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RESEARCH ARTICLE

EFFECT OF PRETREATMENTS ON PHYSIOCHEMICAL PROPERTIES OF APPLE CANDY DURING STORAGE

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ABSTRACT

Apple candy were prepared by steeping in 2% salt solution (blanching with erythrosine colour (T_1), green colour (T_2), with water (T_3), with lime orange (T_4)) and 2% lime solution (T_5-blanching with erythrosine colour, T_6 green colour, T_7 with water, T8-with lime orange) and then candy was stored for 2 months various physio-chemical properties & shelf life were tested at 0, 20, 40 and 60 days after storage. Statistical analysis and physio-chemical evaluation of the data was carried out and observed the effect during storage. On the basis of investigation it was concluded that better quality candy can be obtain by steeping of the fruit pieces in 2% lime solution and blanching with erythrosine colour T1 followed by syruping. The maximum T.S.S. was found in T_7 (78.52) followed by T_6 (78.45) after 60 days of storage period. Maximum ascorbic acid was recorded in T_7 (5.56 mg/100g) in fresh candy followed by T_6 (5.54 mg/100g). Significant loss of ascorbic acid was noted during storage from 0 days (5.56 mg/100g) to 60 days (4.07mg/100g). Maximum acidity was recorded in T_4 (0.132%) followed by T_3(0.129%). Acidity was found to be reduced from 0.132% to 0.073% during storage period. Maximum reducing sugar in fresh candy was recorded in T_7(42.93%) followed by T_6(42.54%). It was found to be increased from 42.93% to 55.41% in T_7 during storage.

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INTRODUCTION

Fruits are among the most important foods of mankind as they are both nutritive and indispensable for maintenance of health. Being 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. Apple (*MalusdomesticaBorkh*) is the most favored fruit of millions of people and is a widely grown fruit in temperate regions of the globe. The world production of apple is about 58 million tons from an area of about 5.26 million ha (FAO 2005). Presently, India is the 9th largest producer of apples in the world contributing about one-third of total apple production of the world with an annual production of 1.42 million tons from an area of 0.25 million ha (Anon 2004). Eighty four percent of the apple is water and the remaining 16 % is total solids. This 16% contains nitrogen, fatty materials, minerals, carbohydrates, astringents, colour compounds, enzymes, volatiles, vitamin A, C and flavonoids (Smock and Neubert 1950). Maine apples usually contain less than 1% fat, have no cholesterol or sodium, are low in calories and have most of the essential vitamins and minerals. Apples are an excellent source of fibre. A medium sized apple has about 5 g of fibre - 25% of the recommended daily intake of fibre (20 g). They also contains about 40 calories; one Kilogram (2.2 lb) of fresh apples provides approximately 2100kJ (500 kcal) of energy. Apples contain both soluble and insoluble fibre, the majority of fibre that apples contain is a soluble fibre called pectin, which is a form of fibre that has cholesterol reduction properties (Smock and Neubert 1950).The amount of sugars and acids in fresh apples can vary. Maturity, production regions and varieties of apples, as well as the weather conditions throughout the year create differences in apple composition. There are numerous flavour compounds in apples, they are complex and volatile. Many of these flavour compounds are lost in making a clarified, preserved juice from freshly squeezed apples. Excluding the peel and core of apples from the diet halves the amount of vitamin C and dietary fiber consumed but makes very little difference to the sugar intake. Addressing the health effects of the fruit. Research suggests that apples may reduce the risk of colon cancer, prostate cancer and lung cancer. Compared to many other fruits and vegetables, apples contain relatively low amounts of vitamin C, but are a rich source of other antioxidant compounds.

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Pre-treatment as Sulphur dioxide, which possesses bactericidal properties and inhibits enzymatic and non-enzymatic darkening has been found to be applicable to air dehydration of fruits for control of browning of cut fruits during drying. Blanching of the vegetable tissue as a pre drying treatment is usually carried out to prevent off flavours and colour changes resulting from enzymatic reactions. It is also applied to decrease the initial microorganism load. 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 (U. Mehta, S. Bajaj (1984), Sharma *et al*, (1998). Caronda, ber and Aonla candies have also been developed (Kaikadi *et al*, 2006) . Candied products available these days are descended from the simplest confections first made more than 4,000 years ago. Candy making is fairly simple process. In traditional candy production, a mixture of sugar, water, and possibly corn syrup are mixed together and boiled until sufficient water has been boiled out of the candy mass.(Ribeiro and Sabaa-Srur (1999) & Chandu and Prasad (2006).Current candy preparation techniques are grouped as semi-solid or soft candy (e.g., chocolate-based, fruit-based, including tamarind, cherry etc.) with or without chili or other visible particulate ingredients (i.e., Chaca-Chaca, Pelon-Pelon Rico), hard candy with or without visible particulate ingredient (chilli) either in the candy or on the surface of the candy, hard candy with supplemental but separate salt and chilli and powdered sugar or flavoured salt products with or without other particulate ingredients. With this view, the study was undertaken to develop consumer friendly candies from cherries. Candy apples, also known as toffee apples outside of North America, are whole apples covered in a hard sugar candy coating. While the topping varies from place to place, they are almost always served with a stick of sorts in the middle making them easier to eat.

MATERIALS AND METHODS

Fresh and mature apples were purchased from the local market in Chitrakoot on daily basis prior to each set of experiment. It should be ensured that the fruit should be free from any kind of damage and infestation. The fruits had good indication of physiological maturity.

Pre-treatment of apples

Pretreatments were applied to the apples before drying, and untreated sample was used as a control. The pretreated samples were pre-treated with chemical treatments. Each sample was weighed before and after pre-treatment. The candy samples were made from apples after pretreatments. Different pretreatments used for apples during candy preparation are follows:

- T_1- Steeping of the fruits pieces in 2% salt solution(24 hours) and blanching with water (3 minutes).
- T_2-Steeping of the fruits pieces in 2% salt solution (24 hours) and blanching with lime orange (3 minutes).
- T_3- Steeping of the fruits pieces in 2% salt solution (24 hours) and blanching with erythrosine colour(3 minutes).
- T_4- Steeping of the fruits pieces in 2% salt solution (24 hours) and blanching with fast green colour(3 minutes).
- T_5 – steeping of the fruits pieces in 2% lime solution (4 hours) and blanching with water(3 minutes).
- T_6- steeping of the fruits pieces in 2% lime solution (4 hours) and blanching with lime orange (3 minutes).
- T_7- steeping of the fruits pieces in 2% lime solution (4 hours) and blanching with erythrosine colour (3 minutes).
- T_8- steeping of the fruits pieces in 2% lime solution (4 hours) and b
- lanching with fast green colour (3 minutes).

Procedure followed for candy preparation

The various steps used for the preparation of candy were follows.

Step 1: For apple candy preparation, mature fruits were peeled and removal of eyes and washed and cut into pieces and then pricked after pricking, the pieces were dipped in 2% of lime water and in 2% salt solution.

Step 2: The candy was prepared by slow process of cooking in sugar syrup using 1- 1/2 times the weight of sugar for fruit. Initially half quantity of sugar i.e.750 g was evenly spread on the fruits and kept for 24 hours.

Step 3: The next day, the water was drawn out from the fruits to form syrup and the syrup consistency became thinner. The fruits were then removed from the syrup and 375 g of sugar was again added to the syrup and it was again heated to dissolved the sugar. The sugar was filtered again.

Step 4: On the third day the fruits were again removed from the syrup and the remaining 375g of sugar was added and heated till it was completely dissolved. The syrup was again filtered by means of a white muslin cloth. The prepared syrup was with 65-70^0 Brix. Fruits were again dipped in the syrup for another 24 hours.

Step 5: On the fourth day the fruits were again removed from the syrup and was boiled for about 3 minutes to raise its Brix by 10. Fruits were again dipped in the syrup for another 24 hours.

Step 6: On the fifth day the concentration of syrup was brought between 70-75^0 Brix.

Step 7: On the sixth day the fruits were kept on a stainless steel sieve to drain out syrup and then fruits are coated with sugar and pectin. The fruits were then dried in the air at room temperature.

Storage period

The apple candy was stored for 2 months various physio-chemical properties and shelf life were tested at 0, 20, 40 and 60 days after storage.

Mature fruits (Apples)
↓
Peeled
↓
Cut into pieces and removal of eyes
↓
Pricking
↓
Steep(in 2% lime solution for 4 hour)
↓
Washing thoroughly

↓
Blanching(with water 3-4 minutes)
↓
Steeping (in syrup solution concentrating with boiling each 40,50and 60%T.S.S)
↓
Draining
↓
Shade drying
↓
Storage

Fig 1 Process flow sheet for the preparation of apple candy

Physio-chemical analysis

The prepared candy samples were analyzed for Total soluble solids (TSS), Titratable acidity by method given by Ranganna (1986), Ascorbic acid and Reducing sugars by AOAC (2005) methods.

Statistical analysis

The experiments were conducted with 3 replicates ± standard deviation (SD). The data recorded during the course of investigation were statistically analyzed using analysis of variance (ANOVA) and quantified in terms of the correlation factor, r^2. Two-way ANOVA was used to determine whether the differences between measurements are significant. This technique was developed by Dr. R. A. Fisher in 1923 gives an appropriate method capable of analyzing the variation of population variance. The significant affect of treatment was judged with the help of 'F' (variance ratio). Calculated F value was compared with the table value of F at 5% level of significance. If calculated value exceeded the table value the affect was considered to the significant.

RESULTS AND DISCUSSION

The important physio-chemical characteristics i.e.,Total soluble solids (TSS), Titratable acidity, Ascorbic acid and Reducing sugars were recorded in the fresh as well as stored apple candy (Table 1 to 4). As for as the quality of apple candy is concerned, the highest amongst of TSS (78.52 ^{0} brix) after 60 days storage , lowest acidity (0.073%), highest amount of ascorbic acid content (5.56 mg/ 100g) and highest reducing sugar (42.93%) were recorded in apple candy prepared from steeping of the fruit pieces in 2% lime solution and blanching with erythrosine colour T_7. These results indicate that pre treatment of apple fruits prior to the preparation of candy with steeping of the fruit pieces in 2% lime solution and blanching with erythrosine colour is the best treatments for the preparation of good quality of apple candy during 60 days of storage.

Total Soluble Solids

Mean values of total soluble solids of candies prepared through various pre-treatment and stored for 60 days are presented in table 1 results are also depicted through bar diagram in fig 2. On storage maximum TSS, (78.52 ^{0} brix) was found in 60 days followed by 40 days 78.45^0 brix. The storage could induce a significant increase in TSS content of all the candies irrespective of their pre-treatment. The same findings were observed in aonla candy and karonda candy (Kumar and Singh, 2001; Manivasagan *et al.,* 2006). The total soluble solids (TSS) content was found to be 10.8 ^{0} brix in fresh fruit. However, the average TSS content of the processed candies during storage were varied from 75.00 ^{0} brix to 78.35 ^{0} brix. With the above data it is clear that the processing employed for preparation of candy has forced out the water content to give place to the soluble solids in terms of sugar, salt, lime and other soluble ingredients present in the various pre-treatment. The increased in TSS content of aonla preserve and candy has been observed by Pathak (1988) and Bhagwan (1992) during storage. In all the 8 treatments of the present investigation, TSS content of the apple candies followed a consistently increasing trend as the storage period increased (Table 1 and figure 2). Similar results were also producing by Baramanray *et al.,* (1995) respectively for guava nectar and in raw aonla fruit. These findings were in consonance with the findings in dehydration studies of muskmelon, guava and mango pulp Tomar *et al*.,(1985) and pine apple Hemakar *et al.,* (2000). Increase in total sugars may be attributed to the breakdown of complex polysaccharides into simple sugars during storage. The effect of different acidity levels on total sugars was due to faster rate of hydrolysis at higher acidity level.

Table 1. Change in the total soluble solids (TSS) in ^{0} Brix of candies as affected by various treatments

Treatments	0 day	20 day	40 day	60 day
T_1	75.00	75.60	77.13	75.76
T_2	75.00	75.20	77.09	78.31
T_3	75.00	75.35	77.07	77.59
T_4	75.00	75.01	77.13	78.23
T_5	75.00	75.47	77.36	78.32
T_6	75.00	75.59	77.42	78.41
T_7	75.00	75.81	77.56	78.52
T_8	74.67	75.56	77.34	78.45
F- test	NS	NS	S	S
S. Ed. (±)	1.431	0.304	0.143	0.050
C.D.(P=0.05)	2.953	0.627	0.295	0.103

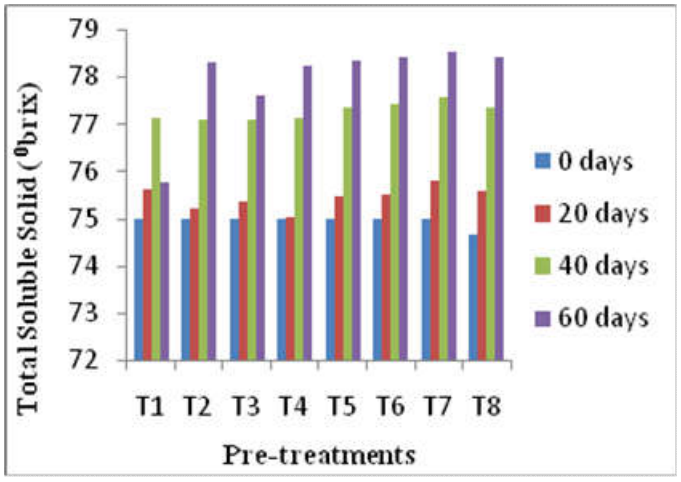

Fig. 2. Change in the total soluble solids (TSS) in ^{0} Brix of candies as affected by various treatments.

Titrable Acidity

Mean values of titrable acidity of different candies stored for 2 months are given in Table 2. Bar diagram is also given in fig 2, for more fruitful discussions of the results for comparing the titrable acidity of different candies. It was found that there was general loss in acidity because of processing of fruit through various pre-treatments and preparation of candies. The observations were similar to the results reported earlier (Rani

and Bhatia, 1985) in which a decrease in acidity with storage period of pear candy was noticed. This table also indicate that the titrable acidity of different candies on 1st day varied from 0.079 to 0.132. Statistical analysis also indicated a significant variation in the titrable acidity of the candies from various treatments. The minimum acidity of 0.073 % decreased recorded to after 60 days of storage T_7. Such loss of acidity content was also noted in aonla preserve Damame *et al*. 2002, Sharma 2000). These findings are in agreement with the present result. The acidity of fresh apple fruit was found to be 0.2%. It was evident from the table 2 that the all treatment showed the decreasing trend in the acidity during storage period. This type of trend in the acid content of the candies prepared by all 8 treatments of the candies could be mainly due to formation of sulphurous acid during storage. Similar findings have been reported by Gupta and Dhawan (1996) in guava jelly also reported change in acidity.

Table 2. Change in the titrable acidity (%) of candies as affected by various treatments

Treatments	0 day	20 day	40 day	60 day
T_1	0.110	0.091	0.088	0.085
T_2	0.126	0.095	0.088	0.086
T_3	0.129	0.096	0.087	0.088
T_4	0.132	0.096	0.088	0.087
T_5	0.079	0.085	0.081	0.078
T_6	0.089	0.084	0.077	0.075
T_7	0.097	0.082	0.078	0.073
T_8	0.098	0.085	0.077	0.076
F- test	S	NS	S	NS
S. Ed. (±)	0.035	0.014	0.003	0.014
C.D.(P =0.05)	0.071	0.030	0.006	0.030

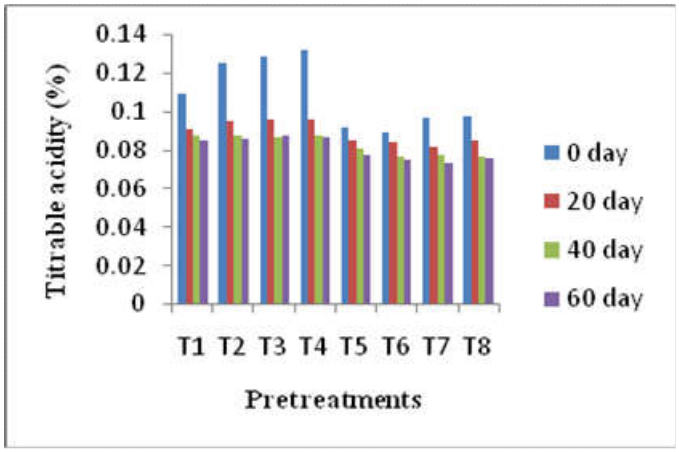

Fig. 3. Change in the titrable acidity (%) of candies as affected by various treatments.

Ascorbic Acid Content

A decreasing trend of ascorbic acid (Table 3) content in all the treatments and storage period was observed. Similar findings were also made in aonla products (Kumar and Singh, 2001). The loss of ascorbic could be consequence of oxidation of ascorbic acid in the formation of dehydro ascorbic acid in syrup. Table 3 comprised the mean value of ascorbic acid content of various candies prepared through different pre-treatment and stored for 2 months. The results are further depicted through bar diagram for more lucid comparison of results. The final products obtained after 60 days of storage were to contain ascorbic acid ranging from 4.07 mg/ 100g to 4.57 mg/ 100g.

The ascorbic acid content in the original fruits as found to be 5.83 mg/ 100g. Such loss of ascorbic acid content was also noted in aonla preserve (Damame *et al*., 2002, Sharma 2000). These findings are in agreement with the present result. This reduction in ascorbic acid content might be due to oxidation. Present findings were similar to those in guava jelly Chauhan (1981).

Table 3. Change in ascorbic acid content (mg/ 100) of candies as affected by various treatments

Treatments	0 day	20 day	40 day	60 day
T_1	5.34	4.79	4.44	4.28
T_2	5.34	4.74	4.35	4.10
T_3	5.39	4.74	4.35	4.07
T_4	5.42	4.77	4.49	4.31
T_5	5.52	4.89	4.55	4.35
T_6	5.55	4.88	4.59	4.38
T_7	5.56	4.94	4.70	4.41
T_8	5.52	4.88	4.68	4.57
F- test	S	NS	S	S
S. Ed. (±)	0.144	0.158	0.016	0.035
C.D.(P=0.05)	0.297	0.327	0.032	0.071

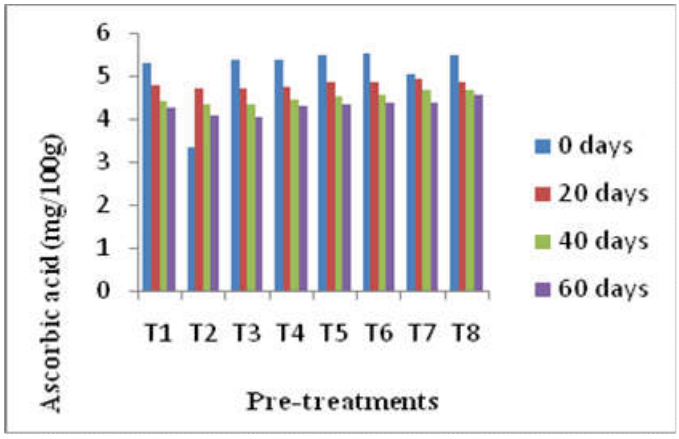

Fig. 4. Change in ascorbic acid content (mg/ 100g) of candies as affected by various treatments.

Reducing sugar

The gradual increase in reducing sugar was noticed during storage period of 60 days. Table 4 comprised the mean value of reducing sugar content of various candies prepared through different treatment and stored for 2 months. The results were in conformity with the findings reported earlier in which they noticed a marked increase in reducing sugar content of aonla preserves (Damame *et al.,* 2002; Sharma, 2000). The reducing sugar continued varied from 42.93% to 40.99% in the fresh candies. There were a significant variation in reducing sugar content of the candies prepared through various pretreatments. The candy obtained from treatment were found to retain significantly maximum reducing sugar (55.41%), followed by T_6 (53.48 %). It is evident from the table 4 that there is gradual and significant increase in reducing sugar content throughout storage period. The increase in reducing sugar might be due to break down of polysaccharides into oligosaccharides and monosaccharide's. Similar observations were also noted Mehta and Rathore (1976), Sharma (2000). The ratio of reducing to non reducing sugars is considerably promoted by acids, and consequently the reducing sugar contents are higher. The opposite effect occurs with non reducing sugars, whose concentration increase as sucrose hydrolysis slows down.

Table 4. Change in reducing sugar of candies as affected by various treatments

Treatments	0 day	20 day	40 day	60 day
T_1	41.55	44.80	48.40	52.36
T_2	40.99	44.77	48.21	51.08
T_3	41.10	45.33	49.09	52.41
T_4	41.36	45.29	49.00	52.19
T_5	42.06	45.68	49.46	52.06
T_6	42.54	45.80	49.99	53.48
T_7	42.93	46.47	50.79	55.41
T_8	42.04	45.69	49.77	52.79
F- test	S	S	S	S
S. Ed. (±)	0.144	0.165	0.146	0.076
C.D.(P=0.05)	0.297	0.340	0.301	0.156

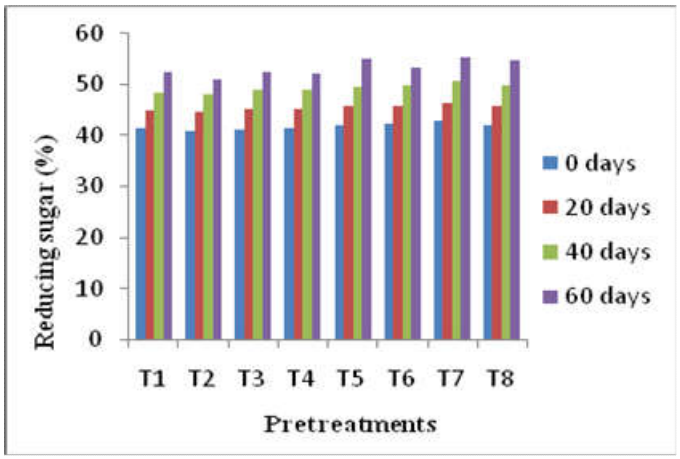

Fig. 5. Change in reducing sugar of candies as affected by various treatments

Conclusion

On the basis of investigation it was concluded that better quality candy can be obtain by steeping of the fruit pieces in 2% lime solution and blanching with erythrosine colour followed by syruping so as to maintained 78^0 brix TSS, 55.41% reducing sugar and 0.073 mg/100g of ascorbic acid was obtained after 60 days storage. Apple candy can be stored for 60days with good retention of physio chemical quality and market value. This experiment may be repeated to substaintiate findings.

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