Fundamental and Applied Agriculture
Vol. 6(2), pp. 163–171: 2021
doi: 10.5455/faa.78496

FOOD TECHNOLOGY | ORIGINAL ARTICLE

Biochemical, sensory and storage ability assessment of different tamarind drink formulations

Bejoya Das Tumpa [1*], Rubaiya Sondhi [2], Nazneen Akter [2], Md Abdul Alim [2]

[1]Department of Food Science and Engineering, German University Bangladesh, Gazipur 1702, Bangladesh
[2]Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

ARTICLE INFORMATION

Article History
Submitted: 03 May 2021
Accepted: 03 Jun 2021
First online: 30 Jun 2021

Academic Editor
Md Anisur Rahman Mazumder
anis_engg@bau.edu.bd

*Corresponding Author
Bejoya Das Tumpa
bejoya.kundu@gmail.com

ABSTRACT

Fruits belong to an emergent class of food items that serve the human diet with nutritive requirements together with vitamins and minerals that are essential for normal daily life and body functions. The study was conducted to prepare Tamarind drinks by using fully ripen Tamarind fruit. Tamarind fruit was processed into pulp analyzed for their moisture, ash, TSS, pH, acidity, vitamin C, reducing sugar, non-reducing sugar and total sugar content. Chemical composition of formulated tamarind drinks, shelf-life and consumer acceptance were investigated. Chemical analysis showed that the Vitamin C content of the tamarind drinks decreased greatly (8.96-5.45 mg/100g) comparatively to other samples during the storage period. Acidity and reducing sugar were increased (0.12-0.144%) and (23.75-24.37%) progressively whereas pH and non-reducing sugar were slightly decreased (3.35-3.25) and (21.0-20.44%) respectively. Storage stability of the products was studied for fifty days with ten days intervals and the result showed that all samples were in good condition but after one month a little bit of faded color was found at end of the storage period. The formulation contains a processed pulp of TSS 8 °B secured the highest score on sensory evaluation and showed the best acceptance by consumers. This research arises that tamarind fruit can be formulated to as tamarind drinks which increase the value addition of tamarind fruits.

Keywords: Fruit drinks, tamarind pulp, nutritional analysis, storage

Cite this article: Tumpa BD, Sondhi R, Akter N, Alim MA. 2021. Biochemical, sensory and storage ability assessment of different tamarind drink formulations. Fundamental and Applied Agriculture 6(2): 163–171. doi: 10.5455/faa.78496

1 Introduction

Tamarind (*Tamarindus indica* L.) is a leguminous tree that belongs to the family of Fabaceae (der Stege et al., 2011). Tamarind is the third largest family of flowering plants. Tamarind is an evergreen tropical plant native to Africa. India, Thailand, Bangladesh, Sri Lanka, Indonesia and some other American countries ordinarily propagate a huge amount of tamarind (Sarkar et al., 2018). Tamarind is one of the most exoteric fruits in Bangladesh. It can be eaten verdant or processed. (Dheeraj et al., 2007) reported that the tamarind fruit comprises 30% pulp, 40% seed and 30% hull. The tamarind pulps used as sweet and sour in taste and it is enriched in tartaric acid, sugar and vitamin B (Razali et al., 2012). Okello et al. (2018) also reported that tamarind pulp consists on 30-40% of sugar which is affluent compared to other conventional and indigenous fruit. Because of its high concentration of sugar and low pH, tamarind pulp is widely used for concentrates, pickles, confections and powders (Sulieman et al., 2015). Tamarind moderates an impressive level of Vitamin C which acts as an antioxidant that can collaborate to reduce the impact of free radicals, the pesky by-product of cellular metabolism that have been linked to heart disease and several health conditions (Toungos, 2019). According to Ranganna (2005b), tamarind can be conceived as a source of all types of essential amino acids except tryptophan. Tamarind is also flourishing in many organic acids as tartaric acids, succinic and malic acid (Ferrara, 2019). Tamarind is also enriched with carotene and aids in lowering bad cholesterol levels (Thombare and Kumar, 2020). Marhan et al. (1998) reported that tamarind pulp contains major volatile constituents of furan derivatives (44.4%) and carboxylic acid (38.2%).

Due to the emergence of the natural occurrence of sugar and plant acid together, tamarind pulp has a unique sour and sweet taste (Girmay et al., 2020). Pungency and sourness are the two important aspects of these products that have a major impression on the sensory profiles. Tamarind is an astonishing anti-inflammatory, anti-cholesterol, anti-bacterial. It is exuberant in tartaric acid (13%) and inverts sugar (50%) which is very forcible antioxidant (Dheeraj et al., 2007). Tamarind beverage is becoming exoteric day by day. In Subcontinent as well as many other foreign countries tamarind drink has a good demand. The Tamarind fruit pulp is also used as beverage items in different regions. Good quality ready to serve beverage, drinks, syrup and concentrate can be made with a shelf life of six months at ambient storage (Kotecha and Kadam, 2003).

Now-a-days fruit drinks are becoming a significant part of the modern diet in many communities. Because of its good taste and a variety of Vitamins (A, B1, B2, C, D and E) and minerals (Ca, Mg, Zn, Fe, K) and organic compound naturally in fruits, it can play a significant part in a healthy diet (Okwu and Emenike, 2006; Dosumu et al., 2009). Fruit drinks enhance detoxification in the human body (Minich and Bland, 2007). This study therefore enlarges an improved process for the production of tamarind drinks from tamarind fruits. This present study was undertaken to fulfill the following specific objectives: (a) to find out the acceptable formulation of tamarind drinks; (b) to analyzed the proximate chemical composition of tamarind pulp and tamarind drinks; and (c) to study the self-life of tamarind drinks.

2 Materials and Methods

2.1 Materials

The tamarind pulp was collected from the newly harvested local variety that was cultivated in Mymensingh region. Tamarinds were separated from tamarind pods or shells and cumin seeds were collected from the local markets. Citric acid, carboxy methyl cellulose (CMC), salt, sugar, potassium meta bi-sulphate and other materials were used from the Food Technology and Rural Industries laboratory. Jiangsu Shangyong Commerce and Trade Co., Ltd, China was the supplier of CMC and citric acid. Tapish Traders, Ghaziabad, Uttar Pradesh was the supplier of KMS.

2.2 Methods

2.2.1 Separation of pulp from tamarind

Fully ripe and flourish tamarinds were used for extraction of pulp. Seeds and fibers were removed to get the raw pulp by using strainer. The raw pulp was soaked in normal temperature drinking water overnight at refrigeration temperature. Using a weighing scale water and tamarind raw pulp were mixed in a 2:1 ratio by weight for easy pulp separation. Then pulps were blended in an electric blending machine (LG electric blending machine, speed at 30000 rpm) for 10 min. After blending, normal temperature drinking water was added to it to get the required TSS such as 4 °B , 6 °B, 8 °B, 12 °B, and 14 °B for formulated tamarind drinks. Then the processed pulp was screened through a muslin cloth. The processed pulp was preserved in a deep freeze at a temperature of −20 °C and raw pulp was preserved at 4 °C for future use.

2.2.2 Preparation of tamarind drinks

At first, the processed tamarind pulps 4 °B , 6 °B, 8 °B, 12 °B, and 14 °B were taken. Next, it was blended with a blender machine and added normal temperature drinking water to get the required TSS 12 °B of tamarind drinks. TSS was maintained by using sugar after calculating the TSS found from tamarind pulp.Cumin powder and salt were mixed with the drinks thoroughly. Next, it was screened through a muslin cloth. The mixer of tamarind drinks was heated for several minutes. When the temperature of drinks rose to 60 °C, sugar, 0.3% carboxy methyl cellulose (CMC) and 0.2% citric acid were added to the tamarind drinks. It was heated until the pasteurization temperature emerged at 90 °C for 30 sec. After pasteurization, homogenization was performed by a homogenizer. After that, 0.02% potassium meta bi–sulphate (KMS) was added to the tamarind drinks. The prepared drinks were bottled in glass containers and preserve at circumfluous temperature for determining the acceptability and also keeping quality with its storage stability. The different formulations coded as S1, S2, S3, S4, S5 were selected for the study. The formulations of all samples are given in Table 1.

2.2.3 Proximate chemical analysis of the drinks

The raw tamarind pulp and prepared tamarind drinks were analyzed for their total soluble solids (TSS), moisture content, ash content, acidity, pH, vitamin C content, total sugar, reducing sugar and non-reducing sugar presented in the Table 2. Moisture content is determined by AOAC (2015) moisture measuring method and ash content is determined using AOAC (2015) . Total Soluble Solid (TSS) is determined by using a refractometer (Model no. 8987 Puji

Table 1. Formulations of the tamarind drinks

Ingredients	S1	S2	S3	S4	S5
TSS of pulp (°B)	4	6	8	12	14
Cumin powder (%)	0.5	0.5	0.5	0.5	0.5
Salt (%)	0.5	0.5	0.5	0.5	0.5
CMC (%)	0.3	0.3	0.3	0.3	0.3
Sugar (%)	8.8	8.1	7.3	5.8	4.9
KMS (%)	0.02	0.02	0.02	0.02	0.02
Citric acid (%)	0.2	0.2	0.2	0.2	0.2

S1 = Formulation contains processed pulp of TSS 4 °B, S2 = Formulation contains processed pulp of TSS 6 °B, S3 = Formulation contains processed pulp of TSS 8 °B, S4 = Formulation contains processed pulp of TSS 12 °B, S5 = Formulation contains processed pulp of TSS 14 °B

Kuki Ltd. Tokyo, Japan). Ascorbic acid (Vitamin C) and titrable acidity were determined following the method of (Ranganna, 2005a). Total sugar and reducing sugar were determined according to Lane and Eynon method by AOAC (1984) and non-reducing sugar is calculated by difference method by AOAC (1984) . pH is ascertained by the conventional procedure followed by Islam et al. (2015) using a pH meter (HI98190, Hanna Instruments Inc. Limena, Italy).

2.2.4 Sensory evaluation

Sensory evaluations of all the formulated tamarind drinks were done by 10 taste panelists and they were selected from teachers, students and employees of Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh. Color, flavor, sweetness, sourness was requested to evaluate by panelists at scoring rate on a 9-point hedonic scale. 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, 1 = dislike extremely. The data were further analyzed for ANOVA and Duncan's Multiple Range Test (DMRT) (Begam et al., 2018).

2.2.5 Storage study

The tamarind drinks were bottled in a glass container and preserved at room temperature in the laboratory for assessing TSS, vitamin C, acidity, pH, reducing sugar, non-reducing sugar and total sugar present in tamarind drinks at a regular interval of ten days up to 50 days.

3 Results and Discussion

3.1 Chemical composition of used tamarind pulp

The initial composition of tamarind raw pulp was analyzed for their moisture, ash, TSS, reducing sugar, non-reducing sugar, total sugar, pH, acidity, ascorbic acid (vitamin C) content. The results are displayed in Table 2. The results of analysis of the fresh pulp of moisture content, ash content, TSS, acidity, pH and vitamin C which is similar to Coronel (1991) and Feungchan et al. (1996). We acquired the TSS of raw tamarind pulp 65 °B, which was between the standard ranges. The standard value of reducing sugar, non-reducing sugar and total sugar are 25-45%, 16.52%, and 41.2-58.7%, respectively (Coronel, 1991; Feungchan et al., 1996). Deliberated data of samples have lied among the standard ranges.

3.2 Initial chemical composition of tamarind drinks

The initial compositions of tamarind drinks was analyzed and presented in the Table 2. Vitamin C content was gradually increased while pulp content was increased in the formulated samples which is similar to Jothi et al. (2014). TSS was adjusted at 12 °B which is close to Begam et al. (2018). Acidity was increased and pH was decreased gradually while pulp content was increased in the formulated tamarind drinks which are similar to Jothi et al. (2014) for quality assessment of mixed fruits squashes.

3.3 Sensory evaluation of the drinks

The samples were requested to evaluate by 10 panelists. The mean scores for color, flavor, sweetness, sourness and overall acceptability of the samples are presented in Table 3. The DMRT test revealed that the color of samples S3 and S4 significantly better. Sample S1 and S5 had shown least color acceptability than other samples. A characteristic flavor was created by the use of cumin powder. So, there was a less significant difference of flavor among the samples. The sample S5 had shown the least acceptability than another sample. The sweetness of the sample S1, S2, S3 was significantly better than samples S4 and S5. Sample S4 and S5 had shown least sweetness than

Table 2. Initial composition of tamarind raw pulp and tamarind drinks

Product	Moisture content (%)	TSS (°B)	Acidity (%)	Vitamin C mg $100g^{-1}$	Ash content (%)	pH	Reducing sugar (%)	Non-red. sugar (%)	Total sugar (%)
RP	33.87	65	1.09	38	4.04	2.43	29	15	44
S1	87.94	12	0.12	6.672	5.05	3.35	23.75	21	44.75
S2	87.88	12	0.203	7.784	5.5	3.21	24.3	19.95	44.25
S3	87.84	12	0.369	8.96	6.02	3.18	24.9	19	43.9
S4	87.77	12	0.605	10	7.04	3.1	25.78	18	43.78
S5	87.75	12	0.659	11.12	7.45	3.05	26.15	17.5	44.75

S1 = Formulation contains processed pulp of TSS 4 °B, S2 = Formulation contains processed pulp of TSS 6 °B, S3 = Formulation contains processed pulp of TSS 8 °B, S4 = Formulation contains processed pulp of TSS 12 °B, S5 = Formulation contains processed pulp of TSS 14 °B; RP = raw tamarind pulp

Table 3. Mean sensory score of tamarind drinks

Sample	Color	Flavor	Sourness	Sweetness	Overall acceptability
S1	6.7b	7.6a	7.2a	7.4a	6.7b
S2	7.7a	7.8a	7.4a	7.3a	7.5a
S3	7.6a	7.9a	7.2a	7.3a	7.6a
S4	7.0c	7.2a	5.9b	5.7b	6.8b
S5	6.7b	6.1b	5.7b	5.6b	6.1c
LSD	0.2514	0.90812	1.15	0.7597	0.2778

S1 = Formulation contains processed pulp of TSS 4 °B, S2 = Formulation contains processed pulp of TSS 6 °B, S3 = Formulation contains processed pulp of TSS 8 °B, S4 = Formulation contains processed pulp of TSS 12 °B, S5 = Formulation contains processed pulp of TSS 14 °B

other samples. The sourness of the sample S1, S2, S3 was significantly better than samples S4, S5. Sample S4 and S5 had shown more sourness than other samples. Overall acceptability of sample S3 was mostly promoted and significantly different than other samples S1, S2, S4, and S5. Sample S5 had shown the least satiety when compared with other samples.

3.4 Chemical changes of tamarind drinks during storage

The tamarind drinks were placed in a glass bottle and preserved at room temperature for 50 days in the laboratory. The changes of TSS, vitamin C, acidity, pH, reducing sugar, non-reducing sugar, and total sugar present in tamarind drinks are presented in Table 5.

3.4.1 Total Soluble Solids (TSS)

TSS was initially fixed 12 °B in arrangements S1, S2, S3, S4 and S5 (Begam et al., 2018). From Table 4, we can see that there is no change in TSS of the formulations during the storage period similar to Sakhale and Kapse (2012), who reported that sweet orange stored under various treatment showed no markable change during storage at ambient temperature.

3.4.2 Acidity

Acidity was calculated based on of titration (titrable acidity). During the storage period acidity for all the formulations was estimated and the results shown in Table 4. The investigation showed that the acidity followed an inverse relation with pH during the storage period. The acidity of the sample S4 and S5 were the most acidic among all samples because it had the highest amount of tamarind pulp. Acidity increased slightly during the storage period which is similar to Majumdar et al. (2011). Hossain and Rahman (2011) found that acidity changed from 0.39% - 0.51% in apple and apricot blended juice during storage. Acidity is also influenced by adding preservatives and storage condition (Singh and Sharma, 2017).

3.4.3 pH

PH is inversely proportional to acidity. Slight variations of pH were founded throughout 50 days storage period in all the samples. pH decreased slightly during storage period which is similar to Dhaliwal and Hira (2001). Samples S4 and S5 have the lowest pH because of the higher amount of tamarind pulp used. The change in pH has happened for a number of reasons; it might be due to the effect of treatment on the biochemical condition of the fruit and slower rate of respiration and metabolic activity (Jitareerat et al.,

Table 4. Analysis of tamarind drinks at storage period

Storage period	Sample	TSS (°B)	pH	Acidity (%)	Total sugar (%)	Reducing sugar (%)	Non red. sugar (%)	Vitamin C (mg $100g^{-1}$)
Initial	S1	12	3.35	0.12	44.75	23.75	21	6.672
	S2	12	3.21	0.203	44.25	24.3	19.95	7.784
	S3	12	3.18	0.369	43.9	24.9	19	8.96
	S4	12	3.1	0.605	43.78	25.78	18	10
	S5	12	3.05	0.659	43.65	26.15	17.5	11.12
10th day	S1	12	3.35	0.12	44.75	23.75	21	6.12
	S2	12	3.21	0.203	44.25	24.3	19.95	7.225
	S3	12	3.18	0.369	43.9	24.9	19	8.45
	S4	12	3.1	0.605	43.78	25.78	18	9.42
	S5	12	3.05	0.659	43.65	26.15	17.5	10.5
20th day	S1	12	3.33	0.128	44.75	24	20.75	5.49
	S2	12	3.19	0.205	44.4	24.4	20	6.59
	S3	12	3.15	0.38	43.95	25	18.95	7.84
	S4	12	3.06	0.607	43.84	25.92	17.92	8.75
	S5	12	3.02	0.661	43.65	26.25	17.4	9.88
30th day	S1	12	3.29	0.139	44.8	24.15	20.65	4.86
	S2	12	3.17	0.208	44.4	24.5	19.9	5.92
	S3	12	3.13	0.39	44	25.15	18.85	7.23
	S4	12	3.03	0.61	43.84	26	17.84	8.1
	S5	12	3	0.664	43.66	26.37	17.29	9.2
40th day	S1	12	3.27	0.141	44.8	24.25	20.55	4.22
	S2	12	3.16	0.21	44.4	24.62	19.78	5.27
	S3	12	3.11	0.395	44.01	25.25	18.76	6.58
	S4	12	3	0.615	43.84	26.11	17.73	7.35
	S5	12	2.97	0.668	43.67	26.47	17.2	8.57
50th day	S1	12	3.25	0.144	44.81	24.37	20.44	3.5
	S2	12	3.15	0.212	44.4	24.7	19.7	4.63
	S3	12	3.1	0.4	44.02	25.35	18.67	5.45
	S4	12	2.99	0.62	43.84	26.11	17.73	6.7
	S5	12	2.96	0.67	43.68	26.59	17.09	7.76

S1 = Formulation contains processed pulp of TSS 4 °B, S2 = Formulation contains processed pulp of TSS 6 °B, S3 = Formulation contains processed pulp of TSS 8 °B, S4 = Formulation contains processed pulp of TSS 12 °B, S5 = Formulation contains processed pulp of TSS 14 °B

Table 5. Changes of color of tamarind drinks during storage period

Storage days	S1	S2	S3	S4	S5
Initial	Rusty color	Rusty color	Rusty color	Rusty color	Rusty color
10th day	No change	No change	No change	No change	No change
20th day	No change	No change	No change	No change	No change
30th day	No change	No change	No change	No change	No change
40th day	Slight change	Slight change	Slight change	Slight change	Slight change
50th day	Slight change	Slight change	Slight change	Slight change	Slight change

S1 = Formulation contains processed pulp of TSS 4 °B, S2 = Formulation contains processed pulp of TSS 6 °B, S3 = Formulation contains processed pulp of TSS 8 °B, S4 = Formulation contains processed pulp of TSS 12 °B, S5 = Formulation contains processed pulp of TSS 14 °B

Table 6. Changes of flavor of tamarind drink during storage period

Storage days	S1	S2	S3	S4	S5
10th day	No change	No change	No change	No change	No change
20th day	No change	No change	No change	No change	No change
30th day	No change	No change	No change	No change	No change
40th day	Slight change	Slight change	Slight change	Slight change	Slight change
50th day	Slight change	Slight change	Slight change	Slight change	Slight change

S1 = Formulation contains processed pulp of TSS 4 °B, S2 = Formulation contains processed pulp of TSS 6 °B, S3 = Formulation contains processed pulp of TSS 8 °B, S4 = Formulation contains processed pulp of TSS 12 °B, S5 = Formulation contains processed pulp of TSS 14 °B

2007). pH might be decreased due to the breakdown of carbohydrate by the action of some microorganisms (Begam et al., 2018).

3.4.4 Vitamin C

Ascorbic acid (Vitamin C) deterioration is very common in all consumable items during storage can be happened aerobically as well as anaerobically (Singh and Sharma, 2017). The vitamin C or ascorbic acid of different formulations was observed at various storage times and presented in Table 4. It had been shown that vitamin C or ascorbic acid is gradually decreased with the increase of storage period. Due to the rapid conversion of L-ascorbic acid to dihydro-ascorbic acid in the presence of L-ascorbic acid oxidase enzyme the loss of ascorbic acid might be occurred (Bhardwaj and Mukherjee, 2011). During processing the tamarind drinks, it has also undergone heat treatment, the agitation which may cause accelerate the destruction of vitamin C in the formulations. Oxidation of ascorbic acid may be caused by various factors including exposure to oxygen, metals, light, heat and alkaline pH (Sritananan et al., 2005). The sealing facility of bottles was not satisfactory. This may be considered one of the reasons of decreasing vitamin C. During the storage period Vitamin C was significantly decreased with increasing storage temperature and time (Ezz and Awad, 2011).

3.4.5 Reducing sugar

The initial reducing sugar content of the formulations was shown in Table 4. During the storage period, the reducing sugar content of the formulated samples were gradually augmented similar to **?**. The increased reducing sugar in juice may be due to the hydrolysis of sucrose to glucose and fructose (Ahmed et al., 2008). The result is also supported by other workers who reported that due to the hydrolysis of sucrose present in fruit juice reducing sugar is increased gradually. During storage increase in reducing sugar might be happened due to conversion of non-reducing sugar to reducing sugar with the storage period (Ahmad et al., 1986). Sarman et al. (1981) viewed an operative increase in reducing sugar in single strength Kinnow mandarin juice in the sample of room temperature as compared to those kept in low temperature.

3.4.6 Non-reducing sugar

The non-reducing sugar content of all formulations showed in the Table 4. Non-reducing sugar was slightly decreased during 50 days storage period, similar to Ayub et al. (2010). The decrease of non-reducing sugar may be due to the conversion of some non-reducing sugar to reducing sugar through the process of glucogenesis (Ahmad et al., 1986).

3.4.7 Total sugar

Total sugars of the tamarind drink are considered one of the basic parameters to evaluate the drink's quality. During 50 days storage period at room temperature there was a negligible variation occurred in total sugar content after 30 days. This variation occurred might be happened due to technical measuring error and slightly metabolic activity. Similarly, Garg et al. (2008) reported that increase of total sugar during storage in blended Indian gooseberry juice treated with 0.05% KMS. Amin et al. (2008) also observed a conspicuous similar effect of preservatives such as potassium meta-bi-sulphite (KMS), citric acid and sodium benzoate (SB) on sugar content of mango pulp.

3.5 Changes of color of tamarind drinks during storage

The color of the tamarind drinks was observed which are shown in the Table 5. All the formulations of tamarind drink possessed attractive natural rust-like color of ripe tamarind pulp. Changes of the color of the drinks were observed in all samples throughout its 50 days storage periods at room temperature. After 40 days due to storage condition, temperature and oxygen content fading color was observed of tamarind drink samples. Jacobs (1959) reported that exposure to light cause little deterioration in color. Acidity or sugar addition had little effect on color retention in fruit drinks during storage.

3.6 Changes of flavor of tamarind drinks during storage

The flavor of drinks was observed for 50 days and presented in the Table 6. The tamarind drinks had the characteristics flavor of cumin powder. The flavor was good until 40th days but at 50th day's observation it was noticed that the flavor had slightly changed.

4 Conclusion

Negligible changes were observed except vitamin C in the composition of tamarind drink throughout the storage period. Vitamin C of the tamarind drinks decreased greatly comparatively than others. Non-reducing sugar and pH decreased slightly and reducing sugar and acidity increased slightly. Through statistical analysis of sensory evaluation, it was observed that color, flavor, sweetness and overall acceptability of the sample S3 were more acceptable than that of the formulated drinks. The study indicated that an acceptable tamarind drink could be prepared from tamarind. A well-developed process for tamarind drink will be valuable for food processors. From the above study it may be concluded that tamarind drink can be formulated to preserved tamarind, to prepare a nutritious food product and to encourage farmers to grow more tamarind in the country.

Acknowledgments

It is pleasure for the authors to the acknowledge the Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh, Bangladesh for providing the facilities to carry out the research.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

Ahmad M, Chaudhry MA, Khan I. 1986. Studies on the standardization and storage stability of citrus and mango squashes. Nucelus 23:42–45.

Ahmed M, Ahmad A, Chatha ZA, Dilshad SMR. 2008. Studies on preparation of ready to serve mandarin (*Citrus reticulata*) diet drink. Pakistan Jounral of Agricultural Sciences 45:470–476.

Amin M, Malik AU, Mazhar MS, Din I, Khalid MS, Ahmad S. 2008. Mango fruit desapping in relation to time of harvesting. Pakistan Journal of Botany 40:1587–1593.

AOAC. 1984. Official Methods of Analysis. Association of Official Analytical Chemists. 15th Edition, Washington, D. C.

AOAC. 2015. Official Methods of Analysis. Association of Official Analytical Chemists. 14th Edition, Washington, D. C.

Ayub M, Ullah J, Muhammad A, Zeb A. 2010. Evaluation of strawberry juice preserved with chemical preservatives at refrigeration temperature. International Journal of Nutrition and Metabolism 2:027–032.

Begam S, Das P, Karmoker P. 2018. Processing of mixed fruit juice from mango, orange and pineapple. Fundamental and Applied Agricuclture 3:440–445. doi: 10.5455/faa.289995.

Bhardwaj RL, Mukherjee S. 2011. Effects of fruit juice blending ratios on kinnow juice preservation at ambient storage condition. African Journal of Food Science 5:281–286.

Coronel RE. 1991. *Tamarindus indica* L. In Plant Resources of South East Asia, Wageningen, Pudoc. No.2. Edible fruits and nuts. (Eds.) Verheij, E.W.M.,Coronel, R.E., PROSEA Foundation, Bogor, Indonesia 298-301.

der Stege CV, Prehsler S, Hartl A, Vogl CR. 2011. Tamarind (*Tamarindus indica* L.) in the traditional West African diet: not just a famine food. Fruits 66:171–185. doi: 10.1051/fruits/2011025.

Dhaliwal M, Hira SK. 2001. Effect of storage of physicchemical and nutritional characteristics of carrotbeetroot and carrot-black carrot juices. Journal Food Science Technology 38:343–347.

Dheeraj S, Lobsang W, Surendra KM. 2007. Processed products of tamarind. Natural product radiance 6:315–321.

Dosumu OO, Oluwaniyi OO, Awolola GV, Okunola MO. 2009. Stability studies and mineral concentration of some nigerian packed fruit juices, concentrate and local beverages. African Journal of Food Science 3:82–85.

Ezz TM, Awad RM. 2011. Effect of some post harvest treatments under different low temperature on two mango cultivars. Australian Journal of Basic and Applied Sciences 5:1164–1174.

Ferrara L. 2019. Nutritional and pharmacological properties of *Tamarindus Indica* L. Journal of Nutrition Food and Science Forecast 2:1012.

Feungchan S, Yimsawat T, Chindaprasert S, Kitpowsong P. 1996. Tamarind (*Tamarindus indica* L.) Plant genetic resources in Thailand. Thai Journal of Agricultural Science 1:1–11.

Garg V, Barwal VS, Sarera S. 2008. Preparation and evaluation vitamin C enriched fruit drinks. Journal of Food Science and Technology 45:524–526.

Girmay H, Tewolde-Berhan S, Hishe H, Asfaw Z, Ruelle M, Power A. 2020. Use and management of tamarind (*Tamarindus indica* L., Fabaceae) local morphotypes by communities in Tigray, Northern Ethiopia. Forests, Trees and Livelihoods 29:81–98. doi: 10.1080/14728028.2020.1737582.

Hossain MA, Rahman SM. 2011. Total phenolics, flavonoids and antioxidant activity of tropical fruit pineapple. Food Research International 44:672–676. doi: 10.1016/j.foodres.2010.11.036.

Islam M, Ahmad I, Ahmed S, Sarker A. 2015. Biochemical composition and shelf life study of mixed fruit juice from orange & pineapple. Journal of Environmental Sciences & Natural Resources 7. doi: 10.3329/jesnr.v7i1.22175.

Jacobs MB. 1959. Manufacture and analysis of carbonated beverages.

Jitareerat P, Paumchai S, Kanlayanarat S, Sangchote S. 2007. Effect of chitosan on ripening, enzymatic activity, and disease development in mango (*Mangifera indica*) fruit. New Zealand Journal of Crop and Horticultural Science 35:211–218. doi: 10.1080/01140670709510187.

Jothi JS, Karmoker P, Sarower K. 2014. Quality assessment of mixed fruit squash: physico-chemical analysis, sensory evaluation and storage studies. Journal of Bangladesh Agricultural University 12:195–201. doi: 10.3329/jbau.v12i1.21412.

Kotecha PM, Kadam SS. 2003. Preparation of ready-to-serve beverage, syrup and concentrate from tamarind. Journal of food science and technology (Mysore) 40:76–79.

Majumdar T, Wadikar D, Vasudish C, Premavalli K, Bawa A. 2011. Effect of storage on physicochemical, microbiological and sensory quality of bottlegourd-basil leaves juice. American Journal of Food Technology 6:226–234. doi: 10.3923/ajft.2011.226.234.

Marhan GH, Wahab SMA, Athan AM. 1998. A phytochemical study of tamarind indica plants. Journal Medical Sciences 29:172–175.

Minich DM, Bland JS. 2007. Acid-alkaline balance: role in chronic disease and detoxification. Alternative therapies in health and medicine 13:62–65.

Okello J, Okullo JBL, Eilu G, Nyeko P, Obua J. 2018. Physicochemical composition of *Tamarindus indica* L. (Tamarind) in the agro-ecological zones of Uganda. Food Science & Nutrition 6:1179–1189. doi: 10.1002/fsn3.627.

Okwu DE, Emenike IN. 2006. Evaluation of the phytonutrients and vitamin contents of citrus fruits. International Journal of Molecular Medicine and Advance Sciences 2:1–6.

Ranganna S. 2005a. Handbook of analysis and quality control for fruit and vegetable products, 2nd Edition. Tata McGraw-Hill Education, New Delhi.

Ranganna S. 2005b. Patterns and determinants of fruits and vegetables Consumption in sub-Saraharan Africa. Background paper for joint FAO/WHO workshop on fruits and vegetables for Health, Kobe, Japan.

Razali N, Mat-Junit S, Abdul-Muthalib AF, Subramaniam S, Abdul-Aziz A. 2012. Effects of various solvents on the extraction of antioxidant phenolics from the leaves, seeds, veins and skins of *Tamarindus indica* L. Food Chemistry 131:441–448. doi: 10.1016/j.foodchem.2011.09.001.

Sakhale BK, Kapse BM. 2012. Short communication Studies on shelf life extension of sweet oranges (*Citrus sinensis* L.). International Food Research Journal 19:779–781.

Sarkar BR, Awasthi P, Joshi H. 2018. Physical properties and nutritional composition of tamarind kernel powder and quality evaluation of instant chutney mix prepared incorporating tamarind kernel powder. Journal of Pharmacognosy and Phytochemistry 7:1342–1346.

Sarman U, Bains GS, Kripal SK. 1981. Studies on processing of kinnow mandarin juice. Punjab Horticulture Journal 21:32–45.

Singh SK, Sharma M. 2017. Review on biochemical changes associated with storage of fruit juice. International Journal of Current Microbiology and Applied Sciences 6:236–245. doi: 10.20546/ijcmas.2017.608.032.

Sritananan S, Uthairatanakij A, Jitareerat P, Photchanachai S, Vongcheeree S. 2005. Effects of irradiation and chitosan coating on physiological changes of mangosteen fruit stored at room temperature. In: International Symposium on New Frontiers of Food and Non-Food Products :22–23.

Sulieman AME, Alawad SM, Osman MA, Abdelmageed EA. 2015. Physicochemical characteristics of local varieties of tamarind (*Tamarindus indica* L), Sudan. International Journal of Plant Research 5:13–18.

Thombare PB, Kumar KPA. 2020. Tamarind: Value Added Products and Its Health Benefits. Agriculture & Food e-Newsletter 2:2581–8317.

Toungos MD. 2019. Tamarind (*Tamarindus indicus* L) Fruit of Potential Value But Underutilized in Nigeria. International Kournal of Innovative Food, Nutrition and Sustainable Agriculture 7:1–10.

The Official Journal of the
Farm to Fork Foundation
ISSN: 2518–2021 (print)
ISSN: 2415–4474 (electronic)
http://www.f2ffoundation.org/faa