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RESEARCH ARTICLE

Optimization of pretreatments and sugar concentration of strawberry candy

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ABSTRACT

The aim of the research was to develop a self-stable dehydrated strawberry product using different pretreatment and sugar solutions on the characteristics of strawberry candy. Whole strawberry candy was prepared using ripe strawberry fruits of the Sweet Charlie cultivars. The strawberries were washed in running tap water and blanched in hot water for 2 minutes. Pretreatments were given using 3 different combinations of chemicals, among which treatment C (2% Ethyl Oleate + 1% Citric acid) was selected based on the color and maximum ascorbic acid retention. The strawberries were then immersed in sugar solutions with concentrations of 40%, 50%, 60%, and 70% for 3-5 hours. The product obtained by osmotic dehydration is more stable during storage due to the low water activity imparted by solid gain and water loss. The concentration of sugar syrup 700B with a dipping time of 3 hours at 45°C was found to be suitable based on the solid gain-water loss ratio.

Keywords: Strawberry candy, pretreatments, osmotic dehydration, organoleptic quality

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INTRODUCTION

Strawberries are the most delicate and highly perishable fruits due to respiration, weight loss, and susceptibility to fungal contamination. They are sensitive to chemical and microbial deterioration during post-harvest storage and handling. Therefore, they have a rather limited shelf life in fresh form (Agnieszka et al., 2010). The production of strawberries was about 9.22 million tons in 2017 worldwide. India produced 5.20 thousand metric tons for the year 2017-18. Maharashtra is the major producer, contributing 12% of India's strawberry production (NHB Database, 2017).

There are different types of varieties of strawberries. Chandler, Tioga, Torrey, Pajaro, Camarosa, winter down, Sweet Charli, Festival, etc. are cultivated in India (Ministry of Agriculture, India). Strawberries are an important commodity for food and are used for manufacturing sweet jams, jellies, biscuits, ice cream, shortcake, angel food cake, and fruit leather with a sprinkling of sugar or a splash of cream (Jafar et al., 2013).

Strawberries are highly perishable fruits. Therefore, they can be preserved by freezing and drying processes such as freeze drying, osmotic drying, microwave drying, air drying, and solar drying (Evans et al., 2002). Besides, they can be consumed fresh

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or in many other forms such as juice, concentrate, jam, jelly, and dried and rehydrated with yogurt and bakery products (El-Beltagy et al., 2006). Owing to their flavor, high vitamin composition, and antioxidant activity, they are consumed as a part of the normal diet, but consumption is also associated with a reduced risk of certain cancers, inflammatory dysfunction, and cardiovascular diseases (Olsson et al., 2004; Giieri et al., 2012). Phenolic compounds and anthocyanins, as the two large and heterogeneous groups of biologically active molecules, are known to be dietary components with antioxidant activities (Panico et al., 2009).

Candy is a sweet food prepared from fruits or vegetables by immersing them in sugar syrup, followed by draining off 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 (Mehta et al., 1984). A mature fruit immersed in heavy sugar syrup until it becomes tender and transparent is known as preserves. Fruits immersed in sugar or glucose syrup and subsequently drained of syrup and dried are known as candy. The most suitable fruits and vegetables for preserves and candy are pineapple, cherry, papaya, amla, etc. (Sen et al., 1990).Drying is the most important process for preserving grains, crops, and foods of all varieties. The removal of moisture prevents the growth and reproduction of microorganisms that cause decay and minimizes many of the moisture-mediated deterioration reactions. It brings about a substantial reduction in weight and volume, minimizing packing, storage, and transportation costs, and enables storability of the product under ambient temperatures (Jayaraman et al., 1995).

Osmotic dehydration is the phenomenon of removing water from a lower concentration of solute to a higher concentration through a semi-permeable membrane, resulting in an equilibrium condition on both sides of the membrane. Osmotic dehydration has found wide application in the preservation of food materials since it lowers the water activity of fruits and vegetables. Osmotic dehydration is preferred over other methods due to its retention value of color, aroma, nutritional constituents, and flavor compounds, and it is used as an effective pretreatment before drying (Tiwari 2005).

Osmo air-dried strawberry fruits are based on a novel approach to dehydration. The osmo-air dehydrated product can be used in ready-to-eat foods, ice cream, fruit salad, kheer, cakes, and bakery products (Parveen et al. 2012).

Sun drying is still the most common method used to preserve agricultural products in most tropical and subtropical countries. However, being unprotected from rain, windborne dirt and dust, and infestation by insects, rodents, and other animals, inedible, and the resulting loss of food quality in the dried products. The conditions in tropical countries make the use of solar energy for drying food practically attractive. The introduction of solar dryers in developing countries can reduce crop losses and significantly improve the quality of dried products compared with traditional drying methods (Muhlbauer, 1986).

MATERIALS AND METHODS

Materials

Strawberries were purchased from the local market in Kolhapur. After removing unripe and spoiled fruits, they were stored in the refrigerator until further use.

For candy preparation, healthy, good quality, ripe fruits are selected. The fruits were washed under clean tap water and then blanched in lukewarm water before pretreatment.

Chemicals

Sodium metabisulfite, citric acid, ethyl oleate, ascorbic acid, and potassium carbonate were used of laboratory grade.

Packaging Material

LDPE was used as a packaging material.

METHODS

Proximate composition

The proximate composition, such as moisture, ash, protein, fat content, crude fiber, titratable acidity, and TSS, was estimated by the standard procedure suggested by Ranganna in 1986. Carbohydrate content was calculated using the difference method. The determination of ascorbic acid was carried out using the titration method with indophenol solution (BIS, 2005).

Colour measurment

Color measurements of the strawberry fruit sles were carried out using a Hunter Lab colorimeter, Colourflex EZ (Erhan, 2012).

Pretreatments for strawberry fruit

Different pretreatments were followed before osmotic dehydration of strawberries, and the treated sles were coded as:

(A) 1% Sodium metabisulfite + 1% Citric acid (El-Beltagy et al., 2005)

(B) 1% Ascorbic acid + 1% Citric acid (El-Beltagy et al., 2005)

(C) 2% Ethyl oleate + 1% Citric acid (El-Beltagy et al., 2005)

Osmotic dehydration of strawberry fruits

Different pieces of strawberries were then dipped in different concentrations of sugar solution. After that, the syrup was drained out and the pieces were dipped in boiling water to remove adhered syrup. Drying was done at 50°C for 15 hours in a tray dryer to minimize the moisture content.

Selection of mature strawberry fruits (Sweet Charlie)

Washing

Dipping of fruits in boiling water

(For 1 minute)

Pretreatment

Preparation of sugar syrup (60^0B)

Dipping of whole shapes of strawberry into sugar syrup

Fruit to syrup ratio (1:3)

(For 4 hour)

Draining of syrup

and dipping of fruits in boiling water

Drying

50^0C for 15 hr.

Strawberry candy

(Ibrahim., 2008)

Fig. 1: Method for Osmotic dehydration of strawberry fruits

Sensory Evaluation

The prepared sles were evaluated for sensory parameters such as color, flavor, texture, taste, and overall acceptability using a 9-point hedonic scale by a panel of 10 semi-trained panel members (Ranganna, 1986).

RESULT AND DISCUSSION

Table. 1: Physical Analysis of strawberry fruit

Sr. No	Parameter	Result
1.	Weight (gm)	7.388 ± 1.488
2.	Width (mm)	11.94 ± 2.720
3.	Length (mm)	28 ± 3.12
4.	volume (cm^3)	0.657
5.	Density (gm/cm^3)	11.22

Results are mean ± SD of 10 determinations

A range of physical properties of strawberry fruits was determined. The average weight, width, length, volume, and density of strawberry fruits were presented in Table 1. The characteristics of the physical properties of strawberry fruit affect the product that has been prepared from strawberry fruit. Strawberry is a sensitive fruit that may be easily destroyed when it is subjected to a small force; therefore, it is necessary to check the physical parameters of strawberries before processing or applying this fruit for the making of different products.

The length and width were measured using a digital vernier caliper. The average length of strawberries was found to be 28 + 3.12 mm, and the width was 11.94 + 2.720 mm. The average weight of the fruit was recorded as 7.388 + 1.488 g.

Table. 2: Proximate Analysis of strawberry fruit

Sr. no	Parameter	Result
1.	Moisture (%)	91.6 ± 0.28
2.	Ash (%)	0.45 ± 0.10
3.	Protein (%)	0.6 ± 0.25
4.	Fat (%)	0.49 ± 0.14
5.	Carbohydrate (%)	6.86
6.	Crude Fiber (%)	3.5
7.	Ascorbic Acid (mg/100gm)	64.832
8.	Total soluble solid (°Brix)	6.1 ± 0.28
9.	Acidity (%)	1.12
10.	pH	3.2

Data is expressed as mean + standard deviation of triplicate experiments (n=3).

Results of physico-chemical analysis of strawberry fruit reveal that strawberries contain moisture 91.24%, crude fat 0.34%, protein 0.6%, crude fiber 3.5%, ash 0.30%, and carbohydrate 6.86%. Vitamin C content in strawberries fruit was found to be 64.83mg/100g, while the TSS is observed to be 6.1 o Brix. The acidity of strawberries fruit was 1.13%. The results of the present analysis are in close relation to the values reported by Giieri et al. (2012).

Table. 3: Effect of pretreatments on color value of strawberry fruit

	Without Treatment	With Treatments		
		A	B	C
L^* (Lightness)	36.706	35.807	36.448	37.190
a^* (Redness)	39.097	37.841	37.617	39.886
b^* (Yellowness)	13.113	19.339	23.419	22.942

Table. 4: Total colour difference

Pretreatments	Δ E
A	6.415
B	10.415
C	9.872

The results of color measurements L*, a*, and b* values by a color scan instrument for strawberry fruits treated with different pretreatments are presented in Table 2. The color showed considerable differences between various treatments. The redness values (a*) of strawberry fruits showed a considerable difference between various pretreatments. The pretreated strawberry fruits showed the lowest a* values compared to fresh strawberry fruit, except for treatment C (39.89), which showed the highest a* value compared to fresh untreated fruits (39.10). Thus, treatment C was redder in surface color compared to other treatments. Among all the pretreatments, Treatment C was found to be the best treatment, having better color properties compared to other treatments. For pretreatment C, redness was retained more compared to other pretreatments. So, pretreatment C is considered a suitable pretreatment for strawberry fruit.

Table No. 05: Osmotic dehydration for whole strawberries.

Brix (°B)	Solid Gain (%)			Water loss (%)			Weight reduction (%)			SG/WL (%)		
	1hr	2hr	3hr	1hr	2hr	3hr	1hr	2hr	3hr	1hr	2hr	3hr
50	1.75	3.5	5.25	3.32	6.64	9.96	1.48	2.96	4.44	0.48	0.52	0.52
60	3.23	6.46	9.70	3.64	7.29	10.94	0.41	0.82	1.23	0.88	0.88	0.88
70	4.53	9.07	13.61	4.65	9.30	13.96	0.11	0.23	0.35	0.97	0.97	3.43

Table 5 shows that for whole strawberries, 70 0B is suitable for 3 hours at 45oC. For that brix and time combination, the SG/WL ratio is maximum and weight reduction is minimum. Due to the maximum solid gain, the bulk of the fruit is retained.

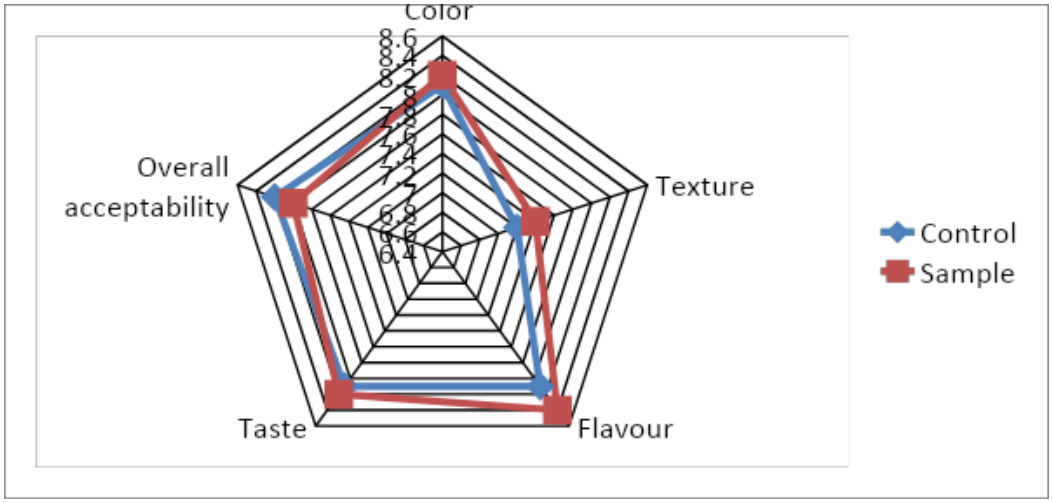

Fig. 2: Sensory attributes of osmotic dehydrated whole strawberry fruits at 700B

The prepared sle was evaluated for sensory parameters such as color, flavor, texture, taste, and overall acceptability using a 9-point hedonic scale. Sensory analysis for the control sle and strawberry candy was carried out using a 9-point hedonic scale. Sensory evaluation was conducted by a semi-trained panel of 10 people. The scores in the table above are the average scores given by the panel for each parameter. Sle A received the highest score for color, with a score of 8.2. The color score for Sle A was slightly lower than that of the control sle. The texture score for the product was around 7. The sensory scores indicate that the flavor of the strawberry candy (Sle A) was liked very much by the sensory panel.

CONCLUSION

The prepared strawberry candy was finalized based on a solid gain to water loss ratio and weight reduction. Prior to preparing the strawberry candy, different pretreatments were applied to the strawberry fruit. In this case, a treatment of 2% ethyl oleate + 1% citric acid was found to be the most suitable as it retained the red color and maximum ascorbic acid. The whole strawberry fruit was chosen for the candy preparation. Osmotic dehydration, which involves removing water from the fruit using high concentration syrups, is the main principle involved in candy preparation. However, the optimum concentrations of sugar syrup and treatment duration need to be determined for each type of fruit to ensure good quality candy. In the case of whole strawberries, a sugar concentration of 700B was found to be optimum due to the solid gain to water loss ratio and weight reduction.

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