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Preserve and Candy Development from Unripe Bel (*Aegle Marmelos)*

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Abstract: The experiment was conducted to develop preserve and candy from fresh unripe bel fruit and studied their storage life. The preserve was made from 60%, 65% and 70% sugar concentration. The candies were made from 65%, 70% and 75% sugar concentration. Among them the best preserve and candy was identified on the basis of overall acceptability. The study showed that the color, flavor, texture and overall acceptability among the preserves and among the candies were different. The preserve (PE70) made from 70% and the candy (CY75) made from 75% sugar concentration was best among others of the similar product. Higher concentration of sugar and slower processing gives higher acceptability for preserve and candy. Among different changes, moisture concentration was prominent during preparation of preserve and candy. The moisture content was 32.5% and 27% for preserve and candy respectively which were nearly half of the initial concentration of fresh unripe bel fruit. The storage stability of candy (120 days) was slightly higher than the storage stability of preserve (90 days).

Key Words: Acceptability, Bel, Candy, Preserve

Introduction

Importance of fruit in human diet is well recognized. Many people are suffering from malnutrition due to inadequate and imbalance diet. The daily per capita fruit requirement is about 250-300gm but the availability may not be enough due to various reasons. Among different fruits one of the less expensive is bel (*Aegle marmelos*). The bel is an important and indigenous fruit of Bangladesh. Nutritionally bel is one of the most nutritious fruits (Gopalan *et al*., 1971). The fruits are good source of different vitamins (Morton, 1987) and also provide calcium, iron and other minerals (Haque, 1985). The bel fruits are also rich in pectin and cellulose, which stimulate intestinal activity and save human from various disorders. The fruits also contain mucilage which is important for organoleptic quality and also for palatability. Its cultivation is restricted and grows mainly wild or scarcity in the homestead area with or without any care. This nutritionally valuable but yet overlooked fruit is not eaten by wild animals because of its hard shell, mucilaginous texture and numerous seeds and difficult to eat by hand. Therefore, this fruit is not popular as fresh fruit. The Fruit product contains different vitamins and minerals. The consumer attracted fruit product, as the consumer behavior is 13.79% influenced by healthy factor (Jaisam and Utama-ang, 2008). The market for nutritional fruit product is expected to expand further due to the trend toward lifestyle diseases (McCoy, 2005). Although products from ripe bel fruits are being processed at home scale or cottage scale level, however utilization of unripe bel fruits is very rare. Processing of unripe bel fruits into various values added products such as preserve, candies etc. may have potential for increased utilization of the valuable fruit. Further, due to least commercial intervention the unripe bel fruit is still to be brought into different food products for commercial use in Bangladesh. And also there is a big market for fruit product from the stand point of health and nutrition. The fruit is perishable but so much beneficial to health. Keeping this view in mind, the present work was undertaken with the following objectives: (1) to develop preserve and candy from unripe bel fruit (2) to assess the shelf stability of preserve and candy.

Materials and Methods

The experiment was conducted in the laboratory of the Department of Food Engineering and Technology, State University of Bangladesh, Bangladesh. The fresh, unripe bel fruit and sugar collected from the local market were used in the study.

Preparation of bel

Fresh, unripe bel fruit was washed and sliced crosswise to a thickness of 2.5 cm. After the removal of shell, pieces was washed with water and pricked on both sides with stainless steel fork. Then the pieces were steeped in cold water for 24 hrs after that blanched in water for 5 minutes at 90^0 C. The blanched edible portion was cut into 3×3×2 cm cubes.

Preparation of preserve

The cubes were steeped in sugar syrup having 40% total soluble solids (TSS) for a day. Then the cubes were removed from the syrup and increased consistency of syrup to 60% TSS by boiling. The cubes were steeped in 60%TSS syrup for a day. Then the process was repeated to raise the strength of syrup from 60% to 65% and finally to 70% TSS. The cubes were steeped in 70% TSS for a week. At each level of TSS (60%, 65% and 70%) the syrup was drained and filled the container with fresh sugar syrup corresponding with the level of TSS from whom that

was collected. The sugar was used as similarly described by Ponting *et al.* (1966).

Preparation of candy

The cubes were steeped in sugar syrup having 40% total soluble solids (TSS) for a day. Then the cubes were removed from the syrup and increased consistency of syrup to 65% TSS by boiling. The cubes were steeped in 65%TSS syrup for a day. Then the process was repeated to raise the strength of syrup from 65% to 70% and finally to 75% TSS. The cubes were steeped in 75% TSS for a week. At each level of TSS (65%, 70% and 75%) the syrup was drained and finally dried under shade to make candy with different sugar content as Cruess (1958) describe that the candied fruit is usually coated with a thin transparent layer of heavy syrup and dried to a more or less firm texture. In the preparation of candy osmotic dehydration step prior to drying was used as described by Ramamurthey *et al.* (1970). The drying time requirement was similarly followed as described by Islam and Flink (1982).

Storage

The prepared preserve was packed in glass bottle and the candy was packed in polyethylene (HDPE). Both the preserve and candy was stored in room temperature (30 ± 3^0C, with RH: 80-90%). The packed preserve and candy was opened at a regular interval to analyze and observe its physical and chemical parameters and consequently to find the storage stability of the preserve and candy.

Chemical Analysis

The fresh *Bel*, processed preserves and candies were analyzed for moisture, ash, vitamin-C, protein and fat content as per the methods of AOAC (2005).

Subjective (sensory) evaluation of preserve and candy

For statistical analysis of sensory data different samples were evaluated for color, flavor, texture and overall acceptability by a panel of 10 testers. All the testers were briefed before evaluation. The samples were presented to 10 panelists and randomly coded sample. The test panelists were asked to rate the different composition presented to them on a 9 point hedonic scale with the ratings of: 9 = Like extremely; 8 = Like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much; and 1 = Dislike extremely. The result was analyzed by statistical software (Mstatc).

Result and Discussion

Effect of preparation method on sensory parameter of preserve

The color, flavor, texture and overall acceptability of preserves made from different concentration of sugar were evaluated by 10 panel judge. Sample PE60 was made from 60% sugar syrup, PE65 was made from 65% and Sample PE70 was made from 70% sugar syrup. The analysis of variance (ANOVA) was performed for color, flavor, texture and overall acceptability of sample PE60, PE65 and PE70.

Table 1. ANOVA (Analysis of variance) for color, flavor, texture and overall acceptability of preserve

Sensorial Property	Statistical Parameter			Sensorial Property	Statistical Parameter		
	Sources of variance	Mean squares	Probability		Sources of variance	Mean squares	Probability
Color	Products	3.733	0.0006	Texture	Products	4.133	0.0000
	Judge	0.093	0.9706		Judge	0.385	0.1260
	Error	0.326			Error	0.207	
Flavor	Products	4.133	0.0006	Overall Acceptability	Products	4.9	0.0000
	Judge	0.089	0.9806		Judge	0.237	0.5624
	Error	0.356			Error	0.270	

Note: degree of freedom (df) were 2, 9 and 18 for products, judge and error respectively.

There was statistical significant difference in color among the samples as the P value was 0.0006<0.01.And the P value for flavor was also 0.0006<0.01 indicates that the samples were different in flavor (Table.1). Separately, the P value for texture and overall acceptability was same and less than 0.01 means that the samples are also different on the basis of texture and overall acceptability (Table.1). The samples are significantly different in color, flavor, texture and Overall acceptability. These differences may be due to variation in there preparation, especially for sugar concentration and processing time.

Effect of preparation method on sensory parameter of candy

The color, flavor, texture and overall acceptability of preserve made from different concentration of sugar

were evaluated by 10 panel judge. Sample CY65 was made from 65% sugar syrup, CY70 was made from 70% and Sample CY75 was made from 75% sugar syrup. The analysis of variance (ANOVA) was performed for color, flavor, texture and overall acceptability of sample CY65, CY70 and CY75.

Table 2. ANOVA (Analysis of variance) for color, flavor, texture and overall acceptability of candy

Sensorial Property	Statistical Parameter			Sensorial Property	Statistical Parameter		
	Sources of variance	Mean squares	Probability		Sources of variance	Mean squares	Probability
Color	Products	5.2	0.0000	Texture	Products	4.133	0.0000
	Judge	0.3	0.2215		Judge	0.385	0.1260
	Error	0.20			Error	0.207	
Flavor	Products	2.10	0.0012	Overall Acceptability	Products	5.20	0.0000
	Judge	0.311	0.2309		Judge	0.074	0.9750
	Error	0.211			Error	0.274	

Note: degree of freedom (df) were 2, 9 and 18 for products, judge and error respectively.

There was statistical significant difference in color among the samples as the P value was 0.0000<0.01.And the P value for flavor was 0.0012<0.01 indicates that the samples were different in flavor (Table.2). Separately, the P value for texture and overall acceptability was same (0.000) and less than 0.01 means that the samples are also different on the basis of texture and overall acceptability (Table.2). The samples are significantly different in color, flavor, texture and Overall acceptability. These differences may be due to variation in there preparation, especially for sugar concentration and processing time.

Effect of sugar concentration on sensory property of preserve

From table 3, among different sample (preserve) the highest score (8.5) for color was for sample PE70 and lowest score (7.3) for PE60 preceded by PE65. For flavor and texture the highest score (8.6) was for sample PE70 similarly lowest score (7.4) for PE60 preceded by PE65. Finally for overall acceptability, the highest score (8.6) was for sample PE70 and lowest score (7.3) for PE60 and was preceded by PE65. For color, flavor, texture and overall acceptability there was no statistical significant difference between sample PE60 and PE65 as they were suffixed by same letter (b). Sample PE70 was significantly different from them as suffixed by different letter (a) and ranked as "Like very much" whereas the sample PE60 and PE65 was ranked "Like Moderately" due to their mean score as per Ranganna (1991) for each of sensory parameter. Sample PE70 was identified as best sample (preserve) as its score for color, flavor, texture and most importantly overall acceptability was highest among the others. So it can be claimed that the high concentration of sugar and slower processing gives better quality preserve as the PE70 was made from 70% sugar syrup whereas PE60 and PE65 was made from low concentration (less than 70%) of sugar and their processing was quicker than PE70.

Table 3. Mean score of color, flavor, texture and overall acceptability of Preserve and candy

Product	Sample	Sensory attributes			
		color	flavor	texture	overall acceptability
Preserve	PE60	7.3^{b}	7.4^{b}	7.4^{b}	7.3^{b}
	PE65	7.7^{b}	7.6^{b}	7.6^{b}	7.5^{b}
	PE70	8.5^{a}	8.6^{a}	8.6^{a}	8.6^{a}
	LSD value	0.7350	0.7681	0.5857	0.6689
Candy	**CY65**	7.3^{b}	7.4^{b}	7.4^{b}	7.4^{b}
	CY70	7.7^{b}	7.7^{b}	7.6^{b}	7.8^{b}
	CY75	8.7^{a}	8.3^{a}	8.6^{a}	8.8^{a}
	LSD value	0.5757	0.5913	0.5857	0.6738

Effect of sugar concentration on sensory property of candy

From table 3, among different sample (candy) the highest score (8.7) for color was for sample CY75 and lowest score (7.3) for CY65 preceded by CY70. The highest score (8.3) for flavor was for sample CY75 and lowest (7.4) for CY65 preceded by CY70. For texture the highest score (8.6) was for sample CY75 and lowest score (7.4) for CY 65 preceded by CY70. Finally for overall acceptability, the highest score (8.8) was for sample PE70 and lowest score (7.4) for PE60 and was preceded by PE65. For color, flavor, texture and overall acceptability there was no statistical significant difference between sample CY65 and CY70 as they were suffixed by same letter (b). Sample CY75 was significantly different from them as suffixed by different letter (a) and ranked as "Like very much" whereas the sample CY65 and CY70 was ranked "Like Moderately" due to their mean score as per Ranganna (1991) for each of sensory parameter. Sample CY75 was identified as best sample (candy) as its score for color, flavor, texture and most importantly overall acceptability was highest among the others. So it can be claimed that the high concentration of sugar and slower processing gives better quality candy as the CY75 was made from 75% sugar syrup whereas CY65and CY70 was made from low concentration (less than 75%) of sugar and their processing was quicker than CY75. Comparing all the sample of preserve and candy, it was clear that highest acceptability (8.8) was for CY75. From this it can be claimed that higher sugar concentration gives higher acceptability for preserve and candy (table.3) as the taste is somewhat influenced by sweetness (Bhuiyan *et al*., 2012).

Laboratory attributes

Initially the moisture content of fresh bel was 66%, protein 1.9%, ash 0.90%, fat 0.25%, acidity 0.37% and vitamin-C 8 mg/100 g. these composition are more or less in similarity with the determination of Singh and Roy (1984). All the parameter i.e moisture, protein, ash, fat, acidity and vitamin of both the preserve and candy were more or less different than the fresh bel. But among different parameter water content and vitamin C concentration was most prominently different than the fresh bel. The moisture content of preserve was 32.5% and 27% for candy. It was clear that the moisture content was reduced to near about half of the initial (66%) concentration. This finding was similar to Ponting *et al*. (1966) as described that 50% of the water of fruit pieces could be removed by mixing with dry sucrose or by immersion in concentrated solution (65-75% solids) of sucrose or invert sugars. The vitamin C concentration was 2.11 and 2.05 for preserve and candy respectively which were different from initial concentration. This difference may be due to processing method applied to prepare preserve and candy. Factors responsible for vitamin C losses are: temperature, oxidation, acidity, pH and metal trace (Villota and Hawkes, 1992).The vitamin-C content of develop products were low due to the fact that vitamin-C is readily oxidized. Moreover reduction of vitamin-C follows the first order kinetic reaction and the rate constant has and Arrhenius type relationship with absolute temperature (Heldman, 1974; Augustin *et al.* 1979 and Islam, 1980).

Storage stability

Observation of color, flavor and fungal growth of preserve and candy has been shown in Table.4. The color, flavor and fungal growth of preserve were acceptable as there were no changes up to 90 days of storage. The remarkable change was noticed at 120 days of preservation and the preserve remarked as unacceptable to consume. The changes occurred possibly due to fermentation in presence of fungus (mold and yeast) as Fraziar and Westheff (1978) describe that main spoilage organism for fruit products are mold and yeast. The color, flavor and fungal growth of candy were acceptable as there were no changes up to 120 days of storage. The remarkable change was noticed at 150 days of preservation and the candy remarked as unacceptable to consume. The changes occurred possibly due to fermentation in presence of fungus (table. 4). Comparing preserve and candy it was clear that the storage stability of candy (120 day) is slightly higher than preserve (90 day) as the moisture content was lower in candy (27%) than preserve (32.5%). Both the preserve and candy were IMF (intermediate moisture foods) due to their moisture content and this type of food provide necessary plastic mouth feel to enable the food to be ready to eat and product can kept for long time without refrigeration or thermal processing in any hermetically sealed container. The storage stability of preserve and candy are within the range as described by Uddin and Islam (1985).

Table 4. Effect of storage on the quality of preserves and candy

Preserve					Candy			
Storage period (Day)	**Color**	**Flavor**	**Fungal growth**	**Remarks**	**Color**	**Flavor**	**Fungal growth**	**Remarks**
0	Deep Orange	Pleasant	Not Visible	Acceptable	Light Orange	Pleasant	Not Visible	Acceptable
15	Deep Orange	Pleasant	Not Visible		Light Orange	Pleasant	Not Visible	
30	Deep Orange	Pleasant	Not Visible		Light Orange	Pleasant	Not Visible	
45	Deep Orange	Pleasant	Not Visible		Light Orange	Pleasant	Not Visible	
60	Deep Orange	Pleasant	Not Visible		Light Orange	Pleasant	Not Visible	
90	Deep Orange	Pleasant	Not Visible		Light Orange	Pleasant	Not Visible	
120	Brown	Rancid	Spoiled	Fermentation occurred and spoiled	Light Orange	Pleasant	Not Visible	
150	Brown	Rancid	Spoiled		Light Orange	Rancid	spoiled	Fermentation occurred and spoiled
180	Brown	Rancid	Spoiled		Light Orange	Rancid	spoiled	

Conclusion

The best preserve and candy of the bel fruit was identified based on the overall acceptability. Sugar concentration showed most prominent effect on overall acceptability. Color, flavor and texture were also influenced by sugar. Both the preserve and candy contains reduced amount of moisture and vitamin C than the fresh fruit. The storage stability of candy was 120 days and is slightly higher than storage stability of 90 days for preserve where moisture content was most important factor.

References

AOAC Methods. 2005. Official Method of Analysis 12th edition. Association of Official Agricultural Chemists, Washington, D.C.USA.

Augusti, K.T. 1977. Hypocholestcholacmic effect of garlic (*Allium sativum L.*). *Indian J. Exp. Bio.,* 15(**6**): 489-790.

Bhuiyan, M. H. R.; Shams-Ud-Din, M. and lslam, M. N. 2012. Development of Functional Beverage Based on Taste Preference. *Journal of Environmental Science and Natural Resources,* 5(**1**): 83-87.

Cruess, W. V. 1958.*Commercial Fruit and Vegetable Products,* 4th Ed. Mcgraw-Hill Book Co, Inc., USA.

Fraziar, W. C. and Westheff, D. C. 1978. Food Microbiology, 3rd Edn. McGrow-Hill Book Co., USA. 2-95.

Gopalan, C.B.N.R.; Shastri and Balasubramain, 1971. Nutritive value of Indian food. National Institute of food, I.C.M.R. Huderabad, India.

Haque, M. E. 1985. Phal-Sabjer Chash-O-Pustiparichiti (In Bangali). Department of Agricultural Extension. Khamarbari. Krishi Khamar Sarkar, Dhaka-1215. PP: 57-58.

Heldman, D. R. 1974. *Food process engineering.*The AVI pub. Co. reprint edition. Westport, USA. pp. 237-311.

Islam, M. N. and Flink, J. M. 1982. Analysis of drying behavior of fresh and o6motically dehydrated potato. *Chemical Engineering Research Bulletin,* 6: 38.

Islam, M. N. 1980. "Use of solar energy for development of shelf stable potato products". Ph.D. Thesis. Royal Veterinary and Agricultural University, Copenhagen, Denmark

Jaisam, S. and Utama ang, N. 2008. Factor analysis of consumer behavior of tea beverage. *Proceedings of the 46th Kasetsart University Annual Conference*, 147-154.

McCoy, J. 2005. Functional foods and drinks - a market overview. *Fruit-Processing*, 146-149.

Morton, J. 1987. *Bel* fruit In: Fruits of warm climates. Julia Morton. Miami, FI. PP: 97-190.

Ponting, J. D.; Watters, G. C.; Forrey, R. R.; Jackson, R. and Stanley, W. L. 1966. More flavorful dried fruits. Food Processing. February, 1966.

Ramamurthy, M. S.; Bongiwar, D. R. and Bondyapadhayay, D. 1970. Osmotic dehydration of fruits, possible alternative to freeze drying. *India Food Packer*, *India*, 32(**1**): 108-111.

Ranganna.S.1991. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*, 2nd Ed. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.

Singh, R. N and S. K. Roy. 1984. The cultivation and processing Indian-Agril. Res. Inst. New Delhi, India. PP:25-27.

Uddin, M. B. and Islam, M. N. 1985. Development of shelf-stable pineapple products by different methods of drying. *Journal of the Instt. of Engineers Bangladesh*, 13(**1**): 5-15.

Villota and Hawkes. 1992. Kinetics in food System. *In:Hand Book of Food Engg.*Edt. by Heldman, D.R 1992. P:58-60.