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PROCESSING OF STRAWBERRY INTO SQUASH AND NUTRITIVE VALUE OF SQUASH DURING STORAGE

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Abstract

The present study was conducted to develop squash and to standardize formulation of recipe produced from strawberry and to determine nutritive value of squash during storage. Fresh ripe strawberries were washed with pure water and blended to collect pulp. The fruits were analyzed to determine the moisture, TSS, total sugar content, titratable acidity, pH, ascorbic acid and β carotene. Three different combinations ($\mathbf{T_1}$= 15% pulp, $\mathbf{T_2}$= 20% pulp $\mathbf{T_3}$= **25**% pulp) were used to process squash. Prepared squash was orgnoleptically evaluated and stored for 60 days and analyzed the nutritive values for every 20 days. According to the opinion of the organoleptic test panel, treatment with 25% pulp of squash was the most preferred one after considering the points of colour, flavour, texture, taste and overall acceptability. During storage TSS, total sugar, titratable acidity increased and moisture content, pH, β-carotene and ascorbic acid content decreased.

Keywords: Strawberry, squash, storage, nutritive value.

Introduction

Strawberries (*Fragaria x ananassa* Duch.) are highly perishable, with short storage life due to their soft texture, high softening rate and highly susceptible to fungal attack and mechanical injury (Shin *et al*., 2008) and cannot be stored for long time on account of its inherent compositional and textural characteristics. The effective way of extending its shelf life, availability in off-season and reduction of post harvest losses is by processing. Processing of fruits reduces post-harvest loss and prevents nutrients from these fruits. Generally, temperature, duration of boiling, pasteurization, sugar and acid content, cultivar and degree of fruits ripeness as well as storage conditions of products are the most important factors determining the nutrition and quality of products (Kim and Zakour, 2004; Garcia-Viguera *et al.,* 1998, 1999). It is necessary to ensure quality, because it is of utmost importance to understand the scientific basis for producing a superior product which must meet the fundamental characteristics like, pH, TSS, sugars and nutritional quality to ensure the standard and excellence of the product (Shahnawaz and Shiekh, 2011). Strawberry is a commercial fruit have great potential for processing and widely used for preparation of purees, squash, juice, jams, preserves, candy, and alcoholic beverages (Sharma *et al*., 2009).

Fruit squash is a beverage which essentially consists of moderate quantity of fruit pulp/ juice (min. 25%) to which cane sugar is added for sweetening to raise TSS above 40^o Brix and is consumed after dilution . It is considering the most important process products that help to reduce post harvest losses and protect men from hot and thrust.

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The increasing social and economic importance of food products, besides the technological complexity of producing, processing, handling and accepting, these highly perishable food materials like strawberries, requires a more extensive knowledge of their physical properties because, the health benefited properties play an important role in quality attributes of processed foods (Rao and Steffe, 1992). But, the processed products are not shelf-stable and standard in quality. For availability of diversified palatable and shelf-stable products from strawberry, the experiment was carried out to develop new processed products from strawberry. The present investigation was therefore undertaken with the following objectives:

i. to explore the potentiality of processing of strawberries into squash
ii. to study the nutritive value of processed product during storage under room temperature

Materials and methods

The experiment was conducted at the laboratory of Postharvest Technology Section, HRC, BARI, during February to April. 2014.

Materials

Ripe strawberries grown in the experimental field of Horticulture Research Center, BARI, Gazipur, Bangladesh were used for squash preparation. Sugar, citric acid, Potassium metabisulphite (KMS), glass bottles, saucepan, stirrer, spoon, blender, balance etc. were used to perform smoothly the experiment.

Preparation of strawberry squash

Ripe, healthy and fresh strawberries were collected. The fruits were washed thoroughly with clean water. The sepals were removed and berries were separated. Fruits were crushed with a blender (Joypan, Osaka, Japan) for collecting pulp. The pulp thus collected was used for squash preparation and analysis for the moisture, TSS, total sugar, titratable acidity, pH, ascorbic acid and β carotene contents. The chemical composition of the extracted pulp was presented in Table 1.

Table 1. Chemical composition of strawberry pulp

Sl. No.	Parameters	Quentity
1.	Moisture (%)	91.5
2.	TSS (%)	8.50
3.	Total sugar (%)	3.37
4.	Acidity (%)	1.02
5.	pH	3.44
6.	Ascorbic acid (mg/100 g)	61.65
7.	β carotene (μg/100 g)	2.19

Preparation of strawberry squash

Table 2. Formulation and ingredients of strawberry squash

Sl. No.	Ingredients	Treatment (percent of strawberry pulp)		
		T_1 (15 % pulp)	T_2 (20 % pulp)	T_3 (25 % pulp)
1.	Strawberry pulp (g)	150	200	250
2.	Sugar (g)	428.5	425	421.5
3.	Citric acid (g)	8.5	8	7.5
4.	Water (ml)	412	366	320
5.	Potassium metabisulphite (g)	0.5	0.5	0.5

Harvesting of 80 -90 % ripe fruits

⇩

Washing, sepals removing and preparation of fruit

⇩

Pulping (blending) and weighed

⇩

Mild heating with stirring

⇩

Preparation of syrup by mixing sugar, water and acid

⇩

Heating the syrup just to dissolve and stirring

⇩

Mixing the pulp and syrup

⇩

Addition of preservative (Potassium metabisulphite)

⇩

Judging the end point (TSS-45 %)

⇩

Determining the end point of cooking

⇩

Bottling (filled the hot squash into clean, dry and pre sterilized glass bottles)

⇩

Cooling and capping

⇩

Stored in clean and dry place

Fig. 1 Flow diagram for preparation of strawberry squash

Processing

All the ingredients were weighed separately. Pulp of strawberry was mixed with water and cooked with mild heat for a few minutes. For making syrup the sugar and acid were mixed with water then cooked and stirring just to dissolve. Sugar syrup was mixed with the fruit pulp. The mixture was cooked slowly with occasional stirring till the mixture reached the desired concentration. Potassium metabisulphite (Preservative) @ 500 ppm was added when the mixture became sufficiently concentrated.

Boiling was continued till the TSS of the final product reached 45^0 Brix. After completion of preparation, squash was kept in a cool place (4-6 hours) for cooling and precipitation. Filled the supernatant of squash into the clean pre sterilized dry bottles and closed the cap tightly and stored in a cool and dry place.

Experimental design

The experiment was carried out in a Completely Randomized Design (CRD) with four replications.

Storage studies

The prepared squash was stored for 60 days. The chemical composition and nutritive value of strawberry squash were determined for 20 days interval, during the storage period at room temperature and calculated the changes over storage time.

Collection of data

Data were collected from the stored strawberry squash of each replicated container at every interval. Measurements of (i) moisture content, (ii) total soluble solids (TSS), (iii) total sugar, (iv) titratable acidity, (v) pH, (vi) ascorbic acid and (vii) β-carotene were recorded.

Statistical analysis

The data were subjected to analysis of variance (ANOVA) using the Crop State Statistical

Software version 7.2. The results showing significant differences were then subjected to mean separation using Tukey's Studentized Range (HSD) Taste at $P<0.05$.

Results and discussion

The results obtained from the squash produced from different concentration of strawberry pulp and their storage study at ambient temperature up to 60 days of storage were discussed character wise as follows.

Sensory evaluation

The sensory profile of strawberry squash was made using the marks given for each attribute by the panel were presented at Table 3. The mean score showed that T_3 (25% pulp) was the most preferred considering all the points as colour, flavour, texture, taste and overall acceptability. However, it was revealed that T_2 and T_3 were statistically similar considering all the sensory attributes except flavour. While T_1 scored the lowest for all the attributes for the sensory evaluation based on 9 point hedonic scale.

The score (7.7-7.97) for colour indicates that colour of the treatments were like very much. The flavour scored the highest for T_3 (7.6), indicates like very much, while T_1 scored the lowest (6.67) means like moderately. Strawberry squash was organoleptically evaluated by Rahman (2012) by a panel of judges on the basis of nine point hedonic scale and found squash of 20% pulp performed better.

Change in moisture content

The moisture content of strawberry squash just after processing ranged from 48.50 to 52.50% (T_1 and T_3, respectively) and during storage the moisture contents slightly decreased (Table 4), might be due to moisture losses by evaporation. After end of the storage, moisture content was higher in T_1 (51.17%), while lowest in T_3 (47.20%). Moisture content in strawberry squash at initial stage varied from 84.22 to 90.43%, observed by Rahman (2012), which was higher than present findings.

Table 3. Sensory evaluation of strawberry squash

Treatment (+ Pulp Concentration)	Colour	Flavour	Texture	Taste	Overall acceptability
T_1 (15% pulp)	7.7 b	6.67 a	6.53 b	8.23 b	8.30 b
T_2 (20% pulp)	7.83 ab	7.47 b	7.53 a	8.66 a	8.77 a
T_3 (25% pulp)	7.97 a	7.6 a	7.57 a	8.73 a	8.90 a
Level of significance	*	**	**	**	**
CV (%)	1.17	0.46	1.35	0.78	1.22

Figures having the same letter(s) in a column are not differ significantly by DMRT

1= Dislike extremely	4= Dislike slightly	7= Like moderately
2= Dislike very much	5= Neither like or dislike	8= Like very much
3= Dislike moderately	6= Like slightly	9= Like extremely

Table 4. Change in moisture content of strawberry squash during storage

Treatment	Concentration	Moisture content (%)			
		Initial	Day-20	Day-40	Day-60
T_1	15% pulp	52.50 a	52.33 a	51.83 a	51.17 a
T_2	20% pulp	49.40 b	49.23 b	48.83 b	48.33 b
T_3	25% pulp	48.50 b	48.33 b	48.00 b	47.20 c
Level of significance		**	**	**	**
CV (%)		0.91	0.68	0.67	0.39

Figures having the same letter(s) in a column are not differ significantly by DMRT

Total soluble solids (TSS)

The total soluble solid (TSS) of strawberry squash during initial stage was ranged from 42.00 - 43.00%, which was in standard range for ideal squash. During storage, the TSS slightly increased (Table 5). The initial TSS content in strawberry squash was found maximum in T_3 (43.00 %) which became 43.57% at the end of storage, while minimum TSS was recorded from T_1 (42.00%) and at the end of storage it reached 42.17%. An increasing trend of TSS of strawberry squash was found from this study. The increase in soluble solid contents may be due to hydrolysis of sucrose to invert sugars as reported by Bhatti (1975) and Ullah (1990). Rahman *et al*. (2011) found that TSS was slightly increased after 8 weeks of storage, which was inconsonant with present findings. This result was similar with that reported by Jacob (1959), Chowdhury *et al*. (2008) and Rahman (2012) .

Total sugar content

The total sugar content in strawberry squash was about 39.07 to 41.00% just after processing, which affected by storage (Table 6). Total sugar content increased in all the treatments of the strawberry squash throughout the storage period. At initial condition the total sugar content was the highest at T_3 (41.00%), which increased gradually and finally reached 41.40%. Although, minimum total sugar content of fresh squash was found in T_1 (39.07%), increased slowly and attained 39.23% after 60 days of storage. Increasing in total sugar in squash might be due to the hydrolysis of acid and conversion of acid in sugar (Rao and Roy, 1979) and conversion of non-reducing sugars to reducing sugars (Meyer, 1966). The increase in TSS and sugars would be attributed to the conversion of starch and other insoluble carbohydrates into sugars (Vidhya and Narain, 2011). The increase of sugar was also observed by Pota

Table 5. Change in TSS content of strawberry squash during storage

Treatment	**Concentration**	**TSS content (%)**			
		Initial	**Day-20**	**Day-40**	**Day-60**
T_1	15% pulp	42.00 a	42.00 a	41.90 b	42.17 b
T_2	20% pulp	42.00 a	42.00 a	43.23 a	43.87 a
T_3	25% pulp	43.00 a	43.00 a	43.37 a	43.57 a
Level of significance		*	*	*	*
CV (%)		1.66	1.50	0.97	0.88

Figures having the same letter(s) in a column are not differ significantly by DMRT

Table 6. Change in total sugar content of strawberry squash during storage

Treatment	Concentration	Total sugar content (%)			
		Initial	Day-20	Day-40	Day-60
T_1	15% pulp	39.07 b	39.13 b	39.20 b	39.23 b
T_2	20% pulp	40.50 a	40.57 b	40.67 a	40.73 a
T_3	25% pulp	41.00 a	41.20 a	41.30 a	41.40 a
LSD		0.476	0.266	0.266	0.291
Level of significance		**	**	**	**
CV (%)		0.74	0.78	0.80	0.77

Figures having the same letter(s) in a column are not differ significantly by DMRT

et al. (1987) where the increase would be attributed to the conversion of starch and other insoluble carbohydrates into sugars. The total sugars increased as the storage time increased which was observed by Islam *et al*. (2013) and Rahman (2012) during storage.

Titratable acidity

Titratable acidity is important and had a remarkable effect on flavour (Table 7). If the acid level is too low, the product may be bland and unappealing (Kramer and Twigg, 1996). Titratable acidity (TA) of strawberry squash stored at ambient temperature increased slowly and differs significantly among the treatment. At initial stage, titratable acidity was found maximum in T_3 (1.18%) While minimum titratable acid was found in T_1 (1.15%). The titratable acidity of all treatments increased significantly and at the end of storage maximum titratable acidity was recorded from T_3 (1.37%), while minimum from T_1 (1.31%). Murtaza *et al.* (2004) found an increase in acidity of all samples of strawberry drinks with the increase in storage days, which was substantiate with present findings. During 0 day the titratable acidity was 0.280% and it was 0.346% after 90 days of storage. The result of present study is fully confirmatory with Murtaza *et al*. (2004), they found that acidity of strawberry drinks gradually increase during storage under room temperature. The gradual increase in acidity might be due to the formation of acidic compounds by degradation or oxidation of reducing sugars present in the drink by the breakdown of peptic bodies (El-Warraki *et al.,* 1976).

The pH level

The pH level of strawberry squash decreased slowly during storage and varied significantly (Table 8). Just after processing pH of strawberry squash was found the highest at T_2 and T_3 (3.16), at the end of storage pH level of

Table 7. Change in titratable acidity of strawberry squash during storage

Treatment	Concentration	Titratable acidity (%)			
		Initial	Day-20	Day-40	Day-60
T_1	15% pulp	1.15 c	1.22 c	1.24 c	1.31 a
T_2	20% pulp	1.17 b	1.25 b	1.28 b	1.35 a
T_3	25% pulp	1.18 a	1.26 a	1.31 a	1.37 a
Level of significance		*	**	**	*
CV (%)		0.57	0.27	0.26	1.80

Figures having the same letter(s) in a column are not differ significantly by DMRT

Table 8. Change in pH level of strawberry squash during storage

Treatment	Concentration	pH level			
		Initial	Day-20	Day-40	Day-60
T_1	15% pulp	3.07 b	3.05 c	3.04 b	3.01 b
T_2	20% pulp	3.16 a	3.15 b	3.14 a	3.13 a
T_3	25% pulp	3.16 a	3.16 a	3.15 a	3.13 a
Level of significance		**	**	**	**
CV (%)		0.11	0.18	0.17	0.11

Figures having the same letter(s) in a column are not differ significantly by DMRT

this treatments were found 3.13. While lower pH was found in T_1 (3.07), which was attained at 3.01 at the end of storage. The decreasing trend of pH might be due to increasing trend of acidity during storage of squash. Murtaza (2004) revealed the pH of the strawberry drink differed significantly with regard to the storage and the mean pH ranged from 3.40 on 0 day which decreased to 2.56 after 90 days storage, which is partially in contrast with present results.

β-carotene

β-carotene content of strawberry squash decreased gradually during storage and varied significantly (Table 9). Just after processing *β*-carotene of strawberry squash was found higher at T_3 (3.4 μg/100 ml), and at the end of storage period 2.43μg *β*-carotene was found in 100 ml squash of same treatment. While lower *β*-carotene was found in T_1 (3.0 μg/100 ml), which was accomplished at 2.27 μg/100 ml at the end of storage. The reduction could be due to both oxidative and non oxidative changes as described by Eskin (1979) and Land (1962). Such changes altered the colour of the product and lowered the flavour and nutritive value (Rahman *et al*., 2011).

Ascorbic acid content

Ascorbic acid content of the squash was found very low (8.10 – 10.00 mg/100 ml) just after production in contrast of 61.65 mg/100g of ascorbic acid in fresh strawberry pulp (Table 10). Due to the most of the ascorbic acid present in the pulp was destroyed during heating (Ihekoronye and Ngoddy, 1985). Fresh strawberry squash of T_3 treatment contained maximum ascorbic acid (10 mg/100 ml) on the other hand T_1 contained minimum ascorbic acid (8.10 mg/100 ml). After 60 days of storage ascorbic acid content of all treatments were found to be decreased and varied significantly. At the end of storage highest ascorbic acid was fount in T_3 (8.67mg/100 ml), and lowest was found from T_1 (7.10

Table 9. Change in *β*-carotene content of strawberry squash during storage

Treatment	Concentration	β-carotene content (μg/100 ml)			
		Initial	Day-20	Day-40	Day-60
T_1	15% pulp	3.0 b	2.80 b	2.53 b	2.27 a
T_2	20% pulp	3.2 ab	2.97 ab	2.67 ab	2.17 a
T_3	25% pulp	3.4 a	3.17 a	2.90 a	2.43 a
Level of significant		**	*	*	*
CV (%)		1.80	3.54	4.28	6.59

Figures having the same letter(s) in a column are not differ significantly by DMRT

Table 10. Change in ascorbic acid content of strawberry squash during storage

Treatment	Concentration	Ascorbic acid (mg/100 ml)			
		Initial	Day-20	Day-40	Day-60
T_1	15% pulp	8.10 b	7.9 c	7.60 b	7.10 c
T_2	20% pulp	9.10 a	8.9 b	8.60 a	8.10 b
T_3	25% pulp	10.00 a	9.67 a	9.33 a	8.67 a
	Level of significance	**	**	**	**
	CV (%)	2.92	2.10	2.33	2.71

mg/100 ml). Murtaza *et al.* (2004) studied storability of strawberry drinks and found that storage period had highly significant effect on ascorbic acid contents and revealed a clear decreasing tendency of ascorbic acid content of strawberry drinks during storage, which was in consonant with present findings. The decrease in ascorbic acid was due to prolong storage at high temperature (Otta) 1984. A substantial reduction was revealed in ascorbic acid content of the sample during storage could be due to both oxidative and non oxidative changes as described by Eskin (1979) and Land (1962).

Conclusion

Considering the overall acceptance of sensory evaluation, nutritive value and chemical changes during processing and storage of squash prepared from strawberry was found to be a unique product. Among the squash component the treatment combination T_3 that is 25% strawberry pulp into the recipe could be selected for commercial processing. Up to 60 days of storage nutritional quality of strawberry squash was found to be satisfactory.

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