



A novel approach to formulation of tomato bar with its shelf life, physicochemical and nutritional studies

Anjumanara Khatun¹, Mohammad Mainuddin Molla^{2*}, Meher Nigad Nipa¹, Ashfak Ahmed Sabuz²

¹ Institute of Food Science and Technology, Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka, Bangladesh

² Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh

Abstract

A novel tomato bar was developed using fully ripen red color tomato with its physicochemical and nutritional properties studies. The bar was developed using locally available quality ingredients. Then the developed bar was sensory evaluated by a trained interdisciplinary scientist, scientific stuffs and visitors. Sensory analyses of the developed bar revealed that the product was appreciated by the pre-trained and trained panelists. Sensory profile analyses by the trained panel consensus concluded that the bar has a good flavor profile with well-balanced sweetness and saltiness, slightly perceptible astringent notes, and no off-taste. Nutritional analyses suggest that the bar is the rich source of lycopene at initial day of storage and after 6 months of storage. The bar could be simply preserved up to 6 months without any quality deterioration and microbes free. The study suggest that the bar could be commercially marketing that can increase the income of the farmers and entrepreneurs with health-promoting compounds.

Keywords: Tomato bar, lycopene, microbial activities, marketable life, sensory attributes

Introduction

A novel approach involves developing new product formulations using different ingredients and important aspect of food processing. A novel product's acceptance depends on the product's composition developed via the selection of ingredients and, more importantly, the specific amounts of each ingredient used in the formulation. Also, food's sensory, nutritional, and physicochemical properties are highly dependent on its ingredients (Kidane, 2021) [3].

The term "fruit bar" or "leather" refers to a product made by combining pulp or puree from healthy, ripe fruit with fresh or previously preserved nutritive sweeteners, butter or other vegetable fat, milk solids, and other ingredients suitable for the product. The mixture is then dehydrated to create a sheet that can have any desired shape or size (Food Safety & Standards Authority of India, 2011).

'Tomato bar' is basically dehydrated tomato puree recipe. People of Bangladesh are very familiar with fruit bar such as 'Mango Bar', which is locally known as "Amsotto". However, edible vegetable bar such as 'Tomato Bar' making is feasible when right ingredients and recipe is applied. Tomato is a very common vegetable in Bangladesh. It is a good source of lycopene and essential micronutrients. Fresh tomatoes are low in carbohydrates and high in fiber. The solemn features of this product are its processing technology is very simple and is based on inexpensive local raw materials. This product is expected to be highly acceptable to all classes of people in the country.

Fruit bar or leather is a dehydrated fruit-based confectionary food product that is frequently consumed as a snack or dessert. It is sometimes referred to as a fruit bar or fruit slab. Eating fruit leather is a cost-effective and practical way to replace real fruit as a source of different nutrients. Additionally, compared to many other snacks, fruit leather has far fewer calories less than 100 Kcal per serving. After a complicated process that includes a dehydration step, fresh fruit pulp or a combination of fruit juice concentrates and

other ingredients are used to create fruit bar. Customers find fruit bar made from fruit pulp to be both nutritional and organoleptically acceptable. Significant amounts of dietary fiber, carbs, minerals, vitamins, and antioxidants are included in them (Damodaran *et al.*, 2010) [1]. Fruit bar is one product that can be made using a drying process. Fruit leathers are dried sheets of fruit pulp that have a soft, rubbery texture & a sweet taste. Fruit leathers can be dried using various drying forces including sun drying, oven drying, cabinet drying & dehydrator drying. The edible portion of fruit (one or more types) is pureed, mixed with other ingredients to improve its physicochemical & sensory characteristics [3].

Tomato is a very well-known horticultural crop in Bangladesh. In order to make tomato production profitable postharvest management is very important. Due to lack of proper postharvest practices, processing and preservation techniques, a huge amount of postharvest loss is occurred at different levels of supply chain. The loss is calculated as 32.90 % with its farm level loss 12.45 %, partial and full damage 3.59 % and 8.86 % respectively. The major causes for postharvest loss of tomato were identified as rotten, disease and insect infestation. This loss incurs financial loss at farm level by BDT 152.45 per decimal of tomato cultivation. However, these losses can be minimized through improved postharvest management practices and development of value-added process products. Thus, tomato bar may be one of the ways to minimize its greater postharvest loss soon after harvest. Hence, the present study has been undertaken to develop novel technique to formulation of tomato bar with its better shelf-life studies, physicochemical and nutritional studies.

Materials and Methods

Materials: Tomato, Sugar, Salt (NaCl), Red chili powder, Cumin powder, Fennel powder, Rock salt, Agar agar.

Preparation of tomato bar

Fresh 5 kg of tomatoes were taken; stems were removed, and washed in running tap water. Then, the washed tomatoes were boiled until a paste like consistency achieved. This was blended to make the paste finer. The ingredients (according to the Table 1) were mixed with past. Then mixture was boiled until it becomes thick enough. The mixture was spread in drying trays and dried at 60°C using mechanical dryer for 5 hrs.

Process flow chart of tomato bar

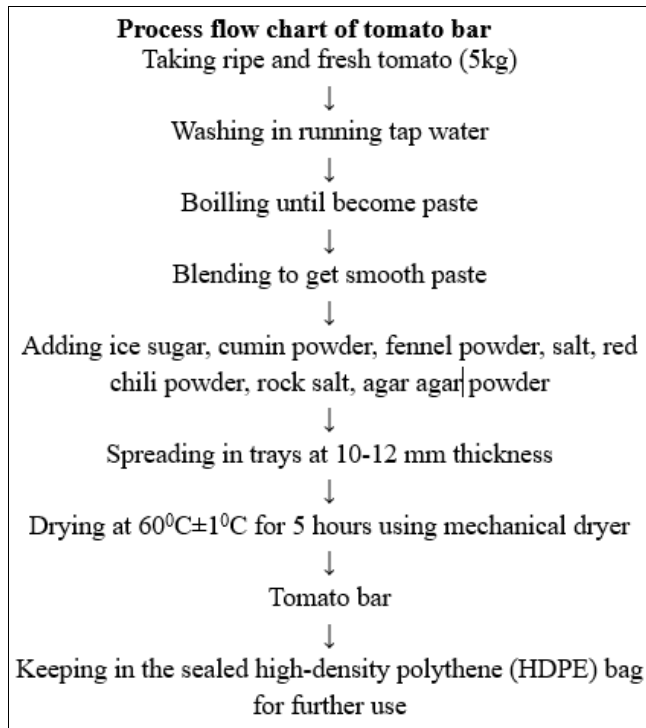


Fig.1: Process flow chart of tomato bar

Table 1: Formulation of tomato bar

Sl. No.	Ingredients	Quantity (g)
01	Tomato	5 kg
02	Sugar	160.0
03	Salt (NaCl)	10.0
04	Red chili powder	2.0
05	Cumin powder	4.5
06	Fennel powder	5.0
07	Rock salt	1.0
08	Agar agar suspension	4.10

Specification of raw materials

- a. **Tomato:** Fresh and good quality. If storage in refrigerated condition shall comply BDS ISO 5524:2015 (Tomatoes – Guide to cold storage and refrigerated transport).
- b. **Sugar:** Must be good quality and shall comply either BDS 138:2006 (Refined sugar), BDS
- c. **Salt (NaCl):** Must be food grade and shall comply either BDS CAC 150:2002 (Food grade salt) or BDS 1236:2020 (Iodized salt).
- d. **Red chili powder:** Fresh and good quality. Shall comply BDS 1017:2020.
- e. **Cumin powder:** Fresh and good quality. Shall comply BDS 1807:2008

- f. **Fennel powder:** Fresh and good quality.
- g. **Rock salt:** Fresh and good quality.
- h. **Agar agar:** Must be food grade.

Physicochemical and nutritional analysis

The physicochemical characteristics, viz., moisture, ash, titratable acidity, pH and crude fiber of the tomato bar were determined followed by AOAC (2020) method. The Kjeldal apparatus was employed for evaluating crude protein, while the Soxhlet apparatus was applied to analyze crude fat. Total carbohydrate was calculated by the difference of total contents (crude fat, crude fiber, crude protein, ash, and moisture content) from 100.

Sensory evaluation

According to the methodology outlined by Dey *et al.* (2025), which was based on a 9-point hedonic scale and adhered to the ethical guidelines of the "International Standards Organization (ISO) Committee on ISO/TC34/SC12," the sensory evaluation was assessed after 180 days (6 months) of storage. In summary, 100 experts from the BCSIR and BARI inter-divisional scientists, scientific staffs and visitors were assembled into four judgment panel groups to assess the tomato bar sensory qualities.

Shelf-Life Studies

The shelf life of the tomato bar was observed at 3 days of interval at ambient condition. Each bar was replicated for 3 times for better understanding of the shelf life. The excess limit of recommended values of the microbial activities (total viable count, total coliform, E. coli, fecal coliform, Yeast and Molds, Salmonella, Bacillus cereus and Clostridium perfringens) was discarded and was recorded up to the consumption level.

Results and Discussion

Physicochemical and Nutritional study

Initial moisture of the tomato bar was recorded 25.10 % but after 6 months of storage, it was increased with the advancement of storage periods. The disruption of cell walls, membranes, and packaging into HDPE pouches during storage might be the cause of the difference in moisture content between the first and last day of storage (6 months). According to Sairagul *et al.* (2020)^[6], there was an increase in the moisture content of hard-boiled candies made with jaggery at the end of their storage. The ash content of the tomato bar was recorded as 5.01 % at initial day of storage (0 day). But after 6 months of storage, the ash content was decreased (4.94 %) with increasing storage time. These findings are consistent with those of Pandita and Gupta (2019)^[5]. The crude fiber of the tomato bar was recorded as 4.97 % at initial day of storage whereas it was decreased as 4.93 % with the advancement of storage. The results indicate that tomato bar is a rich source of crude fiber. The crude protein of the tomato bar was found 9.01 % at initial day of storage whereas it was calculated as 8.35 % after 6 months of storage. The results indicated that tomato bar is the rich source of crude protein. On the first day of storage, the crude fat content was recorded as 2.01 % but after 6 months of storage, the fat content was increased as 2.18 %. According to Molla *et al.* (2022)^[4], changes in lipid metabolism brought on by oxygen may be the cause of the treated sample's higher fat content.

The titratable acidity of the tomato bar was calculated as 0.61 % on the first day of storage, while it was recorded as 0.58 %, indicating that the acidity of the treated tomato bar calculated as 0.58 %. The findings show that the acidity down up as the storage time went on. The significant rise in acidity during extended storage may result from the degradation of pectic substances into soluble acids. Several researchers have indicated that acidity escalates with the advancement of storage duration (Molla *et al.*, 2022) [4]. Iron (Fe) is the essential elements for all kinds of people especially it is recommended for pregnant women. In this study, the Fe was found 4.33 mg/100 g at on the day of storage but after 6 months of storage, it was decreased with the advancement of storage periods. Total sugar content of the tomato bar was calculated as 46.31 % at initial day of storage. But after 6 months of storage, the sugar content was increased with the advancement of storage periods (after 6

months). In this study, total carbohydrate content of the tomato bar was recorded as 55.33 % whereas it was calculated as 55.80 %, results indicated that the carbohydrate content was increased with the advancement of storage periods. The increased carbohydrate might be due to increasing sugar content and accumulation of sugar content in the sample. Energy is an invisible component that is essential for supporting the body's basal metabolism. Fats and carbohydrates are used as a source of energy. In this study, the initial energy content of the tomato bar was recorded as 267.13 Kcal/100 g but after 6 months of storage, it was calculated as 268.22 Kcal/100 g, indicating that the energy content increased with the advancement of storage periods. The reason might be attributed to a significant amount increased of crude fat, total carbohydrates and total sugar.

Table 2. Physicochemical and nutritional composition of the tomato bar on the day of storage and after 6 months of storage

Sl. No.	Parameter	0 day	After 6 months of storage
1.	Moisture (%)	25.10	25.80
2.	Ash (%)	5.01	4.94
3.	Crude Fiber (%)	4.97	4.93
4.	Crude Protein (%)	9.01	8.35
5.	Crude Fat (%)	2.01	2.18
6.	Acidity (%)	0.61	0.58
7.	Iron (mg/100 g)	4.33	4.21
9.	Total Sugar (%)	46.31	46.65
10.	Total Carbohydrate (%)	55.33	55.80
11.	Salt (as NaCl) (%)	1.41	1.47
12.	Energy (Kcal/100 g)	267.13	268.22

Microbiological study of the developed tomato bar

Table 3 shows, the microbiological study of the developed tomato bar were analyzed for total viable count (TVC), total coliform (TC), E. coli, fecal coliform, Yeast and Molds, Salmonella, Bacillus cereus and Clostridium perfringens.

The results indicate that Salmonella, Bacillus cereus and Clostridium perfringens were absolutely absent in the tomato bar. TVC, TC, E. coli, fecal coliform, Yeast and Molds were found in the tomato bar but it was within the acceptable limit of the bar (Table 3).

Table 3. Microbiological study of the tomato bar during storage periods

Month	Total Viable Count (TVC), cfu/g	Total Coliform, MPN/g	E. coli, MPN/g	Fecal Coliform, MPN/g	Yeast and Moulds, cfu/g	Salmonella sp. /25g	Bacillus cereus/25 g	Clostridium perfringens, cfu/g
0	<10*	<0.3**	<0.3**	<0.3	<10*	Absent	Absent	Absent
1 st	<10*	<0.3**	<0.3**	<0.3	<10*	Absent	Absent	Absent
2 nd	<10*	<0.3**	<0.3**	<0.3	<10*	Absent	Absent	Absent
3 rd	<10*	<0.3**	<0.3**	<0.3	<10*	Absent	Absent	Absent
4 th	<10*	<0.3**	<0.3**	<0.3	<10*	Absent	Absent	Absent
5 th	<10*	<0.3**	<0.3**	<0.3	<10*	Absent	Absent	Absent
6 th	<10*	<0.3**	<0.3**	<0.3	<10*	Absent	Absent	Absent

Heavy metals analysis of the developed tomato bar

Heavy metals found in tomato products generally include lead, cadmium, arsenic and nickel, with concentrations varying based on production methods, soil quality, and packaging. In this study, lead and arsenic were detected in the tomato bar after 6 months of storage but the

levels were below the recommendation limits (Table 4). Cadmium and nickel were free from the tomato bar. The detected levels of the tomato bar might be during processing via equipment or leach from packaging materials, especially with prolonged storage time.

Table 4. Heavy metal of the developed tomato bar after 6 months of storage

Sl. No.	Parameters	Result (mg/kg) ***	Acceptable Limit*
1.	Lead (Pd)	Below Detection Limit	0.5
2.	Cadmium (Cd)	Not Detected**	-
3.	Arsenic (As)	Not Detected**	0.5
4.	Nickel (Ni)	Not Detected**	-

*According to USDA GAIN Report; **Detection Limit (mg/kg): Pb = 0.05, Cd = 0.02, As = 0.05 & Ni = 0.02; ***Method: AAS Graphite Furnace.

Sensory evaluation of tomato bar after 6 months of storage

Table 5, shows the sensory evaluation of tomato bar after 6 months of storage. Statistically no significant differences were found of the stored tomato bar. All the panel members were satisfied to the tomato bar. Lower hardness and higher

softness were found of the stored tomato bar. The results confirm an inverse relationship between the hardness and softness of the stored tomato bar. The overall acceptability score varied (7.15-7.21) with the perception of the evaluator.

Table 5. Sensory evaluation of tomato bar after 6 months of storage

Treatment	Color	Flavor	Mouth feel	Hardness	Softness	Overall acceptability
Rep 1 x 10=10	7.20±0.05	7.53±0.10	7.51±0.10	6.50±0.10	7.40±0.04	7.21±0.08
Rep 2 x 10=20	7.10±0.10	7.51±0.10	7.30±0.10	6.51±0.10	7.33±0.03	7.15±0.01
Rep 3 x 10=30	7.20±0.10	7.51±0.10	7.30±0.10	6.53±0.10	7.35±0.05	7.18±0.09
Rep 4 x 10=40	7.20±0.10	7.50±0.10	7.33±0.20	6.55±0.05	7.35±0.05	7.19±0.02
Total=100						

Shelf life of the tomato bar

The microbiological study and sensory evaluation confirm that the shelf life of the bar was 06 (six) months at ambient temperature (25±5°C) in normal sealed HDPE pouches without any quality deterioration.

Conclusion

The results conclude that there is a great scope of manufacturing tomato bar as the product is very delicious and acceptable by the sensory panel members with its high energy value, physicochemical and nutritional compositions as well as health benefits and it is good for school going children.

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References

1. Damodaran S, Parkin KL, Fennema OR. Fennema Quimica de loss Alimentos. Acribia, Zaragoza, Spain, 2010.
2. FSSAI, Food Safety Standards Authority of India Food Safety and Standards Regulations, 2011, 435-436.
3. Kidane SW. Application of Response Surface Methodology in Food Process Modeling and Optimization,” in Response Surface Methodology in Engineering Science, Intech Open, 2021.
4. Molla MM, Sabuz AA, Khan MHH, Chowdhury MGF, Miaruddin M, Alam M, *et al.* Effect of honey and lemon juice on the physicochemical, nutritional, microbial and antioxidant properties of guava–pineapple jelly during storage periods. Discover Food,2022:2:31.
5. Pandita N, Gupta N. Development, and evaluation of flavtheed ladoo from different cultivars of aonla. Bangladesh Journal of Botany,2019:48:957-965.
6. Sairagul S, Kumar D, Kaviya M, Sudhakar V, Manoj JB. Studies on development of jiggery based hard-boiled candy. Proceedings of the 2nd National Conference on Innovations in Biochemical and Food Technology. Department of Biotechnology, Kumaraguru College of Technology, Tamil Nadu, India. International Journal for Innovative Research in Multidisciplinary Field,2020:14:2455-0620.