

Freezing adaptability and chemical composition of Strawberry (*Fragaria X ananassa* Duch.) in Bangladesh

A. N. Chowdhury, A. Nargis, M. Z. Rahman*, A.K.M.S. Alam, M. Ibrahim and
S. Akhter

Bangladesh Council of Scientific and Industrial Research Laboratories, Rajshahi - 6206, Bangladesh.

Abstract: The physiological weight loss of Strawberry (*Fragaria x ananassa*) in different media showed that in ambient temperature, 40% sugar solution (A T) media, has the highest shelf life and it is 8 days. The pulp prepared from RABI-3 and American Festival variety can be preserved for 120 days. The composition of quality parameters were reduced very little (after 120 days) i.e. reduced amount is very low. In RABI-3, Moisture content were 37.63%, TS 62.37%, pH 3.21, TSS 61.8% total sugar 54.2%, reducing sugar 18.01%, non reducing sugar 36.19%, acidity 0.218%, sugar acid ratio 248.42 and vitamin C 27.35% respectively on 120 days. In American Festival variety the moisture were 39.39%, TS 60.59%, pH 3.00, TSS 59.1%, total sugar 46.3%, reducing sugar 15.6%, non reducing sugar 30.70%, acidity 0.228%, sugar acid ratio 203.10 and vitamin C 27.06 on the effect of 120 days storage period.

Key words: American Festival variety, *Fragaria x ananassa*, Preservation, RABI-3, Shelf life.

I. Introduction

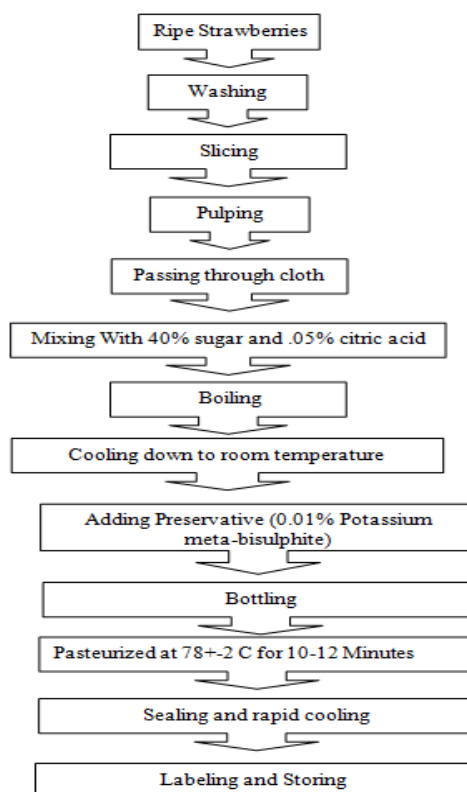
Strawberry *Fragaria x ananassa* is one of the popular fruit of the world and very recently it has gained adaptability as well as popularity in Bangladesh. It is a highly priced fruit in all over the world Though Strawberry has introduced newly in Bangladesh but now it has evolved as a money spinning cash crop. In Bangladesh, micropropagation of strawberry played a vital role in strawberry cultivation.

Strawberries (*F. ananassa*) are an excellent source of vitamin C (average 40-90/100 mg), fiber, foliate, vitamin K and potassium [1]. Depending on age group, the daily requirement for vitamin C is about 60-90 mg [2] [3], thus with a supply of 100 g of strawberries daily needs of vitamin C will be covered [1] [4]. Strawberries also contain substantial amounts of ellagitannins and anthocyanins, which may help treat the hyperglycemia and high blood pressure associated with type 2 diabetes; these substances have antioxidant properties that lowered cholesterol and risk of metabolic syndrome in women [5]. Strawberries contain fisting, an antioxidant that has been studied in relation of Alzheimer's disease and to kidney failure resulting from diabetes [6].

According to its nutritional and medicinal value, development of preservation technology of strawberry products, which is suitable for Bangladeshi agro-climatic condition, is an urgent need. Technical knowledge is very few for Strawberry processing [7]. For this, a research work was done for the processing and preservation of strawberry products.

II. Materials And Methods

Two strawberry varieties namely, RABI-3 and American Festival were used in the experiment. RABI-3 variety was developed and released by Plant Breeding and Genetic Engineering Laboratory, Department of Botany, University of Rajshahi, Bangladesh. It is very popular and commercially cultivated in Bangladesh. Fresh and ripe strawberries were harvested from the experimental field of BCSIR Laboratories, Rajshahi during October to December, 2011. The physical appearance and organoleptic tests for two varieties were conducted by a test panel consisting 5 scientists to determine the quality and acceptability of the strawberries. Flow chart of strawberry pulp preparation method is follows



Flow chart-1. Procedure of making strawberry pulp [8].

The pH was determined by a pH meter and moisture was analyzed by the conventional procedure. Total Titrable Acidity (TTA) after Rangana [9], Total Soluble Solids (TSS) by AOAC method [10] and Vitamin-C content by Bessey and King were followed [11]. Total Sugar Content determined by anthrone method as in Jayaraman [12], reducing sugar using Dinitrosalicylic acid method described by Miller [13] and dry matter followed by Karmas [14].

III. Results and Discussion

The post harvest shelf life of strawberry fruit in different media was studied and results were presented in Tabel-1. It was observed that dipping in 40% sugar solution had the shelf life of 5 days in ambient temperature and above 5 days at freezing condition which is the highest among these media. On the other hand, other two media showed shelf life of 5 days when stored at freezing condition but less than 5 days at ambient temperature.

The overall quality of these two varieties was evaluated by the test panel (Table-2). It was observed that the qualities of RABI-3 variety were better and more preferred than the other variety. However, American festival was not in inferior than RABI-3 at any respect more over its color was more attractive than RABI-3 variety.

Strawberry pulp from two varieties was formulated, processed and stored for 120 days at ambient temperature (22-37°C) to assess their suitability for preservation. The effect of storage on the composition and acceptability was also evaluated at different intervals and the results are presented in Table-3.

Strawberry pulp prepared from both varieties possessed an attractive color. A slight variation in color was observed between the two prepared products. The observed color variation was due to the varietal variation. During storage of the pulp of RABI-3 total soluble solids (TSS) was increased but the rate was found to be very low.

From the first day to 120 days, acidity increased slowly from 0.215 to 0.218 in RABI 3 and 0.225 to 0.228 in American Festival varieties. However, up to 3rd day acidity remained constant (0.215 and 0.225 respectively in RABI 3 and American festival). Then it was increased slowly and remained constant (0.216 and 0.226) up to 20 days. It increased again and rose up to 0.217 and 0.227 and remained constant for 60 days. Finally, from 90th day the acidity started to rise and remained constant (0.218 and 0.228) up to 120 days.

Incase of pulp of RABI-3 variety the rate of decreasing of moisture was lower (from 37.65 to 37.63) that is 0.0531% but in case of American Festival variety this rate was higher than RABI-3 variety (from 39.43 to 39.39) that is 0.1014%. pH of the pulp decreased in both varieties, but in case of RABI-3 decreasing of pH was

lower than (from 3.25 to 3.21;) American Festival (from 3.05 to 3.00; 0.05). In case of RABI-3 the amount of vitamin C was decreased gradually (63.52 at 0 days to 27.35 at 120 days). The decreased amount is 36.17 or 56.94% on the other hand amount of vitamin C in American Festival variety was also decreased (62.12 at 0 day to 27.06 or at 120 days) gradually. The decreased amount is 35.06 or 56.43%. So it can be said that after storage of 120 days the amount of reduced vitamin C in the pulp of both varieties were or less same.

Total sugar was reduced in pulp of both varieties. The RABI-3 variety showed the decrease of total sugar from 54.5 at 0 day to 54.2 at 120 days, so the reduced amount was 0.3. But in case of American Festival total sugar was reduced from 46.8 at 0 day to 46.3 at 120 days. So the reduced amount was 0.5. So it can be said that the reduced amount of total sugar after 120 days storage period is lower at RABI-3 than American Festival. The sugar acid ratio of pulp prepared from RABI-3 variety was reduced from 253.49(at 0 day) to 248.42 (at 120 days) so the reduced amount was 5.07. But the sugar acid ratio of pulp prepared from American Festival variety was also reduced from 208.00 (at 0 day) to 203.10 (at 120 days). So the reduced amount was 4.90 that is lower than that of RABI-3 variety.

Fruits stored at 3°C in air or in 5, 10, 15 and 20% CO₂ remained in good condition for 10 days, and all conditions of CO₂ reduced rotting due to *Botrytis*. The alcohol content of the fruit increased with the length of storage and higher concentration of CO₂ [15]. At 6°C regardless of the treatment, fruit quality could not be preserved for more than 7 days [16]. Hansen and Bohling reported that 20 - 30% CO₂ inhibited respiration and arrested decay for several days but 50% CO₂ resulted in the development of off-flavor [17].

The study of quality parameters of preserved strawberry pulp at different intervals reveals that the pulp prepared from RABI-3 and American Festival variety can be preserved for 120 days. Here the composition of quality parameters were reduced very little (after 120 days) i.e. reduced amount is very low. From the comparative study quality parameters of two preserve strawberry pulps, it is clear that RABI-3 variety is more suitable than the pulp of American Festival variety, though they showed nearly equal results.

After storage of 120 days the amount of Vitamin C reduced in the pulp of both varieties. The results of Ayub *et al* also indicated that storage period and temperature had significant effect on ascorbic acid content of different samples [18]. There was a gradual decrease in vitamin C of strawberry juice. Ascorbic acid is the most difficult vitamin to be preserved during pasteurization. As it is the least stable vitamin in the product during storage. In a similar study Viberg *et al* reported a decrease in ascorbic acid during they recorded that ascorbic acid in strawberry pulp were affected after treatment involving freezing, heating and accelerated storage [19]. These results are in agreement with the findings of Nunes *et al.* [20], who recorded a change in Chandler variety of strawberries stored at 4°C.

In these studies, acidity of both varieties pulps increased. The increase of acidity might be due to hydrolysis of sugar into sucrose and fructose with subsequent fermentation to alcohol and formation of organic acids etc. Microorganisms might be responsible for causing these changes [21]. The findings of Ayub *et al* suggest that storage intervals and treatments had a significant effect on acid content of juice content during storage [18]. These results are in agreement with the findings of Nunes *et al.* [22], who reported an increase in acidity during storage. This increase might be due to the break down of pectin in to pectin acid. The results were confirmed by the findings of Koyuncu and Dilmacunal [23].

According to Table 3(a) and 3 (b) the pH of the pulp was decreased in both materials and gradual increase in TSS and non reducing sugar has decreased during four months storage of pulp.

Ayub *et al* suggests total storage intervals and fragment had a significant effect on acid content of pH content during storage [18]. He found reduced pH values during storage period. Similar results were recorded by Ali who reported that acidity in fruit juices increases and pH decrease during processing and storage [24]. Ayub *et al* also showed that different treatments and storage intervals had a significant affect on TSS of strawberry juice. This result is also similar to our findings [18].

Sugars are the most important constituent of fruit product and are essential factor for the flavor of the food product and also act as a natural food preservative. Results of Ayub *et al* showed that reducing sucrose has increased in their product during three months of storage [18]. These results are in agreement with Ruiz-Nieto *et al* [25] who showed an increase in glucose and fructose contents in strawberry fruits. These results are similar with our findings during storage life of pulps for four months.

Ayub *et al* found that non reducing sucrose decreased in all his samples of strawberry juice in different conditions and during storage life [18]. The storage and treatments had a significant affect on non reducing sucrose of strawberry juice stored at refrigeration temperature. These results are confirmed by Ruiz-Nieto *et al* [25] who suggested that sucrose content of the convert to glucose and fructose during the storage results in the change in sucrose contents of juices. In this work non reducing sugar has also decreased during four months storage life of pulps.

IV. Conclusion

This study on preservation technology of strawberry pulp will help the growers and also local fruit industries which can reduce the post harvest losses and thus it can be available to the customers all the year round, as strawberry product. It is hoped that the findings will help the beverage industries to utilize this fruit for product preparation with increased shelf stability and consumer demand.

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Table -1. The Effect of different sugar concentration on the shelf life of strawberry fruit.

SI N ^o	Sugar solution %	Temperature	Physiological Weight Loss				
			Day-1 %	Day-2 %	Day-3 %	Day-4 %	Day-5 %
1.	25	A T*	100	85	65	55	50
2.		F C*	100	82	62	52	47
3.	30	A T	100	90	70	60	55
4.		FC	100	88	68	58	53
5	35	A T	100	95	75	65	60
6..		FC	100	94	73	62	54
7.	40	AT	100	100	80	75	68
8.		FC	100	100	100	100	100
7.	Control	A T	100	70	40	20	-
9.		F C	100	80	60	40	-

AT = Ambient temperature, FC = Freezing Condition.

Table 2. The organoleptic test score of two strawberry varieties

Features	Varieties	Score					Total score	Mean	Rating
		01	02	03	04	05			
Appearance	RB*	85	80	81	78	77	401	80.20	Excellent
	AF*	72	70	65	71	80	358	71.60	Good
Color	RB	74	70	78	80	75	377	75.40	Good
	AF	80	78	85	81	87	411	82.20	Excellent
Flavour	RB	83	81	80	77	84	405	81.00	Excellent
	AF	68	72	75	59	60	334	66.80	Fair
Taste	RB	81	86	82	80	78	407	81.40	Excellent
	AF	60	67	70	72	68	337	67.40	Fair
Texture	RB	88	80	79	83	86	416	83.20	Excellent
	AF	56	73	68	70	73	304	68.00	Fair

*RB = RABI - 3, * AF = American Festival

Table 3. The effect of storage characteristics at ambient temperature on the composition of strawberry pulp.

	Name of the varieties																		
	RABI - 3					American Festival													
	0	3	6	9	20	30	60	90	120	0	3	6	9	20	30	60	90	120	
Storage Time (Day)																			
Moisture	37.7	38	38	37.6	38	38	38	38	38	39	39	39	39	39	39	39	39	39	39
Total Solid	62.4	62	62	62.4	62	62	62	62	62	61	61	61	61	61	61	61	61	61	61
p ^H	3.25	3.3	3.3	3.23	3.2	3.2	3.2	3.2	3.2	3.1	3.1	3.1	3	3	3	3	3	3	3
TSS	61.5	62	62	61.6	62	62	62	62	62	58	58	58	58	58	59	59	59	59	59
Total Sugar	54.5	55	55	54.4	54	54	54	54	54	47	47	47	47	47	47	47	47	46	46
Reducing Sugar	18.1	18	18	18.1	18	18	18	18	18	15	15	16	16	16	16	16	16	16	16
Non reducing sugar	36.4	36	36	36.3	36	36	36	36	36	31	31	31	31	31	31	31	31	31	31
Acidity	0.22	0.2	0.2	0.22	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Sugar Acid Ratio	253	253	252	251	251	250	250	249	248	208	208	207	206	206	205	205	203	203	203
Vitamin C	63.5	63	63	58.3	54	42	37	29	27	62	62	62	57	53	41	36	28	27	27