Journal of
Food Chemistry & Nanotechnology

https://doi.org/10.17756/jfcn.2024-s1-008

Research Article

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Quality Changes During the Storage of Ready to Eat Pumpkin Butter Prepared Using *Terminalia arjuna* and *Glycyrrhiza glabra* Powder

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Received: November 24, 2023
Accepted: March 05, 2024
Published: March 08, 2024

Citation: Gupta S, Bishnoi JP, Singh R, Walia A, Thakur K, et al. 2024. Quality Changes During the Storage of Ready to Eat Pumpkin Butter Prepared Using *Terminalia arjuna* and *Glycyrrhiza glabra* Powder. *J Food Chem Nanotechnol* 10(S1): S57-S64.

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Abstract

Now a day's people have become highly conscious about their health and demand more herbal, safe, ready to eat, fortified and functional foods. In this study, arjuna (*Terminalia arjuna*) bark and mulethi (*Glycyrrhiza glabra*) roots were processed to prepare powder. Herbal pumpkin butter using arjuna and mulethi powder (2, 4, and 6%) were developed and evaluated. Based on sensory analysis, herbal pumpkin butter using arjuna (2%) and mulethi powder (2%) was found most acceptable. The freshly prepared variants of pumpkin butter using arjuna and mulethi powder (2%) were analyzed for various chemical characteristics. The moisture content (39.8%), water activity (0.76), total soluble solids (TSS) (67.4%), titratable acidity (0.77%), β-carotene (11.70 mg/100 g), total phenols (1.23 mg/g), non-enzymatic browning (NEB) (0.85) and antioxidant activity (38.7%) were recorded for herbal pumpkin butter containing arjuna powder (2%), while the moisture content (40.6%), water activity (0.78), TSS (68.7%), titratable acidity (0.81%), β-carotene (11.75 mg/100 g), total phenols (1.11 mg/g), NEB (0.60) and antioxidant activity (36.3%) were recorded for herbal pumpkin butter containing mulethi powder (2%). Sensory characteristics were found maximum in pumpkin butter having mulethi (PBM). Thus, herbal pumpkin butter has enormous potential in the market as a functional food.

Keywords

Arjuna, Mulethi, Pumpkin, Butter, Antioxidant activity

Introduction

Due to urbanization, the lifestyle of humans has become hectic. People do not have enough time to cook and are becoming habitual to consuming unhealthy fast/street food lacking in basic essential nutrients. Fruits are amongst the first food items known to be consumed prehistorically by human beings. Pumpkin is known as the wonder of vegetables because of its unique characteristics. The name of pumpkin is originated from Greek term "Pepon" which means large melon, commonly known as Kadu. Pumpkins are a member of the family Cucurbitaceae, the largest family in the vegetable kingdom. The genus *Cucurbita* comprised of 27 species out of which five species are mainly cultivated in India i.e., *C. maxima*, *C. mixta*, *C. moschata*, *C. pepo*, and *C. micifolia* [1].

Pumpkin pulp is an excellent source of carotenoids [2]. The yellow to orange color of pumpkin is mainly derived from carotenes which is found to reduce the risk of cardiovascular diseases, cataracts, macular degeneration as well as certain types of carcinomas [3]. Pulp has a significant amount of biologically active components such as polysaccharides, sterols, oils, pigments (xanthophylls),

amino acids (lysine, valine, leucine, isoleucine, phenylalanine, and threonine), and minerals (calcium, chromium, selenium, cobalt, magnesium, and zinc) [4].

Medicinal plants are the most exclusive sources of life-giving drugs for the majority of the world population. *T. arjuna* is one kind of widely used medicinal plant in various indigenous systems of medicine like Ayurveda, Siddha, and Unani. *T. arjuna* is a deciduous and evergreen tree distributed throughout India growing to a height of 20 - 30 m above ground level [5]. The useful parts of *T. arjuna* are stem bark, root bark, fruits, leaves, and seeds. But most commonly bark is considered important because it contains 34% ash in the form of pure calcium carbonate, so it can be a good source of calcium if consumed with other food ingredients. The bark is also rich in triterpenoids, saponins, flavonoids, phenols, tannins, magnesium, zinc, and copper. The bark powder has been shown to have cardioprotective, antioxidant, hypercholesterolemic, antimicrobial, anti-inflammatory, immunomodulatory, antinociceptive, and hyperglycemic activities [6].

G. glabra (mulethi) belongs to the Leguminosae family and is a plant used in conventional medicine across the world for its ethnopharmacological value [7]. Mulethi contains leaves, flowers, calyx, fruits, and roots. The commercially important part of the plant is its roots and underground stem. The root of mulethi contains glycyrrhizin, amino acids, sterols, saponins, and flavonoids. The root constitutes 10 - 25% of licorice which is considered the primary active ingredient. It is 60 times sweeter than cane sugar. Mulethi has memory-enhancing properties. It is used as an anti-inflammatory agent in the treatment of allergic reactions. It possesses antimicrobial, antioxidant, antidiabetic, antiulcer, anxiolytic, and anticarcinogenic activities. It is used traditionally both as a flavoring and sweetening agent in confectionery.

Therefore, here in this study pumpkin was used as main ingredient for the development of nutritionally rich ready to eat functional food such as pumpkin butter. Pumpkin butter is prepared by cooking pumpkin pulp or shreds with sugar and spices. Pumpkin butter has a texture like soft butter and can quickly be spread on bread. The nutritional and medicinal value of processed products can be enhanced by the addition of herbs. The ratio of *T. arjuna* and *G. glabra* for preparation of pumpkin butter was optimized using a 9-point hedonic scale. Furthermore, the impact of storage conditions on the chemical composition and organoleptic qualities of prepared ready-to-eat pumpkin butter was evaluated.

Materials and Methods

Procurement of materials

Pumpkin fruits were procured from the local market adjoining Amity University Rajasthan (SP-1Kant Kalwar, NH 11C, RIICO Industrial Area, Rajasthan) during 2016-2017. Arjuna bark and mulethi roots were procured from the medicinal, aromatic, and potential crops section, Department of Genetics and Plant Breeding, College of Agriculture, Chaudhary Charan Singh, Haryana Agricultural University, Hisar (Haryana, India).

Processing of medicinal plants

Arjuna bark and mulethi roots were cleaned, washed, and dried in freeze dryer at -20 °C. Dried bark and roots were ground to fine powder (Figure 1 and figure 2) in a hammer mill, packed in high density polyethylene pouches and stored at room temperature for use in pumpkin butter [5]. Arjuna bark powder and mulethi roots powder (2, 4, and 6%) were mixed with pumpkin pulp for preparation of herbal pumpkin butter.

Preparation of ready to eat herbal pumpkin butter

For preparation of control pumpkin butter (CPB) 750 g sugar, 10 g salt (common salt + black salt + rock salt), 4 g black pepper, 10 g chat masala and 1 g cardamom (small) were used along with 1 kg pumpkin pulp (Figure 3) [8]. On the basis of sensory evaluation, optimum quantity of arjuna bark powder and mulethi roots powder were standardized for the prepara-

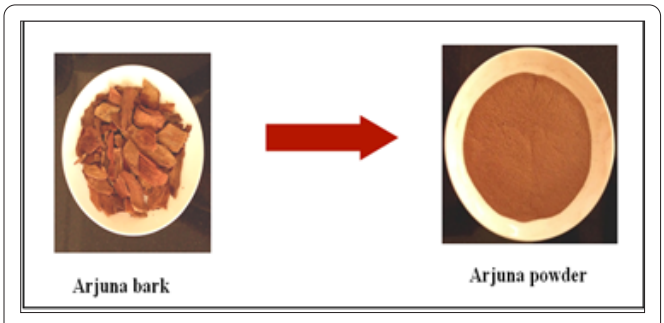


Figure 1: Flowchart for processing of arjuna powder.

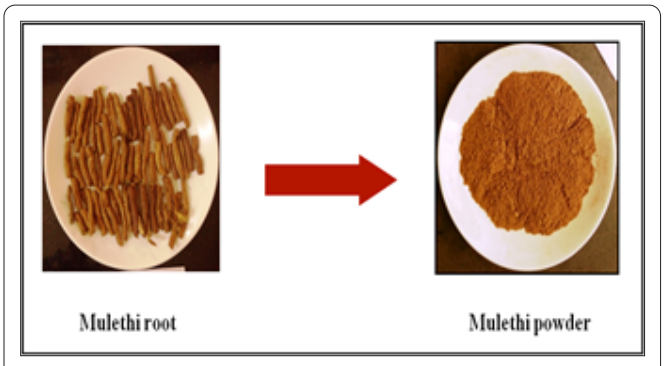


Figure 2: Flowchart for processing of mulethi powder.

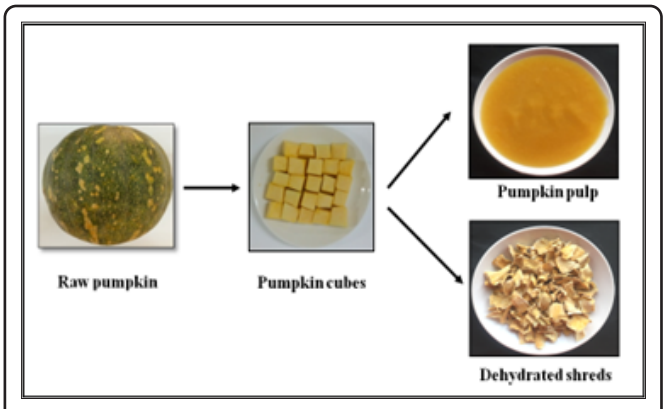


Figure 3: Flowchart for processing of pumpkin pulp.

tion of herbal pumpkin butter variants. For processing pumpkin butter, after mixing the above-mentioned ingredients it was cooked till desired consistency is achieved. The product was then poured hot into dry sterilized glass jars.

Chemical analysis

The freshly prepared herbal pumpkin butter variants containing arjuna and mulethi powder were analyzed for various chemical characteristics. The moisture content of herbal pumpkin butter variants was determined by Dean and Stark method [9]. The water activity of herbal pumpkin butter variants was recorded by water activity meter (Labswift aw, Nevadian, Switzerland). The instrument was calibrated with water activity meter calibration humidity salts (11, 58, and 84%). TSS were estimated at ambient temperature by hand refractometer (0 - 32%) and the values were expressed as percent TSS. Titratable acidity and β-carotene were analyzed using a procedure given by Ranganna [9]. Total phenols (expressed as gallic acid) were analyzed as per the methods given by Amorium et al. [10]. NEB and total plate count were carried out by the method given in Ranganna [9]. Antioxidant activity was measured using stable 2, 2-diphenyl-1-picrylhydrazyl radical as per the method described by Shimada et al. [11].

Organoleptic evaluation

A 9-point hedonic scale method was used for the determination of sensory characteristics of prepared pumpkin butter [12]. The panel of ten semi-trained judges (master's students and staff-faculty members of Food Technology, AIB, Amity University, Rajasthan, India) were selected for evaluation of the sensory characteristics of products. Judges evaluated the product on the basis of sensory parameters such as color and appearance, mouthfeel, texture, taste and overall acceptability and gave the score. The overall acceptability of prepared products was based on the mean score from all sensory characteristics. The sensory characteristics of products were evaluated on the very first day of storage and at intervals of every two months i.e., (2, 4, and 6) during six months of storage.

Statistical data

The data in the present investigation were subjected to analysis of variance technique (Two-factor analysis) and thus analyzed according to two factorial completely randomized designs. The critical difference value at 5 percent level was used for making comparison among different treatments during storage period. Software OP stat was used to analyze experimental results statistically.

Results and Discussion

Optimization of ingredients for preparation of herbal pumpkin butter

Pumpkin butter was prepared by incorporating different levels of medicinal plants i.e., arjuna and mulethi (2, 4, and 6%) were analyzed for sensory characteristics viz., color and appearance, taste, texture, mouthfeel, and overall acceptability. Mean score for color and appearance, taste, texture, mouthfeel, and overall acceptability of CPB were 8.2, 8.2, 8.1, 8.1 and 8.1, respectively. In herbal pumpkin butter, no significant change in mean score of various sensory attributes was noticed with incorporation of 2% arjuna and 2% mulethi, respectively. However, the mean score for sensory characteristics viz., color and appearance, taste, texture, mouth feel and overall acceptability of herbal pumpkin butter containing 4 and 6% arjuna and mulethi powder, respectively was significantly lower than control. Overall acceptability scores indicate that herbal pumpkin butter variants containing 4 and 6% arjuna and mulethi powder, respectively were "Neither liked nor disliked". Thus, formulations containing 2% arjuna and 2% mulethi powder individually were selected for preparation of herbal pumpkin butter.

Chemical analysis of prepared pumpkin butter

Changes in chemical constituents of pumpkin butter variants with storage period

The moisture (%), water activity, TSS, titratable acidity, β-carotene, total phenols, NEB, antioxidant activity, and total plate count in herbal pumpkin butter during six months storage period was analyzed. The moisture content of pumpkin butter variants decreased significantly with storage (Figure 4), which might be due to evaporation of moisture from the samples at room temperature. However, the decrease might also be due to the ability of sodium and chloride ions present in salt to associate with water molecules and thus, hindering it to escape [13, 14]. Singh et al. [15] also reported reduction in moisture content of intermediate moisture baby corn during storage. Priya and Khatkar [16] also observed fall in moisture content of aonla preserve with the advancement in storage duration.

A progressive decrease in water activity was found in pumpkin butter variants during six months period (Figure 5). This decrease might be due to loss of moisture content from the samples and other reason for reduction may be due to association of water molecules with ions like Na^+ and Cl^-. Singh et al. [17] also reported a reduction in water activity of aonla supari for 135 days storage period. Priya and Khatkar [16] observed the decrease in water activity of aonla preserve. Water activity of pumpkin butter variants ranged from 0.76 to 0.81 on zero day of storage. Maximum water activity (0.81) was observed in CPB. Minimum water activity (0.76 and 0.78) was noticed in pumpkin butter containing arjuna (2%) and mulethi powder (2%), respectively as herbal ingredients. Arjuna and mulethi have been known to show some humectants properties, thus, decrease availability of free water.

A significant increase in TSS value was observed in pumpkin butter variants during six months storage (Figure 6). TSS of pumpkin butter variants increased significantly with the advancement in storage duration, which might be due to the conversion of complex/organic molecules into simple forms by hydrolysis process. Similar findings have been confirmed in grape spread, in aonla preserve and strawberry jam by Priya and Khattar [16], Rao et al. [18], and Khan et al. [19]. CPB showed minimum TSS (65.4%), while pumpkin butter containing arjuna (67.4%) and mulethi (68.7%) showed maximum TSS at zero day of storage.

The titratable acidity in variants of pumpkin butter increased significantly with the progress in storage duration of

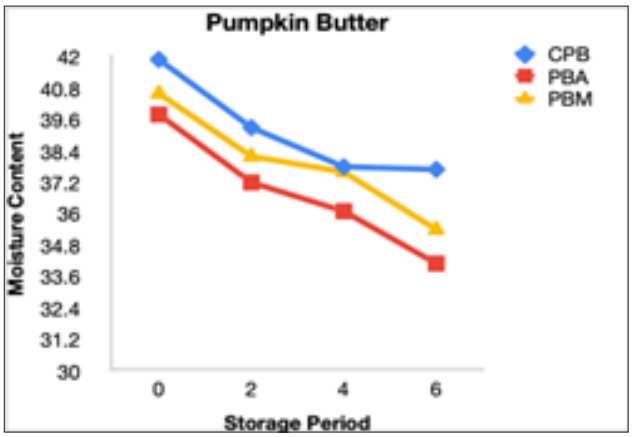


Figure 4: Effect of storage period on moisture content.

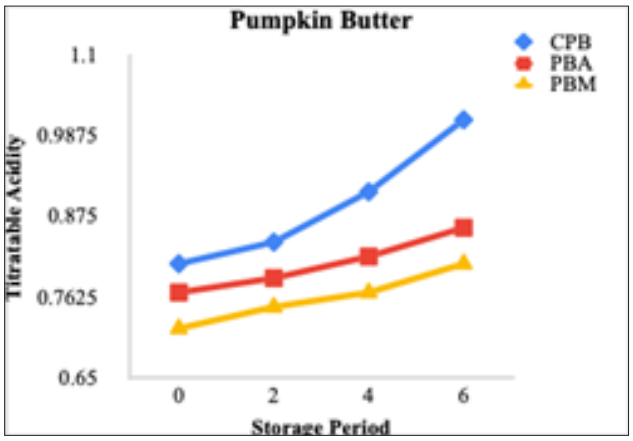


Figure 7: Effect of storage period on tritratable acidity.

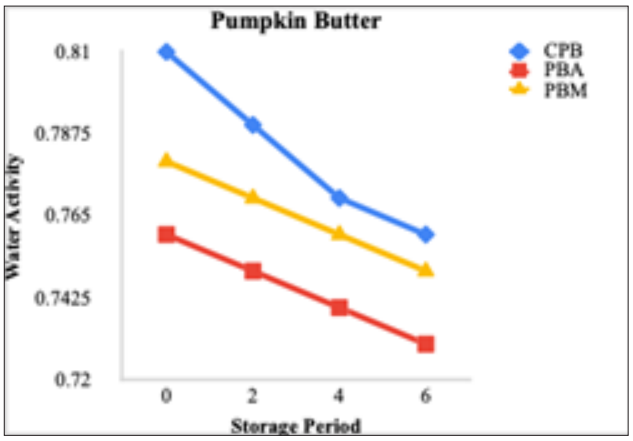


Figure 5: Effect of storage period on water.

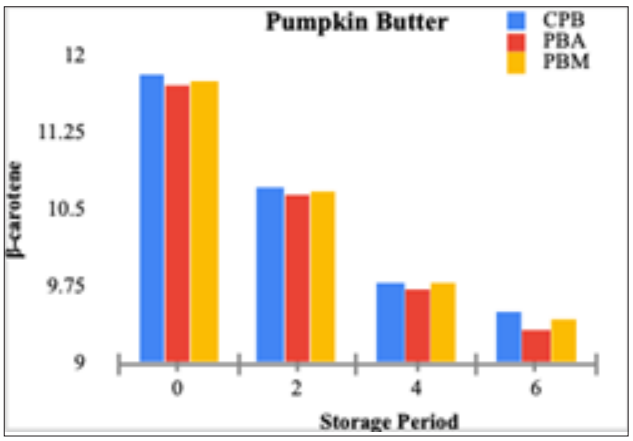


Figure 8: Effect of storage period on β-carotene.

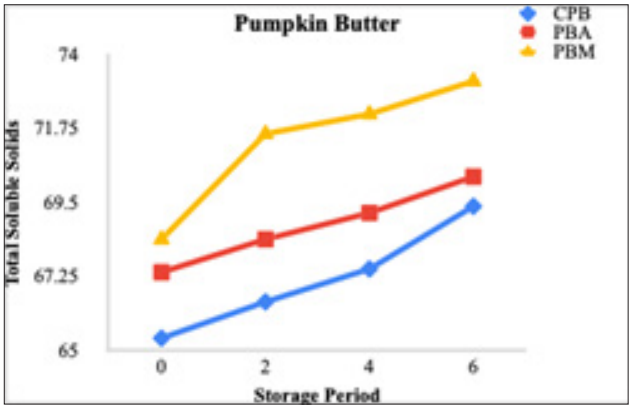


Figure 6: Effect of storage period on TSS.

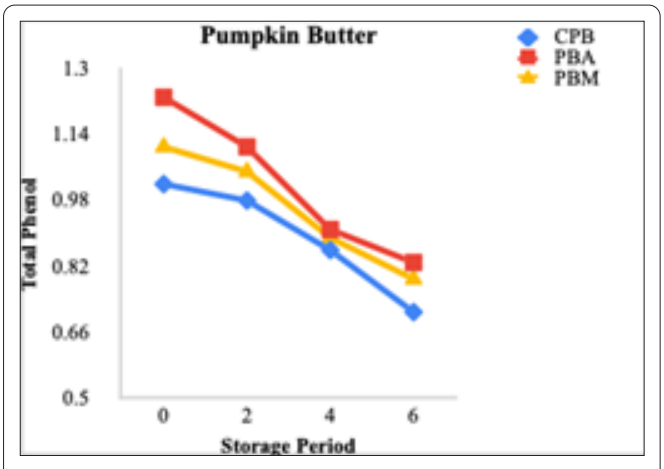


Figure 9: Effect of storage period on total phenol.

six months (Figure 7), which might be due to the oxidation of organic compounds into organic acid and loss of moisture. Rababah et al. [20] also reported an increase in the acidity of strawberry jam. Rising in acidity might be due to the degradation of cell wall components that produced organic acids. The maximum titratable acidity was noticed in PBM (0.81%), and minimum titratable acidity (0.72%) was noticed in CPB [21].

The β-carotene content of pumpkin butter variants reduced significantly during a six-month storage period (Figure 8). This loss could be attributed to the oxidation of carotenoids with increase in time. Similar findings have been confirmed by Muzzaffar et al. [21] in pumpkin candies. On zero day of storage, β-carotene content in pumpkin butter variants ranged from 11.70 to 11.82 mg/100 g.

Total phenol content in pumpkin butter variants decreases significantly with an increase in storage duration (Figure 9). The decrease may be due to condensation of phenols into brown pigments [13]. The phenolic acids are oxidized to O-semiquinone residuals or O-quinone molecules, which are

reactive to give brown products of high molecular weight. The reduction in phenol content might also be due to the degradation and oxidation of phenolic compounds, followed by protein polymerization [22]. During storage reduction in total phenols was also reported by Kopjar et al. [23] in strawberry jam and Poiana et al. [24] in cherry jam. On zero day of storage, phenol content in pumpkin butter variants ranged from 1.02 to 1.23 mg/g. Pumpkin butter containing arjuna as an herbal ingredient had maximum phenol content of 1.23 mg/g.

NEB increased significantly in pumpkin butter variants with the increment in storage duration (Figure 10). It could be due to the condensation of tannins into brown pigments and the inversion of the non-reducing to the reducing sugar which act as reactant of Maillard reaction. Browning index of carrot candy and aonla preserve increased with an increase in storage period [16, 25]. The NEB of pumpkin butter variants on zero day ranged from 0.59 to 0.85. Maximum NEB (0.85) was recorded in pumpkin butter having arjuna (PBA); it might be due to additional browning contributed by arjuna. The minimum value of NEB (0.59) was noticed in CPB.

Antioxidant activity decreased significantly in pumpkin butter variants with increment in storage duration (Figure 11). Phenolic compounds have been proved to be responsible for the antioxidant activity [26]. This loss in antioxidant activity could be attributed to oxidation or loss of phenolic compounds in pumpkin butter variants with the increment in time. A similar finding was confirmed in pumpkin candy by Muzzafaar et al. [21]. On zero day of storage, the antioxidant activity of pumpkin butter variants ranged from 32.6 to 38.7%. Maximum antioxidant activity 38.7% was recorded in PBA and it might be related to the fact that arjuna powder exhibit antioxidant activity due to high phenolic content. A minimum antioxidant value (32.6%) was observed in CPB.

The microbial spoilage in food products like pumpkin butter and pumpkin vegetable dry soup mix may lead to off-flavors, off-odor, off-color and distorted texture. On day zero of storage total microbes were below the detection limit in case of pumpkin butter variants. The microbial count was found to be increased in pumpkin butter variants with advancement in storage period (Figure 12). Similar findings were shown in aonla spread and chutney prepared by Bishnoi [8] and Choudhary et al. [27].

Changes in organoleptic quality of pumpkin butter variants

A significant reduction in mean hedonic score for color and appearance was observed in pumpkin butter variants with the progression in storage duration (Figure 13). Similar findings were confirmed by Sahu et al. [28] in aonla preserve and Bishnoi [8] in aonla spread. This could be due to occurrence of NEB in pumpkin butter variants during storage.

On day zero, the mean score for color and appearance in pumpkin butter variants ranged from 7.7 to 8.2. The highest sensory score (8.2) for color and appearance was observed in CPB, while lowest score (7.7) was observed in PBA. Variants of pumpkin butter remained acceptable up to six months of storage with respect to color and appearance. Similar results were reported by Rao et al. [18] in grape spread, Choudhary et al. [27] in aonla chutney and Bhardwaj et al. [29] in gua-

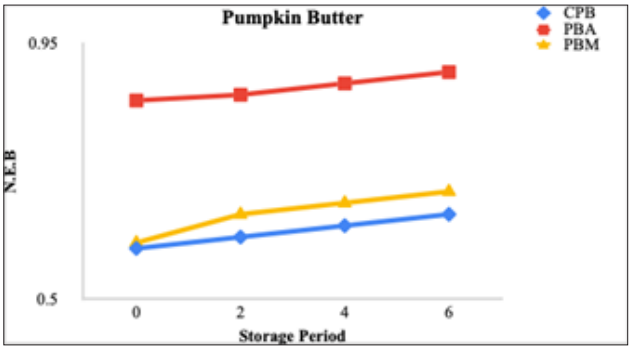


Figure 10: Effect of storage period on NEB.

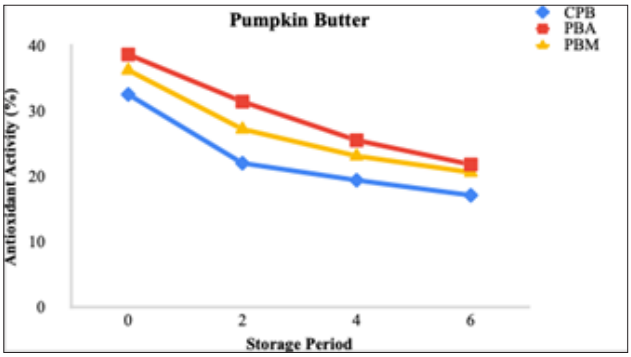


Figure 11: Effect of storage period on antioxidant activity.

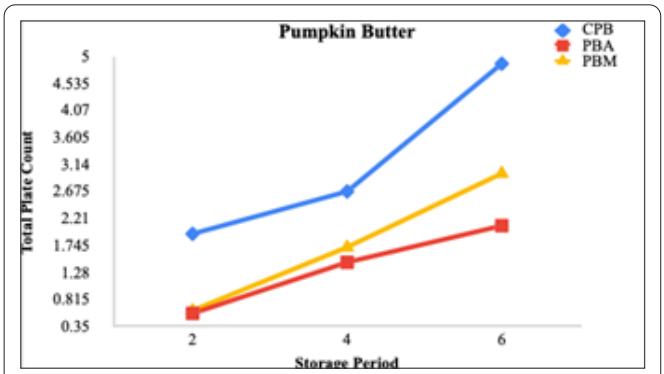


Figure 12: Effect of storage period on total plate count.

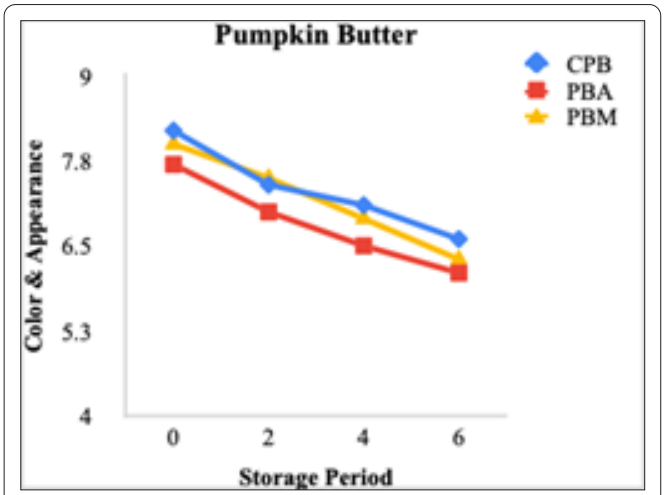


Figure 13: Effect of storage period on color and appearance.

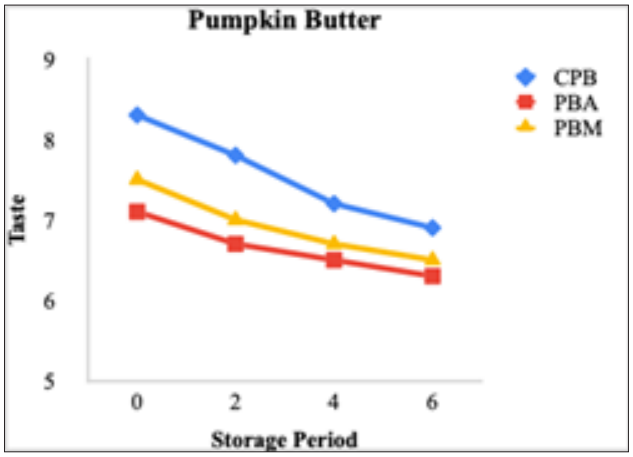


Figure 14: Effect of storage period on taste.

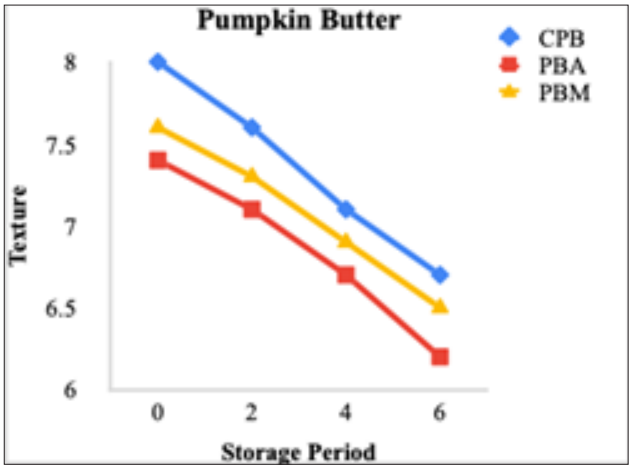


Figure 15: Effect of storage period on texture.

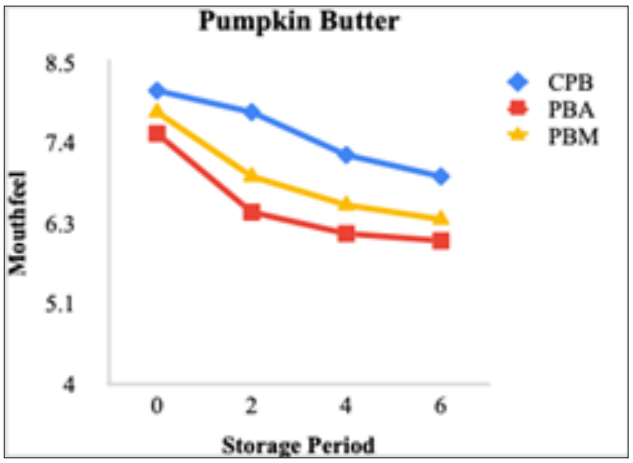


Figure 16: Effect of storage period on mouthfeel.

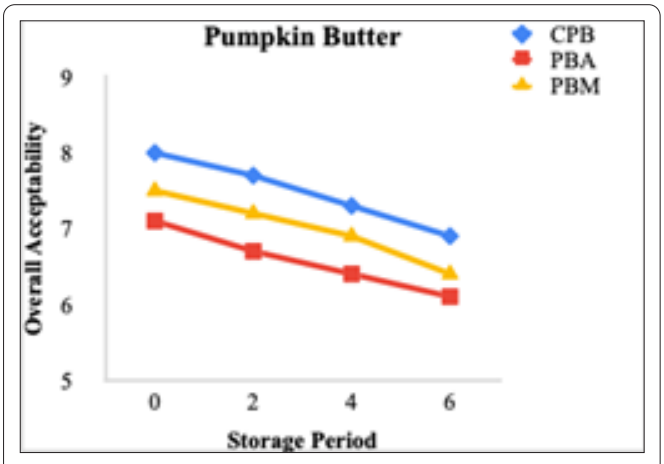


Figure 17: Effect of storage period on overall acceptability.

va-jamun jam and chutney. A significant reduction in mean hedonic score for taste of pumpkin butter variants was recorded during a six-month storage period (Figure 14). Similar findings were reported by Sahu et al. [28] in aonla preserve. It may be due to certain chemical changes such as breaking down complex metabolites into simpler ones that leads to the volatilization of flavoring components, which may affect the perception of taste. On day zero, the mean score for taste in pumpkin butter variants ranged from 7.1 to 8.3. The highest sensory score (8.3) was noticed in CPB, and lowest score was noticed in PBA (7.1) and it might be due to strong after taste of these herbal ingredients.

All the variants of pumpkin butter remained acceptable up to a storage duration of six months with respect to taste. The mean score for texture of pumpkin butter variants decreased significantly during storage (Figure 15). This could be due to loss of moisture from pumpkin butter and the breakdown of complex metabolites into simpler ones. On day zero the mean score for texture in pumpkin butter variants ranged from 7.4 to 8.0. The highest sensory score (8.0) was found for CPB, and lowest score was noticed in PBA (7.4). Similar results were reported by Rao et al. [18] in grape spread, Choudhary et al. [27] in aonla chutney and Bhardwaj et al. [29] in guava-jamun jam and chutney. Pumpkin butter variants remained acceptable up to storage period of six months with respect to texture. In the case of pumpkin butter variants significant reduction in mean hedonic score for mouthfeel was recorded with advancement of storage duration (Figure 16). It may be due to some chemical changes. On day zero the mean scores for mouthfeel in pumpkin butter variants ranged from 7.5 to 8.1. The highest sensory score (8.1) was observed in CPB. The lowest score (7.5) was noticed in PBA and it might be due to the displeasing after taste of these herbal ingredients. Similar results were reported by Rao et al. [18] in grape spread, Choudhary et al. [27] in aonla chutney and Bhardwaj et al. [29] in guava-jamun jam and chutney. Variants of pumpkin butter remained acceptable up to six months with respect to the mouthfeel. The reduced overall acceptability scores in pumpkin butter variants during six months storage were due to a reduction in mean scores for taste, color and appearance, mouthfeel, and texture (Figure 17). CPB was found to be most acceptable (8.0), while PBA (7.1) was found to be least acceptable on basis of overall acceptability scores. Rao et al. [18] observed decline in organoleptic quality of grape spread during six months storage duration. Choudhary et al. [27] observed the decrease in organoleptic characteristics in aonla chutney during storage period. Similarly, Bhardwaj et al. [29] also reported a decrease in organoleptic characteristics in guava-jamun chutney during storage period.

Conclusion

Now a day's demand for functional food has been increasing after COVID-19. Pumpkin is known for its antioxidant, antidiabetic, anti-chronic, anti-inflammatory properties. The pumpkin butter is quite stable at ambient temperature during 6 months of storage. The sensory analysis, chemical composition, antioxidant activity and shelf life of pumpkin butter were determined. The ready to eat pumpkin butter with 2% medicinal plants (arjuna and mulethi powder) was found acceptable by the consumers. Now a day's people are demanding ready to eat healthy nutritious food products. Pumpkin butter containing medicinal plants (arjuna and mulethi powder) is beneficial for all age group people. This pumpkin butter was in agreement with consumers attitudes towards healthy foods. The results are important and positive for companies planning to develop ready to eat products fortified with medicinal plants. The formulation of functional foods products using nutritionally rich vegetables and medicinal plants is expected to get lot of public attentions, thus the present research work taken to formulate ready to eat pumpkin butter with medicinal plants. In the future in addition to the health benefit of medicinal plants, even their antimicrobial attributes can be explored, and they can be used in processed products as natural alternative of synthetic preservative.

Acknowledgements

I would like to acknowledge Amity Institute of Biotechnology, Amity University, Rajasthan, India.

Conflict of Interest

None.

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