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Research Article

DEVELOPMENT AND CHEMICAL EVALUATION OF GUAVA CANDIES

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Abstract- Present work was undertaken to develop Guava (*Psidium guajava*) candies by using two varieties of guava namely Allahabad Safeda and Lucknow-49. Sugar, butter, milk powder, chocolate flavour and glucose were added as ingredients during the boiling of pulp to improve the nutritive value and taste of candy. Different cooking time (90 min, 120 min and 150 min) was tested during the work. A cooking temperature range of 85-95º C and cooking period of 120 minutes were found to be optimal. The good candies were prepared with the addition of 580 g sugar, 160 g skim milk powder, 85 g butter, 90 g glucose and 40 mg colour per kg of guava pulp without addition of any preservative. From the study, Yield and quality of pulp from "Allahabad Safeda" was found better than that obtained from "Lucknow-49". With increased cooking time, nutritive value of guava candies decreased. Candies prepared from Lucknow-49 showed maximum quantity of carbohydrates and acidity. Candies prepared from Allahabad Safeda showed maximum quantity of vitamin C and proteins.

Keywords- Guava candies, Cooking time, Total Soluble Solids, Carbohydrates, Proteins.

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Introduction

Guava (*Psidium guajava*) is an important commercial fruit of India known for an excellent digestive and nutritive value, pleasant flavour, high palatability and availability in abundance at moderate price. India is the second largest guava producing country in the world. The major guava-growing states are Bihar, Uttar Pradesh, Karnataka, Gujarat and Andhra Pradesh. It is estimated that the area and production of guava in India is 184.9 thousand hectares and 1886.8 Million tons respectively [1]. The anti-oxidants in guava are believed to help in reducing the risk of cancer. The vitamin C in guava makes absorption of vitamin E much more effective in reducing the oxidation of the cholesterol. The fiber in guavas promotes digestion and ease bowel movements. The insoluble fiber in the guava fruity is beneficial in preventing and treating diverticulitis. The high content of vitamin A in guava plays an important role in maintaining the quality and health of eyesight, skin, teeth, bones and the mucus membranes [1].

Guava pulps are important value added products having demand in both local and export markets. The local market of guava fruit juices, nectars and drinks has been growing at a very high rate during the past five years. Consequently, the demand for fruit pulps has also increased during this period had contributed towards reducing the post harvest losses, increasing employment opportunities in the area and maximizing crop value for the farmers [2]. The products will be sold in local and export markets. Guava was preferred for candy preparation as it is a highly valued indigenous fruit containing high amounts of nutrients like carotenoids, which are rich of vitamin C [3,4]. Besides, guava also contains good amount of dietary fiber having laxative effect, vitamin C and sugar content. Owing to its seasonal character and perishable nature, a large quantity of guava goes waste due to inadequate handling and storage practices. Its use as candies may prove to be a shelf stable delicious addition in the list of guava products [5,6].

The fresh fruit of guava has limited shelf life. Therefore, it is necessary to utilize this fruit for making different products to increase its availability over an extended period and to stabilize the price. In view of the above points, the study is undertaken with the following objectives: 1 to study the effect of cooking time on guava candy preparation 2 to evaluate nutritive value of guava candies 3 to evaluate consumer acceptability through organoleptic testing [7].

Materials and Methods

Selection of raw materials

Two varieties of guava namely, 'Allahabad safeda" and "Lucknow-49" were selected based upon their TSS content for preparation of guava candies. The following ingredients were used in the preparation of guava candy viz., sugar, milk powder, glucose, butter and chocolate flavour. The following chemicals were also used in estimating the nutritive value of fresh guava and the candy. oxalic acid (4%), dye solution: 2, 6-Dichlorophenol indophenols dye solution, sodium carbonate, copper sulphate, potassium sodium tartarate (Rachelle salt), folin and Ciocalteau (2N) phenol reagent, sulphuric acid and redistilled phenol.

Equipment and apparatus

Following laboratory equipment and apparatus were used for the present study. Thermometer: To know the temperature of the mix for adding ingredients. Hand refractometer: To know the TSS content in the samples. pH meter: To know the pH content in the samples. Hot air oven: To know the moisture content in the samples. Spectro-photometer: To know the protein and carbohydrate content in the samples. Water bath: To heat the working standard. Centrifuge: To centrifuge the working standard and other miscellaneous equipment like stainless steel vessels, electric stove, spoons, stainless steel trays, knife, electric balance, micro oven, moisture boxes, stainless steel sieve, refrigerator, test tubes and pipette were also used.

Experimental procedure for preparation of guava candy

Candy making

For preparing guava candies, an appropriate recipe was explored from the guava fruit and required ingredients were considered carefully. The normal procedure commonly employed for preparing confectionery items was studied and was modified slightly in terms of heating time and temperature to make it optimal for preparing good quality guava candies. Fresh guava fruits were washed with lukewarm water and sliced with a steel knife, keeping slice thickness of 1-1.25 cm. The sliced fruits were boiled for 30 minutes. After heating, softened slices were sieved using a stainless steel sieve (2 mm diameter holes) and seeds were separated. Pulp was obtained by sieving the softened slices. Sugar and milk powder were added first to the boiling pulp. Addition and mixing of sugar crystals and skim milk powder was done at temperature above 60ºC. After thorough mixing the mix was heated at 80-90º C for about 1 h.

Fig-1 Boiled guava slices

Addition of butter to guava pulp mix gave smoothing effect in the mouth while chewing the candies. The milk butter of 85 g was selected and candies were prepared using optimal amounts of sugar and milk powder. The glucose powder was also added to fortify the candies with vitamin C. While cooking the mix, chocolate flavour was added in small amount till the mix attained an appealing colour. Two replications were made. Addition of colour was initiated at 40 mg/kg of guava pulp and was increased by small amounts. Continuous stirring was done during the period of heating until the mix attained consistency. For determining optimum degree of consistency, spec test was conducted. In this test, a spec of mix was put in water, at normal temperature (25-30ºC). Spec forming a solid mass indicated attainment of optimal degree of consistency. Mix was then spread on clean stainless trays maintaining a thickness of 10 cm.

Fig-2 Stirring of guava pulp during cooking

Before spreading, a thin layer of milk butter was smeared to avoid sticking of mix on trays. A thin film of butter was applied on the top surface of the spread to get a smooth surfaced guava candies. The spread was then kept aside for 2 hours for setting. Once it attained room temperature, spread was cut into appropriate sized candies. Candies were then wrapped in butter paper. The flow chart for standard procedure of candy making is given in [Fig-5].

Fig-3 Spreading of guava candy mix

Fig-4 Cutting guava candy mix into cubes

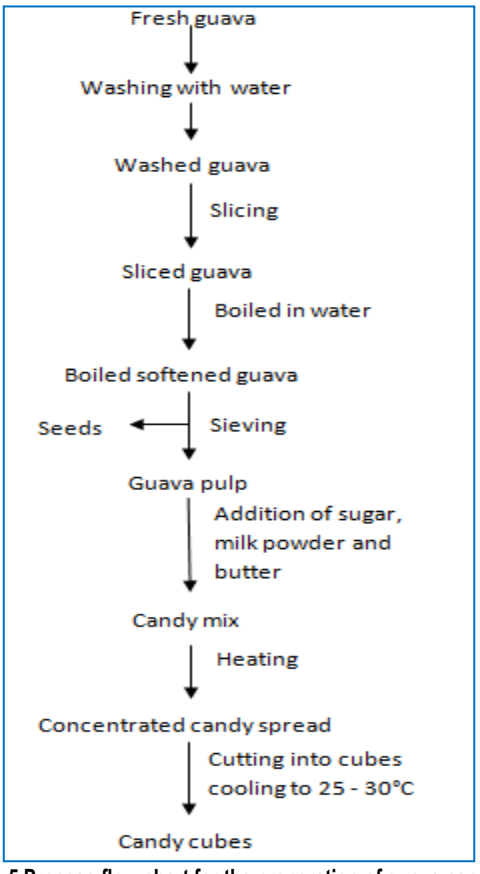

Fig-5 Process flow chart for the preparation of guava candy

Standard procedures given by Dubios *et al.,* (1956) and Ranganna (1986) were followed to determine Total Soluble Sugars, Vitamin C, carbohydrates, proteins and pH. For sensory evaluation, quality attributes such as appearance, aroma, colour, flavour, chewiness, firmness, texture and overall acceptability were evaluated by panel members on Hedonic scale of 1-9.

Physico-Chemical Analysis Of Products

The samples of guava candies were evaluated for moisture content, ascorbic acid, carbohydrate content, protein content, TSS, pH and sensory evaluation.

Moisture content

Moisture content of the fresh guava fruit, pulp and candy was determined by oven drying method. Samples of 10 g of guava fruit, pulp and prepared candy were dried for 24 h in an electric oven at 105° C, cooled in desiccators and weighed. The process was repeated until the differences between the 2 consecutive weights were not more than 0.5-1 mg. The observations were recorded and the moisture content was calculated using the following formula.

$$\text{Moisture content (m.c.), \%} = \frac{W_m}{W_m + W_d} \times 100 \quad \text{..... [1]}$$

Where,

m.c. = moisture content, % wet basis

W_m = weight of water evaporated, g

W_d = weight of dry matter, g

Vitamin C content

Principle

Vitamin C reduces the 2, 6-dichlorophenol indophenols dye to a colorless leuco-base. The vitamin C gets oxidized to dehydrate vitamin C. Though the dye is a blue colored compound, the end point is the appearance of the pink color. The dye is pink colored in the acid medium. Oxalic acid is used as the titrating medium.

Reagents Required

1. Oxalic acid (4%).
2. Dye solution: 2, 6 Dichloro phenol indophenol dye solution: - 42 mg of sodium bicarbonate and 52 mg of dye were weighed and added to dissolve solution. Make up the volume to 200 ml with distilled water.
3. Stock standard solution: 100 mg pure vitamin C dissolved in 100 ml of 4 % oxalic acid.
4. Working standard: 10 ml of the stock solution diluted to 100 ml with 4 % oxalic acid. The concentration of working standard was 100 µg/ml.

5 ml of the working standard solution was pipetted out into a 100 ml conical flask. 10 ml of 4 % oxalic acid was added and titrated against the dye (V_1 ml). At the end point pink colour was appeared, which persisted for a few minutes. The amount of the dye consumed was equivalent to the amount of vitamin C. The sample (1-2 g depending on the sample) was extracted into 4 % oxalic acid and made up to a known volume (100 ml) and centrifuged. 5 ml of this supernatant was pipetted out and added to 10 ml of 4 % oxalic acid and titrated against the dye (V_2 ml).

Proteins

Principle

0.5ml of reagent D (Folin and Ciocalteau (2N phenol reagent) was added and incubated at room temperature in the dark for 30 minutes. The blue colour was developed by the reduction of the phosphomolybdic- phosphotungstic components in the Folin-Ciocalteau reagent by the amino acids tyrosine and tryptophan present in the protein plus the colour developed by the burette reaction of the protein with the alkaline cupric tartarate were measured in the Lowry's method.

Reagents required

Reagent A: 2 % sodium carbonate in 0.1 N sodium hydroxide.

Reagent B: 0.5% copper sulphate ($Cuso_4.5H_2o$) in 1% potassium sodium tartrate (Rachelle salt).

Reagent C: Alkaline copper solution: Mix 50 ml of reagent A and 1 ml of reagent B prior to use.

Reagent D: Folin and Ciocalteau (2 N) phenol reagent. (Readily available).

Solution A: Protein solution (Stock standard)

Solution B: Working standard.

500 mg of the sample was weighed and grinded well with a pestle and mortar in 5-10 ml of the buffer, then the buffer was centrifuged. Supernatant was separated from the centrifuge tubes and it was used for the protein estimation. 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standards were pipetted out into a series of test tubes. 0.1 ml and 0.2 ml of the sample was pipetted out into two other test tubes. The volume was made up to 1 ml in all the other test tubes. A tube, which contains 1 ml of water, was served as the blank. 5 ml of reagent C was added to each tube including the blank and was mixed thoroughly and kept it aside for 10 minutes in order to accumulate the solid particles at the beneath of the tube. 0.5 ml of reagent D was added and incubated at room temperature in the dark for 30 minutes; blue colour was developed. Readings were taken at 660 nm. The standard graph was drawn and the amount of protein in the sample was calculated. The amount of protein content was expressed in mg/g or 100 g sample.

Fig-6 Spectro – photometer

Fig- 7 Centrifuge

Total carbohydrates

Principle

Total carbohydrates are hydrolyzed into simple sugars using sulphuric acid. In hot acidic medium glucose is dehydrated to hydroxyl methyl furfural. This compound forms a green coloured product with phenol and has absorption maximum at 490 nm.

Reagents required

1. Phenol 5 %: Redistilled (reagent grade) phenol (50 g) dissolved in water and diluted to 1 liter.
2. Sulphuric acid (96 %) reagent grade.
3. Standard glucose: Stock-100 mg in 100 ml of water.
4. Working standard: 10 ml of stock diluted to 100 ml with distilled water.

100 mg of the sample was weighed and dissolved in water. Then it was hydrolyzed by keeping in boiling water bath for three hours with 5 ml of 2.5N HCl and cooled to room temperature. The sample was neutralized with solid sodium carbonate until the effervescence ceased. The volume was made up to 100 ml and centrifuged. 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standards were pipetted out into a series of test tubes. 0.1 and 0.2 ml of the sample solution was pipetted

out into two separate test tubes. The volume was made up to 1ml with water in each test tube. The blank was set with 1 ml of water. 1 ml of phenol solution was added to each tube. 5 ml of 96 % sulphuric acid was added to each tube and shook well. After 10 minutes the contents in the tubes were shaken and placed in water bath at 25-30º C for 20 min. The colour was read at 490 nm. The amount of total carbohydrates presented in the sample solution was calculated by using the standard graph.

Calculation

Amount of carbohydrate presented in 100 mg of the sample $= \frac{mg\,of\,glucose}{volume\,of\,test\,sample} \times 100$ [2]

pH

pH was determined using digital pH meter. The pH meter consists of two electrodes, a calomel electrode and a glass electrode (in modern machines both electrodes both electrodes are suitably combined in a single assembly for convenience in handling). The glass electrode contains silver, silver chloride and 0.1N hydrochloric acid. Its tip was covered by a special glass surface, which allows only H^+ ions to pass through it.

Measurement

The zero of the dial was first set by mechanical means. Then the knob for temperature compensation was fixed for the temperature of the solution. This was essential since the equilibrium constant of a reaction does vary with temperature. Now, the electrodes were dipped into a standard buffer solution of known pH. The reading in the dial was recorded. The electrodes are removed, washed well with distilled water, and dipped into the known amount of product which was homogenized with 25 ml of distilled water. Addition of distilled water does not alter the pH of the product. The dial read the pH value.

Fig-8 Digital pH meter

Total Soluble Solids (TSS)

Degrees Brix (symbol °Bx) is the measurement of sugar content of an aqueous solution. One degree Brix is 1 gram of sucrose in 100 grams of solution and represents the strength of the solution as percentage by weight (% w/w) (strictly speaking, by mass). If the solution contains dissolved solids other than pure sucrose, then the °Brix is only approximate the dissolved solid content [8]. The refractometer was held horizontally and pointed it towards a light source. By looking into the eyepiece the scale was rotated focusing knob until the image of the scale was clear.

Fig-9 Hand Refractometer

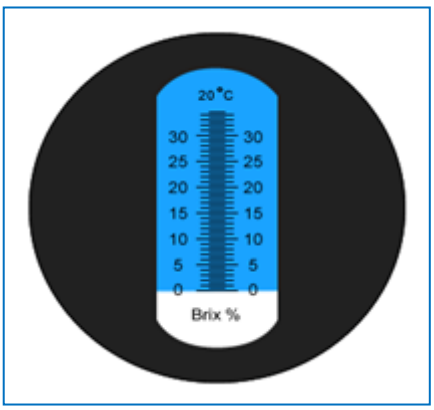

Fig-10 Brix Scale

The refractometer was calibrated by placing-several drops of distilled water of the proper temperature (20° C) between the cover and the prism. While observing through the eyepiece, the scale was rotated for calibrating screw so the boundary line which separates the light and dark areas of the image is aligned with the zero line on the scale. The cover was lifted and the calibrating water was dried off from the prism. One to two drops of the sample was placed on the prism and the cover was closed. With cover and prism facing a light source, by looking into the eyepiece and the boundary line was noted. The correct measurement in percentage of sugar is read at the point where the boundary line crossed the scale. When finished, cover and prism were carefully cleaned and dried.

For measurement of sugar content in samples, 50 mg of sample was taken and homogenized with the distilled water of 200 ml. The supernatant was transferred into separate beaker. After setting the zero scale in the refractometer, one to two drops of the sample to be tested were placed on the prism and the cover was closed. With cover and prism facing a light source, looking into the eyepiece readings were noted where the boundary line appeared. When finished, carefully cleaned and dried the cover and prism.

Sensory Evaluation Of Guava Candies

Sensory evaluation of guava candy samples were carried out by comparing with control samples. Sensory testing was conducted in the sensory evaluation laboratory, Department of Agricultural Process and Food Engineering. The hedonic rating test was used to measure the consumer acceptability of food products. From one to six samples were served to the panellist at one session and was asked to rate the acceptability of the product on a scale, usually of on points, ranging from 'like extremely' to 'dislike extremely'. The results were analyzed for preference with data from panellists. Organoleptic quality of guava candy was determined with the help of a 10 member consumer panel using a 9-point hedonic scale. The parameters evaluated for guava candy were appearance, aroma, colour, flavour, chewiness, firmness, texture and overall acceptability. The average scores of all 10 panellists were computed for different characteristics.

Results and Discussions

This chapter contains the results and discussions of the experiments conducted in order to fulfil the objectives of the study. The guava candy studies were carried out with two guava varieties namely Allahabad Safeda and Lucknow-49, by adding different ingredients namely sugar, butter, skim milk powder, glucose and chocolate flavour.

Optimum parameters for guava candy preparation

Physiologically mature, firm texture fruits were found suitable for preparation of guava candies. For boiling one kg of guava slices, two litres of water was found adequate. A cooking temperature range of 85-95ºC and cooking period of 120 minutes were found to be optimal.

Effect of cooking time on moisture content of guava candy

The moisture content in fresh guava fruits was determined using oven dry method and it was found to be 38.36 % and 24.55 % (w.b.) in Allahabad Safeda and

Lucknow-49 varieties respectively. The pulp of those two varieties contains 84.20%, 82.56%, respectively. The moisture content in the candy was also determined and it was found that the moisture content in guava candy was very less compared to fresh fruit. Most of the moisture in fresh fruit pulp was lost during the boiling process.

Table-1 *Effect of cooking time on moisture content of guava candy*

Sample no.	Variety	Cooking time(min)	Moisture content of candy (%w.b.)
1	Allahabad Safeda	90	4.95
2		120	3.54
3		150	2.41
4	Lucknow-49	90	4.91
5		120	3.48
6		150	2.34

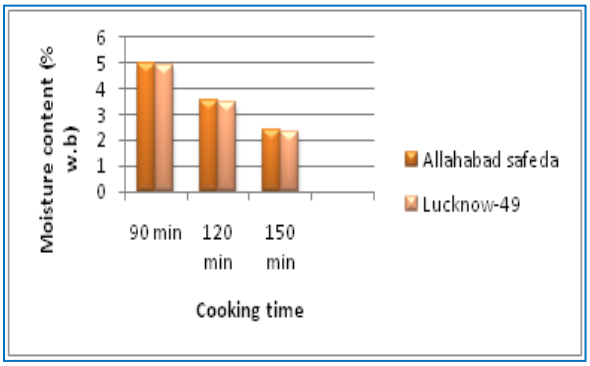

Fig-11 Effect of cooking time on moisture content of guava candy

Effect of cooking time on vitamin C content of guava candy

The vitamin C content in fresh guava fruit (Allahabad Safeda) was found to be 115 mg/100 g of sample and the value recorded for Lucknow-49 was 110 mg/100 g of sample and the pulp of those two varieties contains 110, 105 mg/100 g of pulp. The ascorbic content in candies varied from 104 to 125 mg/ 100 g of candies for both varieties of guava pulp boiled at three cooking times [Fig-12]. Higher content of Vitamin C in guava candies was probably due to addition of glucose. Thus addition of glucose not only improved the taste and other mouth feel attributes but also improved upon Vitamin C content.

Table-2 *Effect of cooking time on vitamin C content (mg/100 g of sample) of guava candy*

Sample no.	Variety	Cooking time (min)	Candy (mg/100 g)
1	Allahabad safeda	90	125
2		120	117
3		150	109
4	Lucknow-49	90	120
5		120	112
6		150	104

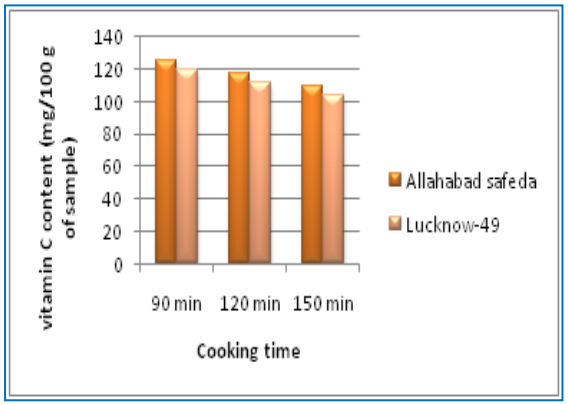

Fig-12 Effect of cooking time on vitamin C content of guava candy

Effect of cooking time on total carbohydrates of guava candy

The carbohydrate content was very high in candy than in fresh fruit because of the addition of sugar in preparation of candy. In fresh guava, the carbohydrate content was 22.68 % in Allahabad Safeda and it was 23.16 % in Luknow-49 and the pulp of those two varieties contain 17.34 % and 18.76 %. In the candy, the maximum carbohydrates of 38.88 % [Fig-13] were found in Lucknow-49 cooked for 90 minutes. It was observed that with increased cooking time, the percent carbohydrates decreased in the candy. The Lucknow-49 variety contained high carbohydrate content (23.16 %) than Allahabad Safeda variety (22.68 %).

Table-3 *Effect of cooking time on total carbohydrate (%) content of guava candy*

Sample no.	Variety	Cooking time (min)	Candy (%)
1	Allahabad Safeda	90	38.04
2		120	34.675
3		150	31.08
4	Lucknow-49	90	38.88
5		120	35.88
6		150	32.76

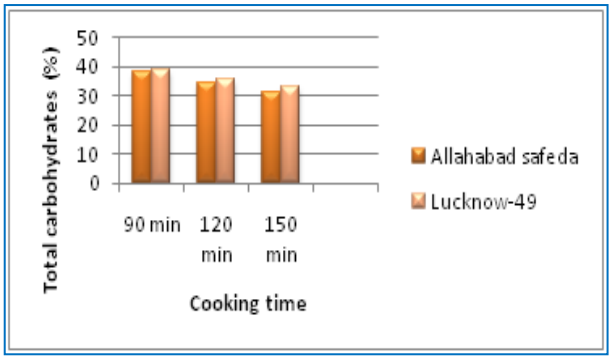

Fig-13 Effect of cooking time on Total Carbohydrates

Effect of cooking time on pH content of guava candy

The fresh guava fruits as well as the prepared candies were acidic in nature. The pH values of Allahabad Safeda and Lucknow-49 varieties were 4.18 and 3.96, respectively in the fresh fruits and the pulp of those two varieties contain 4.06 and 3.82, respectively. The pH value ranged between 4.78 and 5.43 for the candies of two varieties of guava boiled at three time durations. Candy showed more acidity than fruit, because the ascorbic acid content was more in candy.

Table-4 *Effect of cooking time on pH content of guava candy*

Sample no	Variety	Cooking time (min)	Candy
1	Allahabad Safeda	90	4.84
2		120	5.00
3		150	5.43
4	Lucknow-49	90	4.78
5		120	4.86
6		150	5.27

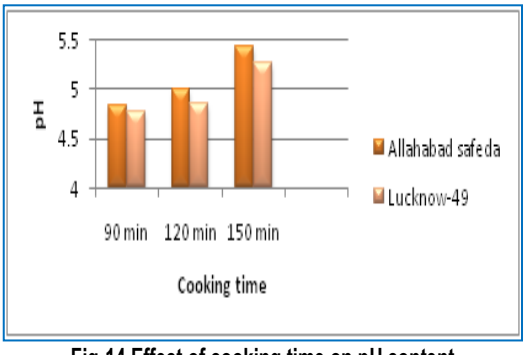

Fig-14 Effect of cooking time on pH content

Effect of cooking time on TSS content of guava candy

The TSS values of Allahabad safeda and Lucknow-49 varieties were 4.40 % and 4.16 % respectively in fresh fruits and the pulp of those two varieties contain 3.88 % and 3.76 % respectively. While that for candies the TSS values ranged between 11.6 to 15.0 %. Candy showed more TSS than fruit and this may be attributed to the fact that different ingredients were added in the candy preparation. Maximum TSS content was recorded in the candy prepared from Allahabad Safeda variety cooked for 15 minutes [Table-5].

Table-5 *Effect of cooking time on TSS (%) content of guava candy*

Sample no.	Variety	Cooking time (min)	Candy (%)
1	Allahabad safeda	90	15
2		120	13.6
3		150	12
4	Lucknow-49	90	14.2
5		120	13
6		150	11.6

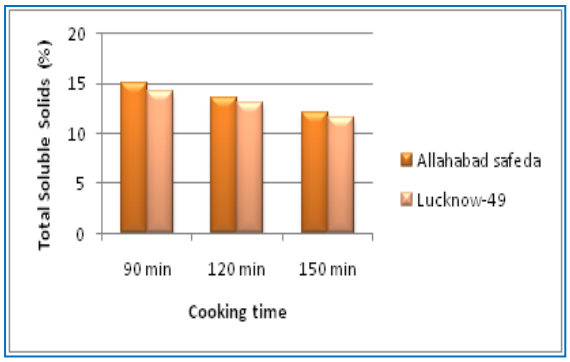

Fig-15 Effect of cooking time on Total soluble solids

Effect of cooking time on protein content of guava candy

The proteins were rich in fresh Allahabad Safeda variety (0.75 %) than fresh Lucknow-49 variety (0.68 %) and the pulp of those two varieties contain 0.61% and 0.56 %, respectively. Protein content was maximum in Allahabad Safeda boiled for 90 minutes [Fig-16]. With increased cooking time, the protein content in the candy decreased.

Table-6 *Effect of cooking time on protein content (%) of guava candy*

Sample no.	Variety	Cooking time (min)	Candy (%)
1	Allahabad Safeda	90	1.0148
2		120	0.89
3		150	0.79
4	Lucknow-49	90	0.95
5		120	0.852
6		150	0.73

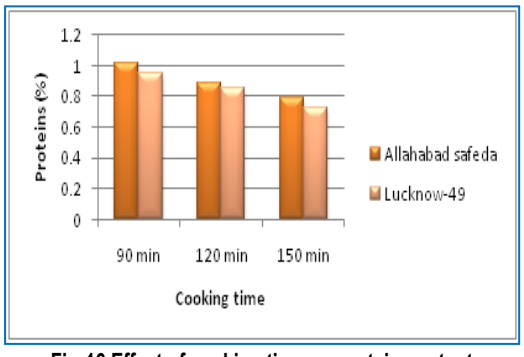

Fig-16 Effect of cooking time on protein content

Sensory evaluation of guava candies

Sensory parameters like appearance, aroma, colour, flavor, chewiness, firmness, texture and overall acceptability were analyzed by 9 – point hedonic scale. The average sensory scores for each parameter of the guava candy are presented in [Table-7].

Table-7 *Average hedonic scores of guava candy samples*

Parameter	Allahabad safeda			Lucknow-49		
	Sample 1 (90 min)	Sample 2 (120 min)	Sample 3 (150 min)	Sample 4 (90 min)	Sample 5 (120 min)	Sample 6 (150 min)
Appearance	7	8	7	7	8	7
Aroma	7	8	7	8	7	7
Colour	8	8	7	8	8	7
Flavor	7	8	7	6	7	7
Chewiness	6	8	7	6	7	7
Firmness	7	8	7	6	7	6
Texture	7	8	7	6	7	6
Overall acceptability	7	8	7	6	7	7

Conclusions

From the experimental results the following conclusions were drawn.

1. The yield and quality of pulp from "Allahabad Safeda" was better than that obtained from "Lucknow 49".
2. Based on the organoleptic evaluation it was concluded that the candies prepared at a temperature range of 85°C-95° and a cooking time of 120 minutes got the good results with respect to sensory attributes.
3. The good candies were prepared with the addition of 580 g sugar, 160 g skim milk powder, 85 g butter, 90 g glucose and 40 mg colour per kg of guava pulp without addition of any preservative.
4. Among the prepared samples, maximum content of ascorbic acid, proteins and Total Soluble Solids was found in candies prepared from Allahabad Safeda variety for a cooking time of 90 minutes.
5. Maximum content of carbohydrates was found in the candies prepared from the pulp of Lucknow-49 variety cooked for 90 minutes and maximum acidity was found in candies prepared from Lucknow 49 variety for a cooking time of 150 minutes.
6. Ascorbic acid, carbohydrates, proteins and TSS decreased with increase in cooking time.

Conflict of Interest: None declared

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