at 30 days interval to monitor the physico- chemical characteristics.

2.4 Parameters Observed

2.4.1 Moisture content (%)

The moisture content was determined based on Ranganna (2003). Weighed samples (5g) in triplicate were dried for eight hours in a hot-air oven at 105oC in pre-weighed crucibles. The crucibles were.

2.4.2 Total soluble solids (%)

Total soluble solids (TSS) were measured by using a hand refractometer (Erma, Japan) and the results were expressed as percent (%) according to standard procedure as given in (Ranganna, 2003). The refractometer was calibrated with distilled water before use.

2.4.3 pH

The pH was estimated with the help of a hand pH-meter. The temperature of the solution to be tested was accurately measured and the temperature control at this temperature was set. The instrument was standardized with a buffer solution of pH 7.

2.4.4 Ascorbic add (mg/100 g)

Ascorbic acid was determined using 2, 6-Dichlorophenol-indophenol visual titration method (A.O.A.C, 1990). Dye factor was determined i.e. mg of ascorbic acid needed for titration per ml of the dye.

2.4.5 Sugars

Total and reducing sugars were estimated by Lane and Eynon method [9]. Percentage of reducing sugars and total sugars were calculated using the following equation:

transferred immediately to desiccators, cooled, weighed and moisture content present was calculated from loss of weight.

$$\text{Reducing or total sugars (\%)} = \frac{0.05 * \text{Vol. made}}{\text{Titre value Weight of sample}} \text{ x } 100$$

2.4.6 Sensory evaluation

To assess the consumer preference, sensory evaluation of the experimental sample was conducted at different intervals of storage by a semi-trained taste panel of 7-8 judges. The samples were evaluated for colour, texture, taste, and overall acceptability.

2.4.7 Economic studies

The product formulation involves two types of costs. One is a fixed cost and another variable cost. Fixed costs are those which are run over many years and only a part of the services of these assets are utilized in a single production period while as variable costs are those which get transformed into the ultimate production during a particular season. Thus, in our situation, fixed costs are cooking gas, citric acid, packaging material, butter paper etc. while the variable costs involve expenses on sugar. The costs stream in respect of fixed and variable costs was drawn and the economics was studied with computing benefit-cost ratio.

2.4.8 Statistical analysis

The data in respect of all the above parameters were tabulated and subjected to the statistical analysis using methods of analysis of variance (ANOVA) for Completely Randomized Design with critical difference (CD at 5%) was worked out.

3. Results and Discussion

3.1 Moisture content

The moisture content of *C. karna* peel candy decreased significantly during the 90 days storage period. This decrease in moisture content is attributed to natural dehydration of product during storage at room temperature [11, 12] The maximum moisture content at the initial (zero) days [Fig 1] was found in T1 (45% sugar solution) [16.8%], while the minimum value showed by T10 (90% sugar solution) [13.28%]. After 90 days of storage period.

treatment T1 showed maximum moisture content (13.50%), while T10 showed a minimum value (10.08%) [Fig 4].

3.2 Total Soluble Solids

The progressive increase in pH during the storage period was reported from *C. karna* peel candy. This is due to the decreasing acidity of candy during the storage period. Maximum value during zero-day [Fig 1] was recorded from T10 (2.84), while T1 showed minimum value (2.08) and at the end of the storage period of 90 days, the maximum value (3.14) showed by T10 (90% sugar solution+ Green), while minimum value (2.14) showed by T1 (45% sugar solution+ Orange) [Fig 4].

3.3 pH

The total soluble solids were found to increase significantly in all the treatments during storage. This might be due to the conversion of polysaccharides into sugars during the hydrolysis process. Maximum TSS value (83.25%) was showed during zero-days [Fig 1] by T10 (90% sugar solution), while minimum value (78.30%) showed by T1 (45% sugar solution+ Orange). At the end of the storage period maximum value (86.21%) recorded by (90% sugar

solution+ Green) due to the high concentration of sugar solution, while minimum value (81.52%) showed by T1 (45% sugar solution+ Orange) [Fig 4].

3.4 Titrable Acidity

A gradual and significant decrease in titratable acidity of *C. karna* peel candy was observed during 90 days storage period. This gradual decrease in acidity in the case of *C. karna* peel candy may be attributed to the effect of salt treatment and the reaction of the acid with basic minerals or interaction binding of acid with peel component with time. maximum value (0.70%) of titrable acidity during zero-days [Fig 1] was reported from T1 (45% sugar solution+ Orange) due to low sugar concentrated solution, while minimum value (0.54%) was reported from T10 (90% sugar solution+ Green) At the end of the storage period, T1 (45% sugar solution+ Orange) showed a maximum value of (0.63%), while the minimum value of (0.39%) was observed from T10 (90% sugar solution+ Green) [Fig 4].

3.5 Ascorbic Acid

The ascorbic acid content in *C. karna* peel candy decreased during 90 days storage period. The possible reason for the reduction in vitamin C could be due to oxidation by oxygen, resulting in the formation of dehydroascorbic acid. During initial days, [Fig 1] T1 (45% concentration sugar solution+ Orange) showed maximum value (11.69 mg/100g) due to less sugar concentration, while candy with (90% concentration of sugar solution+ Green) showed minimum value (8.76 mg/100g). At the end of the storage period of 90 days of *C. karna* peel candy maximum value (2.55 mg/100g) showed by treatment T1 with (45% concentration sugar solution+ Orange), while minimum value (1.08 mg/100g) was reported from treatment T10 with 90% concentration of sugar solution [Fig 4].

3.6 Reducing Sugar

Reducing sugars of *C. karna* peel candy increased significantly with a storage duration of 90 days. This could be due to the inversion of non-reducing into reducing sugars by hydrolysis. Higher reducing sugars (19.66%) were found in the treatment T10 (90% sugar solution+ Green), which may be due to the higher sugar concentration; and the lower reducing sugars (15.08%) were found in the treatment T1 (45% sugar solution+ Orange) in the zero-day of storage candy [Fig 1]. At the end of the storage period of 90 days [Fig 4], reducing sugars was increased from 19.66% up to 22.55% in T10, and T1 reducing sugars increased from 15.08% to 16.76%.

3.7 Total sugar

There was a gradual and significant increase in total sugars of *C. karna* peel candy with the advancement of the storage period. The increase in the level of sugars is attributed to the loss of moisture from the products thereby concentrating sugars. treatment with (90% sugar solution concentration+ Green) T10 showed a maximum value of 84.94% while the treatment T1 with (45% sugar solution concentration+ Orange) showed the minimum value of 40.97% at zero days of storage period [Fig 1]. At the end of the storage period of 90 days, total sugars of candy increased and the treatment T10 showed the maximum value of (88.28%) while the treatment T1 showed a minimum value of 42.10% [Fig 4]. This is due to the high concentration of sugar solution in treatment T10 and low sugar concentration in treatment T1. Drying also causes a significant increase in total sugar content due to the concentration effect of losing moisture after drying. Sucrose hydrolysis is doubly important: there is an increase in the sugar content of candied fruits and it also confers good mouth-texture and a pleasant taste to the candied product.

3.8 Sensory Evaluation of Organoleptic attributes

In the sensory evaluation of all the organoleptic attributes such as colour& appearance, texture, taste & flavour and overall acceptability initially T10 was given maximum score of (8.9) followed by T9,8,7; while T1 was given minimum score of (7.9) [Fig 1]. At the end of 90 days of storage period, T10 was given the maximum (8.5) and the T1 minimum (7.5) [Fig 4]. Fruit peel processing can affect the natural colour, so colours were also added to bring back that colour.

3.9 Economic Studies

The economic analysis indicated that there are better chances of value addition in case of cherry if it is processed into a product like candy. The benefit-cost ratios indicated that the product can compete well with other fruit-based products in the market. The Benefit-Cost ratio decreases with an increase in sugar content. As the rate of sugar comes under the variable cost. Further, the product can be more profitable if prepared on an industrial scale.

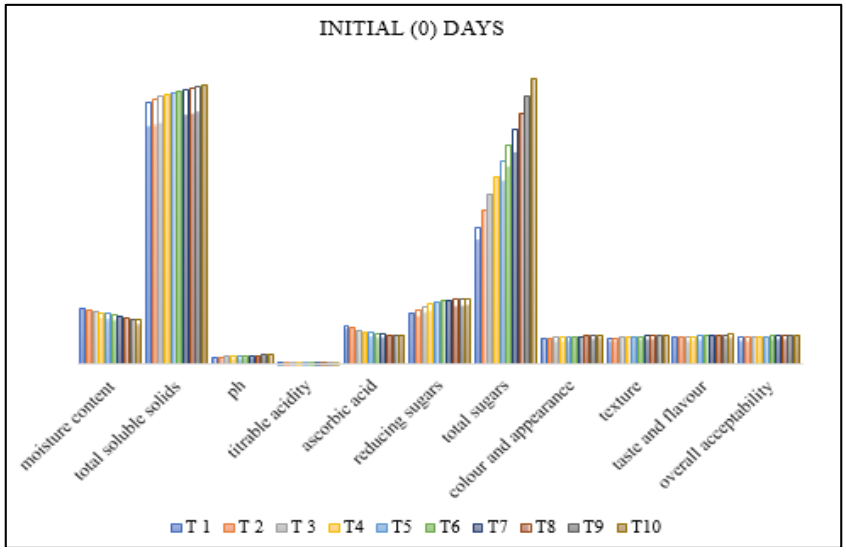

Fig 1: The maximum moisture content at the initial (zero) days

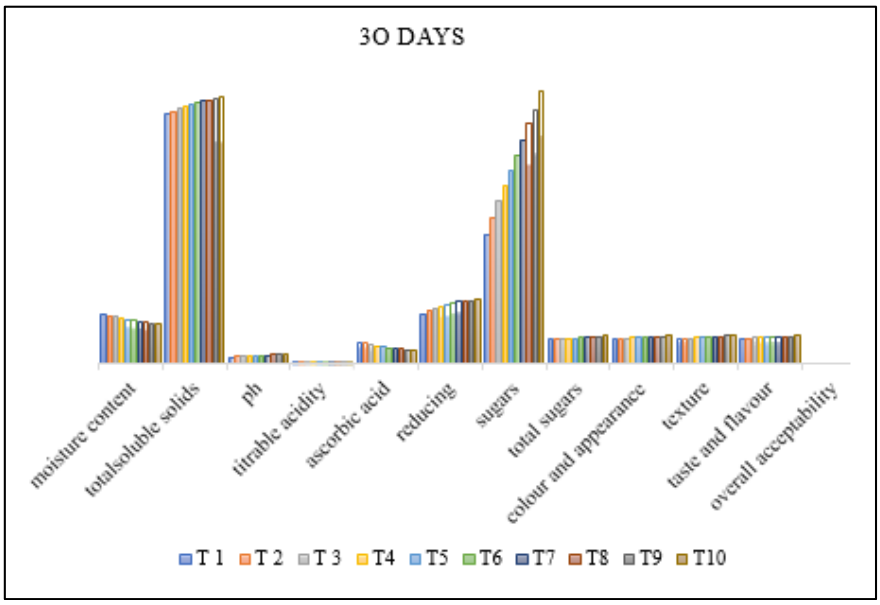

Fig 2: The maximum moisture content at the initial 30 Days

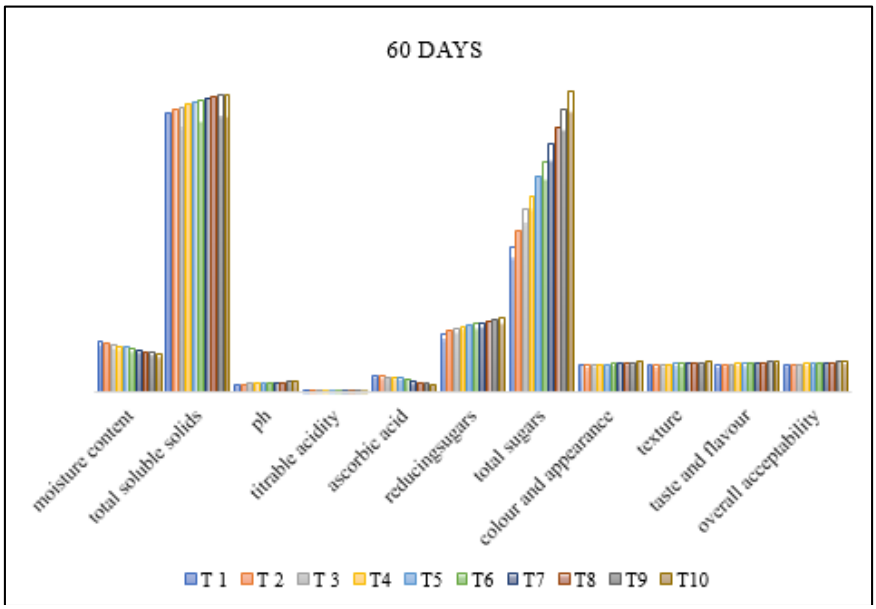

Fig 3. The maximum moisture content at the initial 60 Days

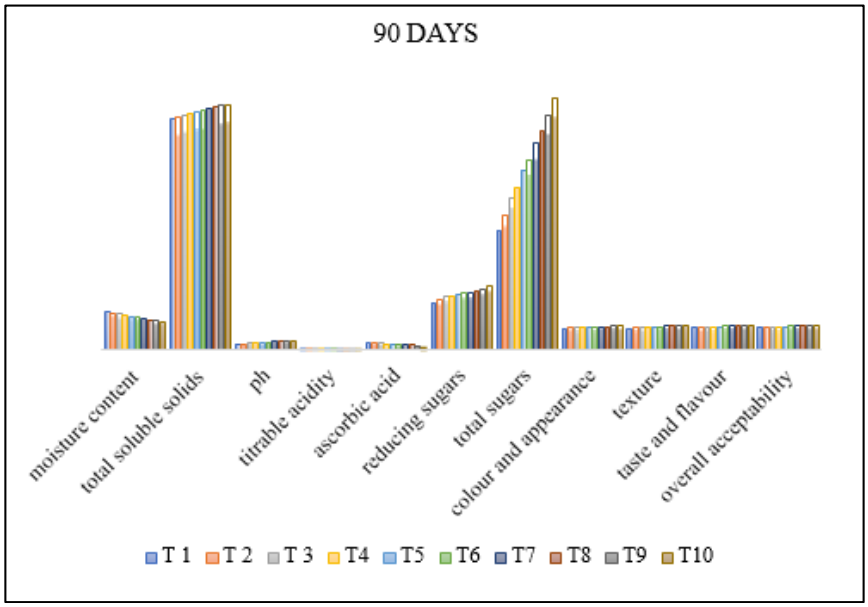

Fig 4: The maximum moisture content at the initial 90 Days

4. Conclusion

It was concluded from the present investigation that the citrus peels considered to be the waste from the processing industries can also be efficiently used by converting them into commercially utilized by-products. High sugar concentration imparted good colour, flavour, and texture to *C. karna* peel candy. After completion of the storage period of 90 days, treatment T10 proved superior concerning overall acceptability scores in terms of colour, taste, texture and flavour during the entire period of storage. The product developed was found economically profitable and viable for commercial production.

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