Quality And Shelf-Life Assessment Of Almond Flavored Soymilk

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Abstract
Soybean *(Glycine max* L. Merrill.*)* a legume crop belongs to the family *Fabaceae.* It is used in many products due to having multiple health benefits like anti-cancerous, boosts heart and digestive health and helps in controlling diabetes. So, almond flavored soymilk is one of its products that is the best alternative of cow milk for the lactose intolerant people and best source of protein who are vegetarians. The objective of this study was to eliminate the beany flavor of soymilk to enhance its quality and shelf life by using different blanching and temperature treatment combinations with addition of almond flavor. Five treatments T_0, T_1, T_2, T_3 and T_4 were prepared by blanching with different concentrations of $NaHCO_3$ at 1.25%, 1.5%, 1.75% and 2% for 25, 20, 15 and 10 minutes at a temperature of 100℃ respectively and results were compared with a control sample blanched for 30 minutes without using $NaHCO_3$. Proximate analysis like moisture, crude protein, crude fat, crude fiber and ash were performed on raw soybean. Physicochemical were performed on flavored soymilk by every 4 days intervals during the storage of 12 days. Titratable acidity, TSS and color measurement (l, a, b) showed increasing trend from 0 day to 12th day (0.45-0.69), (3.67-3.81) and (l, a, b; 19.93-44.76, 0.88-1.41, 5.07-12.16) respectively. While pH showed decreasing trend (8.93-5.73) but specific gravity (1.03-1.03) was not affected noticeably during storage. Mineral analysis was performed to check the concentration of (Na, K, Ca and Mg) in soymilk. Sensory evaluation was done by trained panel of judges to check different parameters *i.e.* color, taste, aroma and overall acceptability on a 9-point hedonic scale. Among all the five treatments, T_4 represented the best results.

Key Words: Soybean, Soymilk, Almond

Introduction

Soybean *(Glycine max* L. Merrill*)* annual legume crop belongs to the family *Fabaceae* that is originated from China and now cultivated Worldwide. USA, Argentina, China and Brazil are the biggest producers. Soy milk and soy drink manufacture in the Asia-Pacific region has a unprocessed market value of over 11.9 USD billion in 2017, China leading the manufacturing of soymilk in this region and in the world has been reported about 2.8 billion tones production every year. The production of soy milk is an aqueous extraction process of soybeans that comprises soaking of the bean in water, mechanical grinding, and filtration of the insoluble fraction and pasteurization of this solution. This milk alternative contains fats, carbohydrates, proteins, vitamins, minerals, and phytochemicals such as isoflavones and soy saponins (Davy and Vuong, 2020). Soybean not only comprises high quality protein but contain almost all essential amino acids with greatly digestibility of about (92-100%) is stored in protein storage particles called aleurone grains compose on mainly two proteins called globulin and glycinin account for about 80% of total proteins. Other proteins present in soybean are trypsin inhibitor, hemagglutinin and lipoxygenases. It also contains healthy fat profile such as high in polyunsaturated fatty acids (PUFA) such as 22.8% oleic acid, 57.6% linolenic acids and 14% stearic and palmitic acids and low in saturated fatty acids (SAFA) with carbon number less than 14 at the ratio of (82:18). It also contains the bioactive phytochemical like isoflavones, phytic acid, saponins and phytosterol etc. (Kundu *et al*., 2018).

Soybean is processed to making soymilk which can serve as the substitute of cow, buffalo and goat milk as is best for the people who are allergic to milk lactose sugar as they are lack of lactase enzyme in their GIT and for the children of galactosemia (Jiang *et al.*, 2013).It is best for the lactose intolerant people and best source of proteins who are vegetarian, means they do not consume meat, poultry, fish and due to some religionist values ,as soy food is rich in proteins and is not only complete plant sourced protein but best alternative of meat protein. (Hassan, 2013). Soybeans are eaten fermented and unfermented, roasted, in pods sauce, tofu, butter, yoghurt, cheese, and soy pickles, among other things like soy flour fortification in grained-based food products. Fermentation has been used to preserve food since the dawn of time. In the current situation, fermentation is a practical technique to increase bioactive moieties and remove anti-nutritional components (Rai and Jeyaram, 2015; Sourabb *et al.,* 2015). Soybean has a distinct spicy flavor and undigested dietary fiber, can induce flatulence. Therefore, fermenting soy milk is the best approach to avoid these problems and increase its acceptability by enhancing its taste and shelf life (Blagden and Gilliland, 2005).

Soymilk is the beverage made from soybean extract in water that's a colloidal solution full of nutrients that nourishing the body. These nutrients are helpful medium for increasing the growth of lactic acid bacteria (Farnworth *et al.,* 2007; Tran and Rousseau, 2013). Now a days the food industries working on the development of good alternative for the consumers based on general acceptability by lactose intolerance and cholesterol free (Schmidt *et al.,* 2016). Lactose deficiency has been reported in many countries like in Mexico, Brazil and Finland is 55%, 28% and 15% respectively. As soybean is lactose and cholesterol free best for nourishing the vegetarians and milk-allergic patients. This is the main reason the demand of non-dairy soy food especially soymilk is increased for the people who are lactose intolerant or vegetarians (Daniel *et al.,* 2010). Soymilk is the best alternative of milk and milk products as they are increasing day by day around the world with incoming future. Greater than 6 billion people consumed milk and milk products around the world. Worldwide the total milk production has been estimated 843 million tons in 2018, with the increase of 2.2 percent from 2017. Bovine milk is consumed all over the world and it consist of some antimicrobial agents which improve health and also comprises a complex combination of lipids (3-6%). It contains so many macronutrients and micro-nutrients. Macronutrients include fat, protein, carbohydrates, and fiber as well as micronutrients contain vitamins and minerals. At high storage temperature for psychotropic, the growth of bacteria in milk can causes the spoilage of milk (Saini and Morya, 2021). Soymilk has beany flavor which has negative impact on its flavor and consumer acceptability. Beany flavor is removed by using good and appropriate temperature and blanching techniques such as by changing the time of boiling during blanching and also by using different concentration of $NaHCO_3$. So, appropriate processing condition, flavoring and proper storage temperature mask beany flavor and increases the taste and storage life of soymilk. To eradicate the beany flavors blanching with hot water is very effective because hot water has been observed to deactivate lipoxygenase ;The enzyme which generating the off-flavor (Lv *et al.*, 2011).

Objectives:

This study is aimed to get the following objectives:

- To study the physicochemical and sensory attributes of almond flavored soymilk
- To assess the quality shelf life during storage

Materials and Methods

Procurement of raw material

The Ajmeeri variety for the preparation of soymilk was collected from National Agriculture Research Center (NARC), Islamabad. Distilled water was taken from the soil sciences department of (UAF). Almond flavor, Muslin clothes and bottles of 500g was taken from the Qadri Mart of University of Agriculture, Faisalabad.

Preparation of Soymilk

Taking (750g) of Soybean seed were soaked for 24 hours at 14 ℃, cleaned it by using de-ionized water. Then, it was blanched at with different concentrations of $NaHCO_3$ including 1.25%, 1.5%, 1.75% and 2% for 25, 20, 15 and 10 minutes at 100 ℃ respectively so that to inactivate the lipoxygenase and anti-nutritional factors. The blanched beans were drained, de-hulled and grounded by the grinder followed by the addition of bottled drinking water in the ratio of (3:1). The resulting slurry was filtered by using muslin cloth and extracted milk was pasteurized at 71 ℃ for 15 minutes by adding 5 pods of cardamom and sugar. Gradually, Adding the CMC in small amount of soymilk in the grinder and mixing it continuously in whole soymilk at about 40 ℃. So, that no lumps formation was occur and require able consistency was achieved. Almond Flavor and preservative were added after cooling. Then bottled it and was stored at 4 ℃.

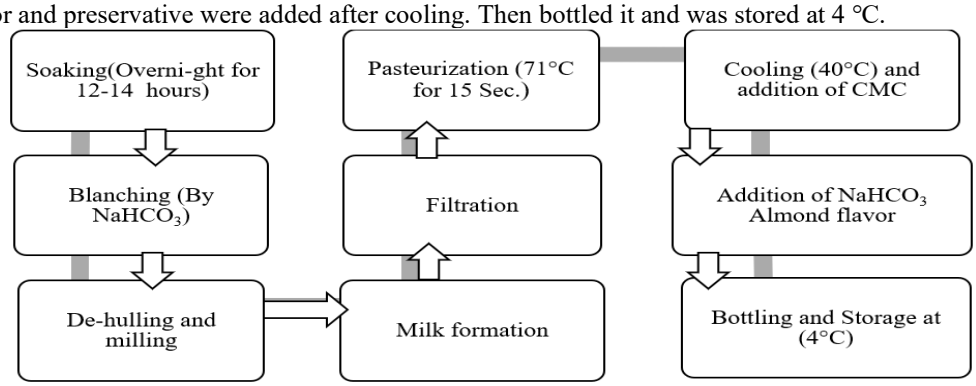

Table. Treatment Plan for development of Soymilk
Treatment Plan:

Treatment	Sodium bicarbonate	Heating time(min)
T_0(Control)	**-**	**30**
T_1	**1.25%**	**25**
T_2	**1.5%**	**20**
T_3	**1.75%**	**15**
T_4	**2%**	**10**

Blanching at 100 ℃ by altering the heating time and concentration of sodium bicarbonate affected the shelf life and quality of the product.

Storage Study
12 days storage study for analysis of soymilk was performed after every 4 days intervals.

Table. Storage Study

Study	Storage days
1	0
2	4
3	8
4	12

Proximate Analysis:
Soy sample was analyzed for proximate analysis like moisture, crude protein, crude fat, crude fiber and ash according to their respective methods described in AOAC, (2016). Soybean was grounded into fine flour for further analysis. Detailed protocols for these methods are given below:

Moisture:
The moisture content of soybean was determined by hot air oven according to the described by AOAC (2016). The 10 g of grounded sample of soybean was taken and put it into hot air oven at 105±5 ℃ for 24 hours. Taking out the sample with the help of tong and keep it into desiccator till cool it at room temperature. Then, weight it in closed air chambered digital weighing balance. The moisture percentage was determined by the following formula:

$$\text{Moisture (\%)} = \frac{\text{Weight (g) of sample before drying-Weight (g) of sample after drying} \times 100}{\text{Weight (g) of sample before drying}}$$

Crude Protein
Total Nitrogen
Nitrogen from the sample was converted into ammonium sulfate which was entrapped in boric acid by converting in ammonia gas through distillation assembly. Then, that solution was titrated against known normality of acid.

Reagents
i. H_2SO_4
ii. Digestion tablets
iii. 2% boric acid solution
iv. Methyl indicator
v. 0.1 N NaOH
vi. 0.1 N H_2SO_4

Procedure
0.5 gram of grounded soybean was weighed by weighing balance and put it into digestion tube along with digestion tablet and 30 ml of concentrated H_2SO_4.Firstly, digestion was done slowly for 45 minutes for avoiding the bubbling and then performed at high temperature till the appearance of clear or pale green color and sample was cooled for half an hour. Then, the solution was transferred in 250 ml volumetric flask after rinsing it 2-3 times and add distilled water for attaining the total volume of 250 ml of the sample.

Distillation
10 ml of sample and 10 ml NaOH was taken in measuring flask and 4% boric acid with few drops of methyl indicator was taken in conical flask and assembled it in digestion assembly. The ammonia gas produced on heating the solution was entrapped in boric acid solution and changes its color from red to yellow. The distillation was continued for 2-3 minutes after appearing the yellow color so that the maximum ammonia was catch.

Titration
Titrated the nitrogen containing boric acid solution against 0.1 N H_2SO_4 and methyl red indicator till the light pink color appeared which indicated the end point. The amount of H_2SO_4 used to neutralize the ammonium hydroxide was noted.

Calculation
Total nitrogen percentage was determined using the formula given below and the result was multiplied by the factor 6.38 in order to obtain total crude protein.

$$\text{Nitrogen (\%)} = \frac{\text{Volume of H2SO4 used (ml) x 250 x 0.0014 x 100}}{\text{Vol. used for digestion x Vol. of digested sample}}$$

Crude Fat
The 10 g grinded soybean flour was used for the analysis of crude fat according to AOAC (2016). Oven dried 10 g sample was placed in thimble by using n-hexane extraction solvent in Soxhlet apparatus.4-5 washing was performed for the complete extraction of fat from the sample till the solvent color was changed. Then dry the sample by hot air oven and measured by weighing balance to check the difference in weight before and after washing of fat from the sample for calculating the fat percentage by given formula.

$$\text{Crude Fat (\%)} = \frac{\text{Wt. of sample before washing (g) – Wt. of sample after fat extraction (g)} \times 100}{\text{Wt. of sample (g)}}$$

Crude Fiber
The moisture and fat free sample was used for the crude fiber estimation. The 5 g sample was digested by with 1.25% H_2SO_4 and 1.25 % NaOH respectively by heating on hot plate oven till the fumes was disappeared and then filtered by muslin clothe. The filtrate was dried by hot air oven then, charring was done on hot plate till the color was blacked and no fumes were present. The ignited sample was measured and then put it into muffle furnace at 550-650 ℃ for 4 hours till
the white or grayish ash was obtained. Crude fiber was estimated by the difference in weight of ignited sample and sample after ash. The crude fiber was calculated by given formula.

$$\text{Crude Fiber (\%)} = \frac{\text{Weight loss on ignition (g) – Weight after ash (g)} \times 100}{\text{Weight of sample (g)}}$$

Ash Content
The ash content of soybean flour was determined by using the method of AOAC (2016). 10 g sample in crucibles was charred on hot plate till there were no fumes coming out. Afterward the sample was put in muffle furnace (MF-102, PCSIR, Pakistan) for ignition of remaining contents besides the mineral residues at 550-650℃ for 5-6 hours until grayish white residues were obtained.

$$\text{Ash (\%)} = \frac{\text{Weight of Ash residues (g)} \times 100}{\text{Weight of sample (g)}}$$

Physicochemical Test
Titratable acidity, pH, total soluble solids and specific gravity of soymilk were analyzed in physicochemical test which are described below in detail.

pH:
According to the method of AOAC (2016) the pH of soymilk was determined by pH meter. Firstly, the pH meter was calibrated with buffer solution and then put the sample in beaker washed with distilled water. Inserted the electrode in beaker by rinsing it with distilled water and the displayed reading on the digital meter was noted.

Determination of Titratable acidity:
The Titratable acidity of soymilk was determined as the sourness or acidity affected its quality and shelf stability, which indicates its aging factor and the way to proceed and transported.

Material
- Sample of soymilk
- Titration flask
- Pipette
- Burette
- 0.1 N NaOH
- Phenolphthalein

Procedure

In titration flask, 10 ml of soymilk was taken and add 2-3 drop of phenolphthalein indicator. After that, the 0.1 N solution of NaOH was allowed to add drop to drop by continuously shaking of the sample. The process was continued till the appearance of pink color and the reading was noted.

$$\text{Acidity (\%)} = \frac{\text{Vol. of 0.1 N NaOH solution is used (ml)} \times 0.009 \times 100}{\text{10 ml}}$$

(AOAC, 2016)

Total Soluble Solids

Firstly, the refractometer was calibrated before measuring and clean the surface with distilled water to get zero reading. By taking 10 ml sample in beaker, taking 1-2 drops with the help of dropper and put on the clean surface of prism and the reading was noted.
(AOAC, 2016)

Specific gravity

Taking soymilk sample by mixing well and poured it into dry cylinder. Lactometer was put in it so that it was not touched to the wall of cylinder. Reading was noted when the lactometer was stable and calculation was done by using the following formula.

$$\text{Specific gravity} = \frac{\text{Corrected lactometer reading} + 1}{1000}$$

Corrected lactometer reading (CLR) = LR + CF

Mineral Analysis

Mineral analysis for calcium, sodium and potassium of soybean were performed by flame photometer (Sherwood Scientific Ltd., Cambridge, Model 410) and magnesium by using atomic absorption spectrophotometer (AAS). Wet digestion was done for the preparation of sample by taking (0.5 ml) of soymilk and digested by using 5ml of 65% HNO_3 and 2ml of 35% H_2O_2 on hot plate until the solution was cleared and no further fume were appeared. After that the samples were filtered and diluted by using distilled water to make the volume up to 50 ml for further analysis on flame photometer and atomic absorption spectrophotometer (AOAC, 2016).

Sensory Analysis

The sensory analysis for color, taste, aroma and overall acceptability for soymilk were done by using 9-point hedonic scale. The expert judgmental panel marked it by giving their opinion on extremely, very much, slight or neither liking and disliking the almond flavored soymilk. The color was also analyzed by hunter lab color meter by note done the reading of L, a, b and calculated by given formula.

Hue= a/b

Chroma = $(a^2 + b^2)^{1/2}$

Color score = $(L^2 + a^2 + b^2)^{1/2}$

Results and Discussion

The goal of this research project was to use the Ajmeeri type to create soy milk with an almond flavor. The purpose of the study was to remove the beany flavour from soy milk using almond flavor and various blanching techniques. Soy milk extraction from soybean seeds was the first stage. The second phase involved preparing several treatments of blanched soy milk by adding NaHCO3 at various concentrations and varying the boiling time for experimental purposes. A variety of physicochemical analyses were performed to assess the qualitative characteristics of soy milk with an almond flavor. Additionally, sensory analysis, color measurements, and mineral analysis were done. The University of Agriculture, Faisalabad's dairy lab, meat lab, and high-tech lab all carried out these analyses.

These were the treatments of almond flavored soy milk:

T_0 = plain soy milk blanched for 30 minutes

T_1 = Almond flavored soymilk with 1.25% $NaHCO_3$ blanched for 25 minutes

T_2 = Almond flavored soymilk with 1.5% $NaHCO_3$ blanched for 20 minutes

T_3 = Almond flavored soymilk with 1.75% $NaHCO_3$ blanched for 15 minutes

T_4= Almond flavored soymilk with 2% $NaHCO_3$ blanched for 10 minutes

Table. Mean values for proximate analysis of raw material

Proximate analysis	**Mean value + SD**
Moisture (%)	11.96±0.21
Protein (%)	37.01±0.11
Fat (%)	23.56±0.57
Ash (%)	4.97±0.64
Crude fiber (%)	10.81±0.26

pH

The pH directly affects the biochemical changes that occur during storage, which has an impact on how consumers perceive the product's flavour. According to the results shown in table, the pH of the almond-flavored soy milk ranged from 6.61 to 7.44 on average. There were five treatments: T_0, T_1, T_2, T_3, and T_4. Treatment T_0 displayed the greatest mean pH value of 8.93, while treatment T_4 displayed the lowest mean pH value of 5.73. Research storage days were divided into intervals of 0, 4, 8, and 12 days. The lowest mean value of pH was 5.73 after a 12-day interval, while the highest mean value of pH 8.93 was displayed at 0 days.

Table. Effect of different treatments and storage on pH of almond flavored soy milk

Treatments	pH				Means
	0 Day	4 days	8 Days	12 Days	
T_0	7.46±0.11^{fg}	7.35±0.01^{g}	6.40±0.01^{j}	5.25±0.26^{o}	**7.77±1.81^{a}**
T_1	9.15±0.03^{bc}	8.35±0.01^{e}	7.35±0.02^{g}	6.11±0.03^{k}	**7.74±1.69^{b}**
T_2	9.04±0.06^{c}	7.50±0.03^{f}	6.72±0.03^{i}	5.94±0.06^{l}	**7.30±1.33^{c}**
T_3	9.25±0.02^{b}	8.50±0.02^{d}	6.20±0.02^{k}	5.81±0.05^{m}	**7.24±1.31^{a}**
T_4	9.76±0.01^{a}	8.55±0.02^{d}	7.23±0.02^{h}	5.54±0.03^{n}	**6.61±1.03^{d}**
Means	**8.93±0.87^{a}**	**8.05±0.58^{b}**	**6.78±0.50^{c}**	**5.73 ±0.34^{d}**	

Titratable Acidity

The entire number of free protons and dissociated acid in a solution that can be neutralized by a reaction with a storage base may be considered its definition. Since pH and titratable acidity are inversely related, a rise in TA tends to lower pH value while a reduction in TA results in an increase in pH value. According to AOAC, titration using a diluted, standardized alkali solution using either a glass electrode or an end point indicator can be used to assess titratable acidity (2016). The mean values of various treatments in relation to storage interval or storage days are shown in Table. The computed values, according to the table, fell between 0.48 and 0.59. There were five treatments: T_0, T_1, T_2, T_3, and T_4. Treatment T_3 displayed the highest mean titratable acidity (TA) value of 0.82 while treatment T0 displayed the lowest mean value of 0.48. Research storage days were divided into intervals of 0, 5, 10, and 15 days. After 8 days, the titratable acidity (TA) showed its greatest mean value of 0.72, while the lowest mean value was 0.45 after a 0-day interval. Spiced soy milk demonstrated an increase in titratable acidity from 0.45 (0 day) to 0.69. (12 day). Ajala *et al*. (2013) who studied with spiced corn-soy milk and discovered that the acidity of milk greatly increased after storage provide support for this study.

Table. Effect of different treatments and storage on TA (%) of almond flavored soy milk

Treatments	Titratable Acidity				Means
	0 Day	4 days	8 Days	12 Days	
T_0	0.36±0.01^{h}	0.54±0.006^{f}	0.45±0.01^{g}	0.57±0.001^{ef}	**0.4817 ±0.10^{e}**
T_1	0.54±0.0.01^{f}	0.54±0.001^{f}	0.543±0.006^{f}	0.059±0.005^{ef}	**0.5525±0.02^{d}**
T_2	0.37±0.01^{h}	0.45±0.015^{g}	0.807±0.015^{d}	0.88±0.026^{c}	**0.6275±0.25^{b}**
T_3	0.627±0.005^{e}	0.55±0.025^{f}	1.017±0.073^{b}	1.107±0.015^{a}	**0.8258±0.28^{a}**
T_4	0.367±0.01^{h}	0.37±0.006^{h}	0.807±0.015^{d}	0.84±0.01^{cd}	**0.5933±0.27^{c}**
Means	**0.45±0.12^{c}**	**0.49±0.08^{b}**	**0.72±0.23^{ab}**	**0.69±0.40^{a}**	**0.18±0.12^{c}**

Total soluble solids

Total soluble solids concentration is a crucial factor in the food industry's evaluation of beverages. For soy milk's lipid and protein content, as well as its nutritional value, its recovery from soybean is crucial (Rinaldoni *et al.,* 2012). The mean values of several treatments are shown in table with regard to storage days or intervals. The table displayed mean values that ranged from 3.141°Brix to 5.07°Brix. There were five treatments: T_0, T_1, T_2, T_3, and T_4. Treatment T_4 displayed the greatest mean value of 5.07 °Brix, while T_0 displayed the lowest mean value. Research storage days were divided into intervals of 0, 4, 8, and 12 days. The lowest mean value of TSS was 3.141 °Brix at 0 day, while the highest mean value was 5.07 °Brix at day 12.

Table. Effect of different treatments & storage on TSS of almond flavored soy milk

Treatments	Total soluble solids				Means
	0 Day	4 days	8 Days	12 Days	
T_0	3.02±0.02^{e}	3.07±0.04^{e}	3.09±0.15^{e}	3.10±0.01^{e}	**3.141±0.04^{a}**
T_1	4.91±0.03^{b}	5±0.01^{ab}	5.06±0.05^{a}	5.08±0.005^{a}	**4.014±0.08^{a}**
T_2	1.433±0.06^{g}	1.43±0.12^{g}	1.59 ±0.02^{f}	1.58±0.01^{f}	**4.51±0.09^{a}**
T_3	4±0.01^{d}	4.03±0.05^{d}	4.12±0.06^{cd}	4.17±0.03^{c}	**4.58±0.08^{a}**
T_4	4.99±0.005^{ab}	5.08±0.03^{a}	5.09±0.01^{a}	5.10±0.03^{a}	**5.07±0.049^{a}**
Means	**3.67±1.48^{a}**	**3.72±1.52^{a}**	**3.79±1.47^{a}**	**3.806±1.49^{a}**	

Specific Gravity

The mean values of various treatments in relation to storage interval or storage days are shown in Table. The table demonstrated that there was no discernible difference between the calculated mean values. There were five treatments: T_0, T_1, T_2, T_3, and T_4, and there was no variation in the specific gravity of the milk between them. Research storage days were divided into intervals of 0, 5, 10, and 15 days. The average values across all treatments were stable and did not significantly alter. This research supports the findings of Basharat *et al.* (2020), who investigated the physicochemical characteristics of soy milk and found that specific gravity did not vary significantly over time.

Table. Effect of different treatments & storage on Specific gravity of almond flavored soy milk

Treatments	Specific gravity				Means
	0 Day	4 days	8 Days	12 Days	
T_0	1.03±0.001^{cd}	1.032±0.003^{bc}	1.0303±0.001^{cd}	1.032±0.001^{bc}	**1.031±0.001^{c}**
T_1	1.02±0.003^{f}	1.036±0.001^{ab}	1.0363±0.0005^{ab}	1.0393±0.002^{a}	**1.033±0.009^{b}**
T_2	1.026±0.001^{de}	1.023±0.001^{ef}	1.024±0.0006^{ef}	1.027±0.001^{de}	**1.025±0.002^{d}**
T_3	1.037±0.0036^{a}	1.035±0.0015^{ab}	1.036±0.0006^{ab}	1.038±0.001^{a}	**1.037±0.001^{a}**
T_4	1.038±0.001^{a}	1.036±0.001^{ab}	1.038±0.0006^{a}	1.040±0.001^{a}	**1.038±0.002^{a}**
Means	**1.0302±0.008^{c}**	**1.0324±0.006^{b}**	**1.0329±0.006^{b}**	**1.0352±0.005^{a}**	

Mineral Analysis

The body's healthy operation and the production of hormones and enzymes depend on minerals. Calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), iron (Fe), manganese (Mn), copper (Cu), and zinc (Zn) are all minerals found in soybeans (Costa *et al.*, 2015).

Sodium

The average values of various treatments are shown in Table, in relation to the amount of sodium present in parts per million (ppm). There were five treatments, labelled T0, T1, T2, T3, and T4, with relative sodium concentrations of 25.33+1.53, 34.66+0.58, 28.33+0.57, 34+1, and 36.33+1.53 ppm. The outcome makes it clear that there was a considerable variation in sodium content between the various treatments. T4 had the highest salt content, whereas T0 had the lowest.

Table. Mean values for sodium in almond flavored soy milk

Treatments	Mean Values + SD
T_0	25.33±1.53
T_1	34.66±0.58
T_2	28.33±0.57
T_3	34±1
T_4	36.33±1.53

Potassium

The average values of several treatments are shown in Table, with respect to the amount of potassium present in parts per million (ppm). There were five treatments: T_0, T_1, T_2, T_3, and T_4, with relative potassium concentrations of 6.5+0.5, 5.6+0.53, 4.4+0.36, 6.27+0.64, and 7.07+0.60 ppm. The outcome makes it clear that there was a considerable difference in potassium content between the various treatments. T4 had the highest potassium value, whereas T2 had the lowest. The findings of the current study are consistent with Porter and Jones' (2003) analysis of the nutritional content of soy flour, which determined K to be 2333 mg/100g. Similar to this, Shi *et al.* (2010) found that the germinated soybean had the greatest potassium concentration at 1900 mg/100 g.

Table. Mean square values for potassium in almond flavored soy milk

Treatments	Mean Values + SD
T_0	6.5±0.5
T_1	5.6±0.53
T_2	4.4±0.36
T_3	6.27±0.64
T_4	7.07±0.60

Calcium

The average values of various treatments are shown in Table, in relation to the calcium concentration, which was given in parts per million (ppm). There were five treatments, labelled T_0, T_1, T_2, T_3, and T_4, with respective calcium concentrations of 131.83+4.07, 111.73+2.86, 100.5+1.32, 124.5+1.32, and 77.17+2.84 ppm. The outcome makes it clear that there was a considerable variation in calcium content between the various treatments. T_0 had the highest calcium

levels, whereas T_4 had the lowest. The findings of the current study are consistent with those of Ozcan and Al-Juhaimi (2014), who estimated that soybeans contain 287.9 mg of calcium per 100g.

Mean values for calcium in almond flavored soy milk

Treatments	Mean Values + SD
T_0	131.83±4.07
T_1	111.73±2.86
T_2	100.5±1.32
T_3	124.5±1.32
T_4	77.17±2.84

Magnesium

The average values of various treatments are shown in Table, in relation to the amount of magnesium present in parts per million (ppm). There were five treatments: T_0, T_1, T_2, T_3, and T_4, with respective magnesium concentrations of 67.567+0.51, 73.167+1.04, 61.900+1.65, 70.333+1.53, and 68.167+0.7 ppm. The outcome makes it clear that there was a considerable difference in magnesium content between the various treatments. Magnesium levels were highest in T_1 and lowest in T_2, respectively. According to the findings presented in Table, magnesium was the second most common mineral discovered in the soy milk samples used in this study. The findings of this study are consistent with those of Costa *et al*. (2015), who stated that the average magnesium concentration of soybeans was 218.52 mg/100g.

Color Measurements

Using a colorimeter, samples were examined for color analysis. L, a, and b were recorded as the intensity values utilized for color assessment.

• L signifies lightness and darkness using a reading scale of 0 to 100. 100 is the brightest while 0 is the darkest.

• A represents the range of red and green color intensities (0–60), with the plus sign denoting red and the minus sign denoting green.

• The symbol b expresses the range of blue and yellow intensity from 0 to 60, with the plus sign denoting yellowness and the minus sign denoting blue intensity.

L* value

The sample's lightness is indicated by the L value. Table, presents the variance analysis for L. Table, displays the mean values. The estimated values, according to the table, fell between the ranges of 19.933 and 44.767. There were five treatments: T0, T1, T2, T3, and T4. Treatment T4 displayed the highest mean value of L 44.767 while treatment T0 displayed the lowest mean value of 19.933. The results of the colour analysis were consistent with those of the study by Vuki *et al* (2018).

Table. Mean values for Color L* of almond flavored soy milk

Treatments	Mean Values + SD
T_0	19.933 ± 0.58^{e}
T_1	39.827 ± 0.22^{b}
T_2	33.940 ± 0.05^{d}
T_3	38.803 ± 0.10^{c}
T_4	44.767 ± 0.03^{a}

a* value

The sample's lightness is indicated by a* value. The analysis of variance for a value was shown in Table, while the mean values are shown in Figure 4.22. The estimated mean values fell between the ranges of 0.8800 and 1.4133. There were five treatments, labelled T_0, T_1, T_2, T_3, and T_4, with T_1 having the greatest mean value of 2.0433 and T_0 having the lowest mean value of 0.8800. The results of the color analysis were consistent with those of the study by Vuki *et al* (2018).

Table. Mean values for Color a* of almond flavored soy milk

Treatments	Mean Values + SD
T_0	0.8800 ± 0.03^{c}
T_1	2.0433 ± 0.03^{a}
T_2	1.1233 ± 0.20^{c}
T_3	1.6733 ± 0.09^{b}
T_4	1.4133 ± 0.06^{b}

b* value

The sample's yellowness is depicted by the b value. The analysis of variance for b is presented in Table. According to Table, the calculated means fell between the ranges of 5.077 and 12.157. There were five different treatments (T_0, T_1, T_2, T_3, T_4), and T_4 had the highest mean value of b (12.157) and the lowest mean value (5.077). The results of the color analysis were consistent with those of the study by Vuki *et al* (2018).

Table. Mean values for Color b* of almond flavored soy milk

Treatments	Mean Values + SD
T_0	5.077 ± 0.20^{d}
T_1	8.883 ± 0.10^{c}
T_2	9.870 ± 0.06^{b}
T_3	10.027 ± 0.27^{b}
T_4	12.157 ± 0.16^{a}

Sensory evaluation

The global demand for food is rising as a result of the promotion of fierce competition, high-quality products with extended shelf lives at affordable prices, and more options with no trade restrictions everywhere. The industry's ability to innovate new functional products, raise consumer awareness of their health benefits, and execute and measure them effectively are key factors in this difficult context. An essential tool for processing all of information is the sensory evaluation. An essential first step in understanding consumer perception of a value-added product is sensory evaluation of soy milk. The four periods of soy milk were assessed using a 9-point hedonic scale for the attributes of flavor, mouth feel, and general acceptability.

Flavor

Flavor may affect consumer perceptions and behavior in the food business. Consumers are first attracted to a product's flavor before learning about its health benefits. Consumers are less likely to enjoy the beany and astringent flavor of soy in its natural state. Therefore, the primary goal of soy functional food is flavor development. As a result, increasing the sensory qualities of products by integrating useful ingredients like lemon grass extract and ginger juice can increase consumer interest in soy-based products. Spice addition gives the opportunity to change the sensory characteristics of products made from soy. The mean values of various treatments with regard to storage days or intervals are shown in Table. The estimated values, according to the table, fell between 7.550.88 and 7.060.66. There were five different treatments (T_0, T_1, T_2, T_3, and T_4). Treatment T_4 had the highest mean flavor value (8.010.52) and the lowest mean value (6.180.43). The flavor of spiced soy milk showed a trend toward waning during the course of the 12-day storage period. Research storage days were divided into intervals of 0, 4, 8, and 12 days. After 12 days, the mean value was shown to be 7.030.66 at its lowest, and at 0 days, it was 7.550.87 at its highest. Ajala *et al.* (2013), who worked on corn-soy milk with the addition of spices (ginger), provided support for this study by reporting that spices can greatly improve the flavor of soy milk. Another study by Laswai *et al.* (2009) found that the beany flavor of soy milk can be reduced by adding ginger and lemon grass to a beverage. By incorporating ginger juice into soy milk powder, a team of scientists Zhou *et al.* (2004) observed that the flavor characteristics of soy milk were greatly improved.

Table. Effect of different treatments and storage on Flavor of almond flavored soy milk

Treatments	Flavor				Means
	0 Day	5 days	10 Days	15 Days	
T_0	6.33 ± 0.56^{abc}	6.13 ± 0.53^{bc}	6.05 ± 0.01^{c}	6.11 ± 0.57^{c}	**6.18 ± 0.43^{b}**
T_1	7.11 ± 0^{abc}	7.23 ± 0.57^{bc}	7.02 ± 0.53^{bc}	6.97 ± 0.03^{c}	**6.56 ± 0.50^{b}**
T_2	7.66 ± 1.15^{abc}	7.13 ± 0.57^{abc}	7.12 ± 0.55^{abc}	$7.12\pm1.51b^{c}$	**7.10 ± 0.41^{b}**
T_3	8.01 ± 1^{abc}	7.90 ± 1.15^{abc}	7.67 ± 0.56^{abc}	7.01 ± 1.51^{abc}	**7.22 ± 0.53^{b}**
T_4	8.68 ± 0^{a}	8.31 ± 1.15^{ab}	8.32 ± 0.58^{abc}	8.11 ± 0.52^{abc}	**8.01 ± 0.52^{a}**
Means	**7.55 ± 0.87^{a}**	**7.34 ± 0.74^{a}**	**7.06 ± 0.70^{ab}**	**7.03 ± 0.66^{b}**	

Mouthfeel

Mouthfeel is a separate parameter of the sensory evaluation of a product since it is described as the physical experience of food or drinks in the oral cavity. Along with flavor, fragrance, and taste, it is regarded as a fundamental quality that helps gauge how well-liked a manufactured food product would be. It is also frequently referred to as an item's texture quality. The sensory evaluation panelists in this study were also going to test the texture of spiced soy milk. The mean values of several treatments were shown in Table 4.31 with regard to storage days or intervals. The estimated values, according to the table, fell between 7.88 and 0.81 and 7.46 and 0.65. There were five treatments: T_0, T_1, T_2, T_3, and T_4. Of the five, T_4 had the greatest mean mouthfeel (8.530.42) and T_0 had the lowest mean (6.780.43). Research storage days were divided into intervals of 0, 4, 8, and 12 days. After 12 days, the mean value is shown to be 7.460.65, while at 0 days, it is 7.780.81. The texture of soy milk can be improved by adding blends of ginger and lemon grass, according to another

study by Laswai *et al.* (2009). The outcomes of this study are supported by a study by Kieling and Prudencio (2017) that looked at soy milk beverages with lime juice and lemon grass extract added. They suggest adding spices and lemon grass extract to increase the acceptance of soy milk.

Table. Effect of different treatments and storage on Mouthfeel of almond flavored soy milk

Treatments	Mouthfeel				Means
	0 Day	5 days	10 Days	15 Days	
T_0	6.65±0.57^{abc}	6.33±0.53^{bc}	6±0^{c}	5.66±0.57^{c}	**6.78±0.43^{b}**
T_1	7.22 ±0.1^{abc}	7.01±0.58^{bc}	6.23±0.43^{bc}	6.77±0.01^{c}	**7.31±0.45^{b}**
T_2	6.65±1.05^{abc}	7.43±0.47^{abc}	6.55±0.65^{abc}	6.13±1.52b^{c}	**7.71±0.42^{b}**
T_3	7.91±1.11^{abc}	6.76±1.14^{abc}	7.03±0.54^{abc}	6.87±1.58^{abc}	**7.93±0.43^{b}**
T_4	8.68±0.17^{a}	8.03±1.55^{ab}	7.76±0.47^{abc}	7.43±0.58^{abc}	**8.53±0.42^{a}**
Means	**7.78±0.81^{a}**	**7.71±0.75^{a}**	**7.50±0.66^{ab}**	**7.46±0.65^{b}**	

Overall acceptability

The degree to which a product is generally regarded favorably determines its acceptance rate. Any product's quality is mostly determined by its sensory attributes, of which general acceptance ranks at the top. After testing a product's color, scent, texture, flavor, and general acceptability, the industry always develops it. In order for the spiced soy milk to be commercialized and gain public acceptability, all of these qualities were likewise removed (Granato *et al.,* 2010). The mean values of several treatments were shown in Table, with regard to storage days or intervals. The estimated values, according to the table, fell between 6.790.45 and 8.530.48. There were five treatments: T_0, T_1, T_2, T_3, and T_4. Treatment T_4 had the highest mean of overall acceptability (8.530.48) and the lowest mean value (6.790.45). During storage, the overall acceptability of spiced soymilk decreased. Research storage days were divided into intervals of 0, 4, 8, and 12 days. The greatest mean value was 7.810.76 after 0 days, while the lowest mean value was 7.800.65 after 12 days. The study is consistent with Ma *et al.* (2015), who investigated soy milk made from seeds of various genotypes of soybeans and found that, noticeably, the overall acceptability was only affected by genotypes and independent of two environments in this study, which implied that it could be a stable parameter in soy milk sensory evaluation among soybean genotypes. They looked at the correlation coefficient (r), which revealed a substantial and favorable relationship between the overall acceptability and other soy milk sensory metrics. This implied that general acceptability was a crucial sensory quality.

Table. Effect of different treatments and storage on Overall acceptability of almond flavored soy milk

Treatments	Overall acceptability				Means
	0 Day	5 days	10 Days	15 Days	
T_0	6.64±0.55^{abc}	6.31±0.52^{bc}	6.33±0.35^{c}	5.65±0.66^{c}	**6.79 ±0.45^{b}**
T_1	7.05 ±0.1^{abc}	7.77±0.56^{bc}	6.32±0.43^{bc}	6.66±0.53^{c}	**7.28±0.51^{b}**
T_2	6.65±1.25^{abc}	7.37±0.48^{abc}	6.67±0.65^{abc}	6.03±1.41b^{c}	**7.88±0.55^{b}**
T_3	8.32±1.11^{abc}	8.12±1.05^{abc}	7.23±0.59^{abc}	6.87±1.521^{abc}	**8.25±0.47^{b}**
T_4	8.36±0.71^{a}	8.48±1.05^{ab}	7.76±0.46^{abc}	7.03±0.68^{abc}	**8.53±0.48^{a}**
Means	**7.81±0.76^{a}**	**7.76±0.88^{a}**	**7.80±0.55^{ab}**	**7.80±0.65^{b}**	

T_0 = plain soy milk blanched for 30 minutes
T_1 = Almond flavored soymilk with 1.25% $NaHCO_3$ blanched for 25 minutes
T_2 = Almond flavored soymilk with 1.5% $NaHCO_3$ blanched for 20 minutes
T_3 = Almond flavored soymilk with 1.75% $NaHCO_3$ blanched for 15 minutes
T_4= Almond flavored soymilk with 2% $NaHCO_3$ blanched for 10 minutes

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