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Research Article

DEVELOPMENT AND QUALITY EVALUATION OF STRAWBERRY BASED VALUE ADDED PRODUCTS

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ABSTRACT

Locally grown strawberry fruit was used for the development of strawberry based cottage cheese and cake for the improvement of nutritional status and quality. In product development phase, four kinds of treatments were adopted like T1 (5% strawberry pulp), T2 (10% strawberry pulp), T3 (5% strawberry pulp) and T0 (control). The developed products were analyzed for their sensory characteristics and microbial analysis (TPC). The resultant data indicated that the T2 treatment of strawberry based cake and cream cheese with 10% strawberry pulp was appreciated during sensory profiling whereas, the minimum microbial count was found in T1 at 6 day of storage of cake. Similarly, the minimum count of cream cheese was accessed in T3 at 10 day of storage.

Keywords: **Strawberry, cream cheese, flavored cream cheese, strawberry cake**

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Introduction

The strawberry fruit is popular as "Queen of the fruits" owing to its high nutritional profile and therapeutic potential (Bona et al., 2015). It is a delicate fruit with excellent organoleptic properties (Correia et al., 2011). It is a perennial plant that is a herb and reproduces via seeds and runners. It is an evergreen shrub, belongs to the genus Fragaria and family is Rosaceae. There are about 22 species of genus Fragaria. It was first cultivated in France and North America (Finn et al., 2013). In Pakistan it was first cultivated during 1980 and got fame as ground mulberry (Rajwana et al., 2017). The quality of strawberry is characterized by different parameters including shape, firmness, aroma, color, size and flavor (Bernardi et al., 2012). This fruit have a great importance in terms of production and fall in 4th position. It is ranked as 5th in position due to consumption (Fang, 2014).

The production of strawberry has been reported as 7.7 million tons. The strawberry fruit is cultivated in November and harvesting starts from April to May due to the short maturity period of fruit of about 30 to 40 days. There are number of cultivars of strawberries including Cruz Pocahontas, Toro, Douglas, Corona, Honeyo, Chandler, Gorella, Korona, Polka and tufts. Toro and

Douglas are best for southern areas of Pakistan while Tufts have better results in Islamabad (Afridi *et al*., 2009).

Value addition is a process of adding value to food items with the help of any unit operation including simple washing to development of value added products. Basically, value addition is a vast field for improving overall product characteristics for the benefits of mankind (Parveen *et al*., 2012). About 21% of total strawberry production used for the manufacturing of value added products. Due to short shelf life of strawberry, there are different industrial processes used to improve the shelf-life, quality and commercial value of value added products. These process include freezing, drying, processing into different products like juices, jams, candies, biscuits, jellies, smoothies, yoghurt, purees, pies, ice creams, chocolates, flavored cheese, preserves, cold soup, salad, syrup, cake, popsicles, lassi, energy bar, lemonade, pancake, freeze dried, dehydrated slices, canned products, whole frozen berries, and spry dried. The current research signifies an outline on strawberry fruit processing and its possible value added products with superior importance to Pakistani market (Kowalska *et al*., 2017).

Post-harvest losses of strawberry is a serious issue in Pakistan, the total losses of strawberries from farm to fork is estimated as 30-40% whilst, losses in strawberry fruit decayed and shrink around 10-15% are recorded which reduce the market value and consumer acceptance level. By considering these losses, there is a need of processing for extending the shelf-life and maintaining the quality of strawberry. So keeping in view the post-harvest losses of strawberries we need to secure and prolong the shelf-life of *Fragaria annanassa* by developing innovative, functional and value added product of strawberries. The industrial productions of strawberry produce a food waste that is a rich source of bioactive compounds like sugars and phenols (Gutierrez *et al*., 2018).

Material And Methods

The current study was conducted in the Department of Food Science and Technology (FST) at MNS-University of Agriculture, Multan (MNS-UAM). The planned research work was performed in Microbiology Lab, Hi Tech, Post-Harvest Lab and Soil Testing Lab. In current study, strawberry fruit was used for the product development. Furthermore, the prepared products were subjected for further analysis. All chemicals necessary for instant work was procured from Cayman Chemicals and Sigma Aldrich, Bioassay. The procedures and protocols used for research work are discussed below.

Procurement of raw material

The Chandler variety of strawberry were obtained from Department of Horticulture, MNS-UAM by considering quality traits as size, shape, color, damage & abrasion free and maturity level. The fruit was washed, cleaned and dried before storage. A condition of refrigeration was ensured to maintain the quality of particular fruit.

Characterization of strawberry

During product development phase, strawberry based cake and cream cheese were prepared followed by their sensory evaluation and respective analysis.

Development of value added product

Cake preparation (Product-1)

Cake was prepared by the formation of batter. The egg yolk was mixed with 250 g icing sugar and 250 g butter for 5 minutes. Mixing was done in electric beater to form a shortening (white in color). The egg white was blend with 250g flour in another container. Then 1 teaspoon baking powder, 2-3 drops of strawberry essence was mixed with batter. The mixture was blended uniformly for obtaining the sponge like mixture. 13 g, 25 g and 38 g pulp of strawberry fruit was added as per treatment plan. Greasing of mold was done with

butter. Then mixture was transferred into a mold for baking purpose in an oven at appropriate baking temperature of 180 °C for 30 mins. The baking of cake was checked by inserting the knife in the cake. After baking, manufactured cake was cooled at 18 °C and 75% relative humidity (Sudha *et al*., 2007). The treatment plan to be followed is mentioned in Table 1.

Table 1. Treatment plan for cake preparation

Treatments	Description
T_1	5% Strawberry pulp
T_2	10% Strawberry pulp
T_3	15% Strawberry pulp

1.1.1. Cream cheese preparation (Product-2)

2 litter of buffalo milk was subjected for pasteurization. After pasteurization, the milk was subjected for fermentation at 70 °C by addition of 6 gram citric acid then mixture was transferred into formation of whey and casein protein. Afterwards, the whey and casein protein was separated by draining the whey. Casein was subjected for squeezing on a muslin cloth by the formation of a mold. The prepared chadder cheese was left for cooling. Then cheese was shredded into small pieces. 250 ml cream, 250 g cheese, 50 g icing sugar and strawberry pulp was mixed as per treatment plan in a mixer of about 500 g by the proposed method of Mendes *et al*. (2019). All ingredients were beaten in a beater till the predictable quality. The treatment plan to be followed is mentioned in Table 3.2.

Table 2. Plan for cream cheese preparation

Treatments	Description
T_0	Control
T_1	5% Strawberry pulp
T_2	10% Strawberry pulp
T_3	15% Strawberry pulp

Analysis of value added products

Prepared value added product was subjected for microbial analysis and sensory evaluation.

Microbial analysis of product

Microbial analysis including total plate count and fungal growth was carried out according to the method described in AOAC (2006).

Sensory evaluation

The value added products (T_0, T_1, T_2, T_3) was used for sensory evaluation (color, texture, aroma flavour) following 9-point hedonic scale by the prescribed method of Meilgaard *et al.* (2007).

Statistical analysis

The collected data was subjected to statistical analysis by ANOVA to check the significance differences between treatments by the proposed method of Montgomery (2008).

RESULTS AND DISCUSSION

Sensory profiling of Strawberry based cake

Among different varieties of products, the cake was fortified with strawberry pulp that has been evaluated for its acceptance via sensory profile. Cake was prepared by using strawberry pulp in different concentrations 0%, 5%, 10% and 15% respectively. Bakery products have become a crucial portion for the diet of human all over the world.

Color

The mean standards for the treatment on storage stability of cake shown in Table 3 indicates that storage index found highest in T_2 at 0 day whereas, the minimum values was noticed in T_3 at 6 day of storage. At 0 day of storage, the overall mean values measured as 7.5, 7.6, 7.8 and 7.0 scores for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp), correspondingly whilst at 3 day the overall mean values was observed as 6.9, 5.8, 5.2 and 6.7 scores for T_0, T_1, T_2 and T_3, separately. Similarly, at 6 day, the findings observed as 5.3, 4.6, 4.8 and 3.9 points for T_0, T_1, T_2 and T_3 individually.

The treatment effects for color of the cake are in line with the result of Stavale *et al.* (2018) reported as like moderately. The findings observed during the current exploration are in accordance with the discoveries of Yaqoob *et al.* (2018). The variation in the results of color stability may be due to change in cultivar, processing techniques and quality of the raw material. The variation may be due to the percentage of pulp supplemented in the preparation of cake.

Figure. 1 Strawberry based cake

Table 3 Mean table for sensory evaluation of Cake

Color	Treatment	0 Day	3 Day	6 Day	Mean
	T_0	7.53 ± 1.13^{a}	6.93 ± 0.96^{ab}	5.33 ± 0.72^{c}	6.60 ± 1.14^{a}
	T_1	7.60 ± 0.99^{a}	5.80 ± 1.61^{bc}	4.67 ± 0.83^{cd}	6.02 ± 1.48^{b}
	T_2	7.80 ± 0.86^{a}	5.20 ± 0.86^{c}	4.80 ± 1.01^{cd}	5.93 ± 1.63^{b}
	T_3	7.00 ± 0.85^{a}	6.73 ± 1.03^{ab}	3.94 ± 0.87^{d}	5.89 ± 1.69^{b}
	Mean	7.48 ± 0.34^{a}	6.17 ± 0.81^{b}	4.69 ± 0.57^{c}	
Flavor	T_0	7.00 ± 1.46^{abc}	6.93 ± 0.80^{abc}	5.20 ± 1.15^{de}	6.38 ± 1.02^{a}
	T_1	7.00 ± 1.25^{abc}	6.20 ± 1.15^{bcd}	5.47 ± 1.19^{de}	6.22 ± 0.77^{a}
	T_2	7.73 ± 0.80^{a}	6.07 ± 1.10^{bcd}	4.60 ± 0.74^{e}	6.13 ± 1.57^{a}
	T_3	7.13 ± 0.83^{ab}	5.92 ± 1.04^{cd}	5.78 ± 0.94^{cd}	6.28 ± 0.74^{a}
	Mean	7.22 ± 0.35^{a}	6.28 ± 0.45^{b}	5.26 ± 0.50^{c}	
Aroma	T_0	7.67 ± 1.11^{ab}	7.47 ± 0.83^{abc}	5.27 ± 1.03^{f}	6.80 ± 1.33^{a}
	T_1	7.87 ± 0.99^{a}	6.20 ± 1.15^{def}	$5.60\pm1.05e^{f}$	6.56 ± 1.17^{ab}
	T_2	7.53 ± 1.30^{ab}	6.60 ± 0.99^{bcde}	5.67 ± 1.11^{def}	6.60 ± 0.93^{ab}
	T_3	6.87 ± 0.64^{abcd}	6.27 ± 1.06^{cdef}	5.44 ± 1.10^{ef}	6.19 ± 0.71^{b}
	Mean	7.48 ± 0.43^{a}	6.63 ± 0.58^{b}	5.49 ± 0.18^{c}	
Texture	T_0	7.40 ± 1.40^{ab}	6.47 ± 0.64^{ab}	4.93 ± 0.96^{a}	6.27 ± 1.25^{a}
	T_1	7.27 ± 1.16^{ab}	6.47 ± 1.25^{ab}	4.47 ± 1.16^{b}	6.07 ± 1.44^{a}
	T_2	7.33 ± 1.05^{ab}	6.60 ± 0.83^{ab}	4.60 ± 1.06^{b}	6.18 ± 1.41^{a}
	T_3	6.73 ± 1.10^{ab}	6.33 ± 0.70^{ab}	4.83 ± 1.47^{ab}	5.97 ± 1.00^{a}
	Mean	7.18 ± 0.30^{a}	6.47 ± 0.11^{ab}	4.71 ± 0.21^{b}	
Appearance	T_0	7.33 ± 1.45^{a}	6.47 ± 0.74^{abc}	5.40 ± 0.91^{c}	6.40 ± 0.97^{a}
	T_1	6.87 ± 1.06^{ab}	6.27 ± 1.28^{abc}	5.33 ± 1.00^{c}	6.16 ± 0.77^{a}
	T_2	7.00 ± 1.07^{ab}	6.00 ± 0.93^{bc}	5.47 ± 1.06^{c}	6.16 ± 0.78^{a}
	T_3	6.47 ± 0.83^{abc}	6.20 ± 0.93^{abc}	5.61 ± 0.98^{c}	6.09 ± 0.44^{a}
	Mean	6.92 ± 0.36^{a}	6.23 ± 0.19^{b}	5.45 ± 0.12^{c}	
After taste	T_0	7.13 ± 1.30^{ab}	6.80 ± 0.94^{abc}	5.20 ± 1.15^{def}	6.38 ± 1.03^{a}
	T_1	7.40 ± 1.35^{a}	5.93 ± 1.44^{bcde}	5.40 ± 1.11^{cdef}	6.24 ± 1.04^{a}
	T_2	7.53±0.83a	4.87 ± 1.41^{ef}	4.40 ± 1.30^{f}	5.60 ± 1.69^{ab}
	T_3	6.60 ± 1.30^{def}	5.60 ± 1.35^{cdef}	5.00 ± 0.84^{cdef}	5.73 ± 0.81^{b}
	Mean	7.17 ± 0.41^{a}	5.80 ± 0.80^{b}	5.00 ± 0.43^{c}	

Acceptability	T_0	7.20 ± 1.21^{ab}	6.8 ± 1.01^{abc}	4.87 ± 0.99^{de}	6.29 ± 1.25^{a}
	T_1	7.93 ± 0.88^{a}	6.0 ± 1.41^{bcd}	4.40 ± 1.05^{e}	6.11 ± 1.77^{a}
	T_2	7.67 ± 0.90^{a}	5.60 ± 0.96^{de}	5.00 ± 0.93^{de}	6.09 ± 1.40^{a}
	T_3	7.00 ± 0.76^{ab}	4.87 ± 0.99^{cde}	4.61 ± 0.50^{de}	5.49 ± 1.31^{a}
	Mean	7.45 ± 0.43^{a}	5.82 ± 0.81^{b}	4.72 ± 0.27^{c}	

Flavor

The mean index for the treatment on storage stability of cake shown in Table 3 designates that storage index found highest in T_2 at 0 day of storage whereas the minimum values was perceived in T_2 at 6 day storage. The inclusive mean values observed as 7.0, 7.0, 7.7 and 7.1 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) respectively at 0 day of storage and at 3 day of storage the overall mean values was observed as 6.9, 6.2, 6.0 and 5.9 for the T_0, T_1, T_2 and T_3 respectively whilst at 6^{th} day of storage the total mean was recorded as 5.2, 5.4, 4.6 and 5.7, respectively.

The present study findings for flavor of cake are in harmonization with the result of Stavale *et al*. (2018). Previously, Ghaboos *et al*. (2018) found that flavor of the cake changes significantly during storage which is in justification with the present investigation. The effect of treatment of flavor of the cake is in line with the result of Yaqoob *et al*. (2018). The variation in the results of flavor stability may be due to change in cultivar, climatic condition, processing techniques and quality of the raw material. The variation in the flavor of the cake may be due to the percentage of pulp supplemented.

Aroma

The effect of treatment on storage stability of cake by the mean index shown in Table 3 displayed that storage index found highest in T_1 at 0 day storage whereas the minimum values was perceived in T_0 at 6 day of storage. The overall mean values measured as 7.6, 7.8, 7.5 and 6.8 at 0 day for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) correspondingly and at 3 days of storage the overall mean values was pragmatic as 7.4, 6.2, 6.6 and 6.2 for the T_0, T_1, T_2 and T_3 respectively whilst at 6 days of storage the total mean was noted as 5.6, 5.5, 5.6 and 5.5, respectively.

Earlier Stavale *et al*. (2018), found that aroma of the cake changes significantly during storage which is in line with the findings of the present study. The variation in the results of aroma stability may be due to agronomic practices, climatic condition, processing techniques and quality of the raw material. The variation may be due to percentage of pulp supplemented.

Texture

The treatment effect for mean value on storage stability of cake indicates storage index was highest in T_0 at 0 day storage whereas the lowest value was perceived in T_1 at 6 day of storage. The overall mean values measured as 7.4, 7.2, 7.3 and 6.7 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) respectively at 0 storage and at 3^{rd} the overall mean values was noticed as 6.4, 6.4, 6.6 and 6.4 for the T_0, T_1, T_2 and T_3 respectively whilst at 6 days of storage the total mean was recorded as 4.9, 4.4, 4.6 and 4.7 respectively that can be viewed in Table 3.

The results obtained during the present study are in corroboration with the result of Yaqoob *et al*. (2018). Previously, Ghaboos *et al*. (2018), found that texture of the cake changes significantly during storage which is in line with the findings of the present study. The variation in the results of texture stability may be due to climatic condition, processing techniques, processing equipment and quality of the raw material.

Appearance

The mean square index for the treatment on storage stability of cake found top value in T_0 at 0 day storage whereas the minimum values was apparent in T_1 at 6 day of storage. The overall mean values noticed as 7.3, 6.8, 7.0 and 6.4 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) respectively at 0 day of storage and at 3 day of storage the overall mean values was noticed as 6.4, 6.2, 6.0 and 6.2 for the T_0, T_1, T_2 and T_3 respectively whilst at 6 day of storage the total mean was verified as 5.4, 5.3, 5.4 and 5.6 respectively showed in Table 3. Score of T_0 was in highest range due to lower percentage of pulp. Appearance scale varied with the different percentage of strawberry pulp used in preparation of cake.

The present study findings are in harmonization with the result of Ghaboos *et al*. (2018). Previously Kim *et al*. (2014), found that appearance of the cake changes significantly during storage which is in line with the findings of the present study. The variation in the results of appearance stability may be due to varietal variation, processing techniques and quality of the raw material.

After taste

The mean for the treatment effect on storage stability of cake shown in Table 3 indicates that storage index found maximum value in T_2 at 0 day storage whereas the minimum values was accessed in T_2 at 6 day of storage. The overall mean values observed as 7.1, 7.4, 7.5 and 6.6 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) respectively at storage of 0 day and the storage at 3 day was noticed as 6.8, 5.9, 4.8 and 5.6 for the T_0, T_1, T_2 and T_3 respectively whilst at 6 days of storage the total mean was verified as 5.2, 5.4, 4.4 and 5.0, respectively. Score of T_2 was in highest range due to lower percentage of pulp. Appearance scale varied with the different percentage of strawberry pulp used in preparation of cake.

Earlier Goranova *et al*. (2015), found that after taste of the cake changes significantly during storage which is in line with the results of present study. The existing study is in unity with the findings of Kim *et al*. (2014). The variation in the results of after taste stability may be due to varietal variation, processing techniques and quality of the raw material.

Overall acceptability

The mean of treatment on storage stability of cake showed that storage catalogue found supreme value in T_1 at 0 day storage whereas the minimum values was measured in T_1 at 6 day of storage. The overall mean values observed as 7.2, 7.9, 7.6 and 7.0 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) respectively at 0 day of storage study and at 3rd day of study the overall mean values was noticed as 6.8, 6.0, 5.6 and 4.8 for the T_0, T_1, T_2 and T_3 respectively whilst at 6th day of storage the total mean was verified as 4.8, 4.4, 5.0 and 4.6 respectively shown in Table 3. Score of T_1 was in highest range due to lower percentage of pulp. Appearance scale varied with the different percentage of strawberry pulp used in preparation of cake.

In current work, the dose of strawberry pulp was higher in T_3 thereby displaying less acceptance rate due to the low volume of cake than T_1 and T_2. Previously Ghaboos *et al*. (2018), found that overall acceptability of the cake changes significantly during storage which is in line with the present study findings. The current findings are in harmony with the result of Kim *et al*. (2014). The variation in the results of overall acceptability stability may be due to agronomic practices, climatic condition, processing techniques and quality of the raw material.

Table 4 Mean table for sensory evaluation of cream cheese

Color	Treatment	0 Day	5 Day	10 Day	Mean
	T_0	7.3 ± 0.62^{ab}	6.92 ± 1.29^{abc}	5.16 ± 1.14^{e}	6.5 ± 0.35^{a}
	T_1	7.20 ± 0.68^{ab}	6.64 ± 1.50^{abc}	5.6 ± 1.32^{bcde}	6.6 ± 0.43^{a}
	T_2	7.60 ± 1.24^{ab}	5.92 ± 1.44^{abcd}	5.32 ± 1.32^{e}	6.5 ± 0.10^{a}
	T_3	7.27 ± 1.22^{ab}	5.16 ± 1.15^{cde}	4.96 ± 0.86^{de}	5.8 ± 0.1^{a}
	Mean	7.35 ± 0.18^{a}	6.16 ± 0.79^{b}	5.26 ± 0.27^{c}	
Flavor	T_0	7.0 ± 1.20^{ab}	6.6 ± 1.25^{abc}	5.2 ± 1.30^{de}	6.3 ± 0.05^{a}
	T_1	7.4 ± 1.12^{a}	6.2 ± 1.47^{abcde}	5.2 ± 1.23^{bcde}	6.3 ± 0.18^{a}
	T_2	7.3 ± 1.44^{a}	6.3 ± 1.68^{abcd}	5.4 ± 0.93^{cde}	6.3 ± 0.38^{a}
	T_3	7.0 ± 1.00^{abc}	5.9 ± 1.32^{abcd}	4.8 ± 1.51^{e}	5.9 ± 0.26^{a}
	Mean	7.17 ± 0.20^{a}	6.27 ± 0.30^{b}	5.16 ± 0.29^{c}	
Aroma	T_0	7.07 ± 1.28^{ab}	6.44 ± 1.26^{abc}	5.4±1.44c	6.3 ± 0.10^{b}
	T_1	7.00 ± 1.13^{ab}	6.32 ± 1.11^{a}	5.32 ± 1.38^{abc}	6.2 ± 0.15^{a}
	T_2	7.33 ± 0.90^{ab}	6.04 ± 0.98^{abc}	5.33 ± 1.05^{bc}	6.2 ± 0.07^{ab}
	T_3	6.67 ± 1.18^{ab}	5.88 ± 1.20^{abc}	5.00 ± 1.10^{bc}	5.8 ± 0.05^{ab}
	Mean	7.02 ± 0.27^{a}	6.17 ± 0.26^{a}	5.26 ± 0.18^{b}	
Texture	T_0	6.80 ± 0.94^{a}	6.04 ± 1.70^{abc}	5.12 ± 1.17^{bc}	6.0 ± 0.39^{a}
	T_1	6.93 ± 1.83^{a}	5.8 ± 2.10^{abc}	5.12 ± 1.36^{c}	6.0 ± 0.37^{a}
	T_2	6.40 ± 1.30^{ab}	5.92 ± 1.61^{abc}	5.0 ± 0.86^{abc}	5.8 ± 0.38^{a}
	T_3	6.20 ± 1.61^{abc}	5.72 ± 1.14^{abc}	4.79 ± 0.83^{bc}	5.6 ± 0.39^{a}
	Mean	6.58 ± 0.34^{a}	5.87 ± 0.14^{b}	5.0 ± 0.16^{c}	
Appearance	T_0	7.20 ± 1.42^{a}	6.48 ± 1.12^{ab}	5.2 ± 1.22^{c}	6.3 ± 0.15^{a}
	T_1	7.40 ± 1.35^{a}	5.96 ± 1.27^{abc}	5.1 ± 1.32^{c}	6.1 ± 0.04^{a}
	T_2	7.00 ± 1.13^{ab}	5.88 ± 2.01^{bc}	5.3 ± 0.99^{c}	6.0 ± 0.55^{a}
	T_3	6.53 ± 1.68^{abc}	5.72 ± 1.28^{abc}	5.0 ± 1.08^{c}	5.7 ± 0.31^{a}
	Mean	7.03 ± 0.37^{a}	6.01 ± 0.33^{b}	5.12 ± 0.13^{c}	
After taste	T_0	7.53 ± 1.19^{ab}	6.56 ± 1.66^{abc}	5.28 ± 0.84^{c}	6.5 ± 0.41^{a}
	T_1	7.20 ± 1.26^{a}	6.08 ± 2.18^{abc}	5.16 ± 0.99^{c}	6.1 ± 0.62^{a}
	T_2	7.60 ± 1.30^{a}	$5.84\pm2.13b^{c}$	5.04 ± 0.91^{c}	6.2 ± 0.63^{a}
	T_3	7.27 ± 1.10^{ab}	5.68 ± 1.25^{c}	5.21 ± 0.72^{c}	6.1 ± 0.27^{a}
	Mean	7.40 ± 0.20^{a}	6.04 ± 0.38^{b}	5.17 ± 0.10^{c}	
Acceptability	T_0	7.53 ± 0.74^{ab}	$6.8\pm1.04ab^{c}$	5.08 ± 1.08^{f}	6.5 ± 0.18^{a}
	T_1	7.40 ± 1.40^{a}	$6.68\pm1.44b^{cde}$	5.04 ± 0.93^{ef}	6.4 ± 0.28^{a}
	T_2	7.47 ± 1.36^{a}	5.8 ± 1.55^{cdef}	5.33 ± 0.92^{ef}	6.2 ± 0.33^{a}
	T_3	6.67 ± 0.72^{bcd}	5.36 ± 1.25^{def}	5.00 ± 0.78^{f}	5.7 ± 0.29^{b}
	Mean	7.27 ± 0.40^{a}	6.16 ± 0.70^{b}	5.11 ± 0.15^{c}	

Cream cheese

Figure 2 Strawberry based cake

Color

The effect of treatment for mean value on storage stability of cream cheeses shown in Table 4 indicates that storage index found highest in T_2 at 0 day storage whereas the minimum values was noticed in T_3 at 10 day of storage. The overall mean values at 0 day measured as 7.3, 7.2, 7.6 and 7.2 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% strawberry pulp), respectively whilst at 5 day of interval the overall mean values was detected as 7.0, 6.9, 6.6 and 5.9 for T_0, T_1, T_2 and T_3 respectively. Similarly, the mean value for T_0, T_1, T_2 and T_3 at 10 days of storage was observed as 5.1, 5.6, 5.3 and 5.0, respectively.

The impats of treatment of color of the cream chese are in accordance with the result of Jeon *et al*. (2012). The current study are in agreement with the results of Fangmeier *et al*. (2018), found that color of the cream cheese changes significantly during storage. The variation in the results of color stability may be due to change in cultivar, processing techniques and quality of the raw material. The variation may be due to the percentage of pulp supplemented in the preparation of cream cheese

Flavor

The mean index for the impact of treatment on storage stability of cream cheese shown in Table 4 designates that storage index found highest in T_1 at 0 day storage whereas the minimum values was perceived in T_3 at 10 day of storage. The inclusive mean values observed as 7.0, 7.4, 7.3 and 7.0 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) respectively at 0 day of storage period. At 5 day of storage the overall mean values was observed as 6.6, 6.2, 6.3 and 5.9 for the T_0, T_1, T_2 and T_3 respectively whilst at 10 days of storage the total mean was recorded as 5.2, 5.2, 5.4 and 4.8 respectively. It was concluded that T_1 of flavored cream cheese was preferred with superior performance of flavor for sensory profiling whereas the rest of treatment exhibited the value in the range of 6.6.

The present study findings for flavor of strawberry based cream cheese are in harmonization of the result of Jeon *et al*. (2012), noticed the values as 7.2. Previously, Fangmeier *et al*. (2018), found that flavor of the cream cheese changes significantly during storage which is in corroboration with the verdicts of the present findings. There may be narrated difference due to the agronomic practices, processing equipment and techniques. The variation in the flavor of the cream cheese may be due to the percentage of pulp supplemented.

Aroma

The value of mean for the treatment on storage stability of cream cheese shown in Table 4 showed that storage index found highest in T_2 at 0 day storage whereas the minimum values was perceived in T_3 at 10 day of storage. The overall mean values measured as 7.1, 7.0, 7.3 and 6.7 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) respectively at 0 day of storage and at 5 days of storage the overall mean values was pragmatic as 6.4, 6.3, 6.0 and 5.9 for the T_0, T_1, T_2 and T_3 respectively whilst at 10 days of storage the total mean was noted as 5.4, 5.3, 5.4 and 5.0 respectively.

The present study are in harmonization with the consequences of Jung *et al*. (2013), observed that aroma of the flavored cream cheese changes significantly during storage. The recent work is in validation with the values of Fangmeier *et al*. (2018). The variation in the results of aroma stability may be due to agronomic practices, climatic condition, processing techniques and quality of the raw material. The variation may be due to percentage of pulp supplemented.

Texture

The mean values for the effect of treatment on storage stability of flavored cream cheese shown in Table 4 designates that storage index found highest in T_1 at 0 day storage whereas the lowest values was perceived in T_3 at 10 day of storage. The overall mean values measured as 6.8, 6.9, 6.4 and 6.2 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) respectively at 0 day of storage and at 5 days of storage the overall mean values was noticed as 6.0, 5.8, 5.9 and 5.7 for the T_0, T_1, T_2 and T_3, respectively whilst at 10 days of storage the total mean was recorded as 5.1, 5.1, 5.0 and 4.8, respectively.

The results obtained during the present study are in corroboration with the result of Jeon *et al*. (2012). Previously, Mohamed and Shalaby (2016) found that texture of the cream cheese changes significantly during storage which is in line with the findings of the present study. The variation in the results of texture stability may be due to climatic condition, processing techniques, processing equipment, concentration of pulp supplemented and quality of the raw material.

Appearance

The mean values for the effect of treatment on storage stability of cream cheese shown in Table 4 indicates that storage file found top value in T_1 at 0 day storage whereas the minimum values was apparent in T_3 at 10 day of storage. The overall mean values noticed as 7.2, 7.4, 7.0 and 6.5 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) respectively at 0 day of storage and at 5 day of storage the overall mean values was noticed as 6.5, 6.0, 5.9 and 5.7 for the T_0, T_1, T_2 and T_3 respectively whilst at 10 days of storage the total mean was verified as 5.2, 5.1, 5.2 and 4.8 respectively. Score of T_2 was in highest range due to lower percentage of pulp. Appearance scale varied with the different percentage of strawberry pulp used in preparation of the product.

The present study findings are in harmonization with the result of Jeon *et al*. (2012). The variation in the results of appearance stability may be due to varietal variation, quality of the raw material and concentration of pulp used in the formation of the product.

After taste

The mean values for the effect of treatment on storage stability of cream cheese shown in Table 4 indicates that storage index found maximum value in T_2 at 0 day storage whereas the minimum values was accessed in T_3 at 10 day of storage. The overall mean values observed as 7.5, 7., 7.6 and 7.3 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) respectively at 0 day of storage and at 5 days of storage the overall mean values was noticed as 6.6, 6.1, 5.8 and 5.7 for the T_0, T_1, T_2 and T_3 respectively whilst at 10 days of storage the total mean was verified as 5.3, 5.2, 5.1 and 50 respectively. Score of T_2 was in highest range due to lower percentage of pulp. Appearance scale varied with the different percentage of strawberry pulp used in preparation of cake.

Earlier, Fangmeier *et al*. (2018) found that after taste of the cream cheese changes significantly during storage which is in line with the findings of the present study. The variation in the results of after taste stability may be due to varietal variation, processing techniques and quality of the raw material.

Overall acceptability

The mean values for the effect of treatment on storage stability of cream cheese shown in Table 4 showed that storage catalogue found supreme value in T_2 at 0 day storage whereas the minimum values was measured in T_3 at 10 day of storage. The overall mean values observed as 7.5, 7.4, 7.5 and 6.7 for the T_0, T_1, T_2 and T_3 (control, 5%, 10%, 15% pulp) respectively at 0 day of storage and at 5 day of storage the overall mean values was noticed as 6.8, 6.7, 5.8 and 5.4 for the T_0, T_1, T_2 and T_3 respectively whilst at 10 day of storage the total mean was verified as 5.1, 5.0, 5.4 and 5.0 respectively. Score of T_2 was in highest range due to

lower percentage of pulp as compare to T_3. Appearance scale varied with the different percentage of strawberry pulp used in preparation of the flavored cream cheese.

Previously, Fangmeier *et al*. (2018) found that overall acceptability of the cream cheese changes significantly during storage which is in line with the findings of the present study. The variation in the results of overall acceptability stability may be due to agronomic practices, climatic condition, processing techniques and quality of the raw material.

Microbial analysis of strawberry based cake (TPC cfu/mL)

The mean values for the effect of treatment on storage stability of cake shown in Table 3 indicated that storage directory found superlative value in T_1 at 6 day storage whereas the minimum values was measured in T_1 at 6 day of storage. The overall mean values observed as 9.0 cfu/mL, 6.9 cfu/mL, 8.0 cfu/mL and 8.17 cfu/mL for the T_0, T_1, T_2 and T_3 respectively at 0 day of storage and at 3 days of storage the overall mean values was noticed as 12.9 cfu/mL, 15.9 cfu/mL, 15.9 cfu/mL and 19.1 cfu/mL for the T_0, T_1, T_2 and T_3 respectively whilst at 6 days of storage the total mean was verified as 22.2 cfu/mL, 27.37 cfu/mL, 23.9 cfu/mL and 25.1 cfu/mL respectively.

Previously, El-Kadi *et al*. (2018) found that total plate count of the strawberry based cake changes significantly during storage which is in line with the findings of the present study. The variation in the results of total plate count stability may be due to agronomic practices, climatic condition, processing techniques and quality of the raw material.

Table 3. Microbial analysis of cake and cream cheese (TPC cfu/mL)

Cake	**Treatment**	**0 Day**	**3 Day**	**6 Day**	**Mean**
	T_0	9.05 ± 52.31^{ab}	12.97 ± 32.39^{ab}	22.20 ± 31.95^{ab}	147.0 ± 16.7^{a}
	T_1	6.93 ± 17.93^{ab}	15.90 ± 74.55^{ab}	27.37 ± 14.15^{a}	167.3 ± 33.8^{a}
	T_2	8.03 ± 19.86^{b}	15.97 ± 23.86^{ab}	23.90 ± 48.5^{a}	159.7 ± 15.5^{a}
	T_3	8.17 ± 23.16^{ab}	19.10 ± 58.90^{ab}	25.13 ± 37.42^{a}	174.7 ± 18.0^{a}
	Mean	80.17 ± 8.24^{b}	159.83 ± 25.05^{b}	246.5 ± 21.74^{a}	
Cream Cheese	**Treatment**	**0 Day**	**5 Day**	**10 Day**	**Mean**
	T_0	13.43 ± 48.52^{ab}	15.80 ± 68.43^{abc}	25.10 ± 17.78^{f}	181.1 ± 25.5^{a}
	T_1	14.33 ± 20.98^{ab}	16.70 ± 79.61^{bcde}	21.90 ± 26.0^{ef}	176.4 ± 32.5^{a}
	T_2	13.10 ± 22.27^{a}	19.00 ± 68.69^{cdef}	22.27 ± 27.01^{ef}	181.2 ± 25.5^{a}
	T_3	15.10 ± 49.27^{bcd}	24.10 ± 65.02^{def}	21.70 ± 55.33^{f}	203.0 ± 7.9^{b}
	Mean	139.9 ± 9.04^{a}	189.0 ± 37.1^{b}	227.4 ± 15.9^{c}	

Microbial analysis of strawberry based cream cheese (TPC cfu/mL)

The mean values for the effect of treatment on storage stability of cream cheese shown in Table 3 indicated that storage index found maximum value in T_0 at 10 day storage whereas the minimum values was measured in T_2 at 0 day of storage. The overall mean values observed as 13.4 cfu/mL, 14.3 cfu/mL, 13.1 cfu/mL and 15.1 cfu/mL for the T_0, T_1, T_2 and T_3 respectively at 0 day of storage and at 5 days of storage the overall mean values was noticed as 15.8 cfu/mL, 16.7 cfu/mL, 19.0 cfu/mL and 24.1 cfu/ mL for the T_0, T_1, T_2 and T_3 respectively whilst at 10 day of storage the total mean was noted as 25.1 cfu/ mL, 21.9 cfu/ mL, 22.2 cfu/mL and 21.7 cfu/ mL, respectively.

Previously Miarka *et al*. (2015) found that total plate count of the strawberry based cream cheese changes significantly during storage which is in line with the findings of the present study. The variation in the results of cream cheese stability may be due

to processing techniques, processing equipment's, quantity and quality of the raw material.

CONCLUSION

Strawberry is cultivated in Pakistan but still categorized as minor fruit. New packing materials are introduced to reduce post-harvest losses of strawberry. Various value added imported products of strawberry are already in market however, innovative products are formulating at national level with improved sensoric profile to reduce the import.

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Conflict

There is no conflict of interest of this research.

REFERENCES

Afridi, G. S., M. Ishaq and S. Ahmad. 2009. Cost and Revenue Analysis of Strawberry Production in the Sub-Tropical Areas of NWFP, Pakistan. Pak. J. Life Soc. Sci. 7: 59-65.

AOAC. 2006. Official Methods of Analysis of Association of Official Analytical Chemist International. In: Horwitz, W. (ed.), 18th edition. AOAC Press, Arlington, VA, USA.

Bernardi, D., M.S. Garcia, M. Botton and D.E. Nava. 2012. Biology and fertility life table of the green aphid *Chaetosiphon fragaefolli* on strawberry cultivars. J. Insect Sci.12: 28.

Bona, E., G. Lingua, P. Manassero, S. Cantamessa and F. Marsano. 2015. AM fungi and PGP pseudomonads increase flowering, fruit production, and vitamin content in strawberry grown at low nitrogen and phosphorus levels. Mycorrhiza. 25: 181-193.

Correia, P. J., M. Pestana, F. Martinez, E. Ribeiro, F. Gama, T. Saavedra and P. Palencia. 2011. Relationships between strawberry fruit quality attributes and crop load. Sci. Hortic. 130: 398-403.

El-Kadi, S.M., H.A. El-Fadaly and E.S.M. El-Gayar. 2018. Examination of Pathogenic Bacteria in Some Cake Samples. Int. J. Microbiol. Application. 5: 56-63.

Fang, J., 2014. Some anthocyanins could be efficiently absorbed across the gastrointestinal mucosa: extensive presystemic metabolism reduces apparent bioavailability. J. Agri. Food Chem. 62: 3904-3911.

Fangmeier, M., G.T. Kemerich, B.I. Machado, M.J. Maciel and C.F.V.D. Souza. 2018. Effects of cow, goat, and buffalo milk on the characteristics of cream cheese with whey retention. Food Sci. Technol. (AHEAD).

Finn, C. E., J. B. Retamales, G. A. Lobos and J. F. Hancock. 2013. The Chilean strawberry (*Fragaria chiloensis*) over 1000 years of domestication. Hortic. Sci. 48: 418-421.

Ghaboos, H.S., S.S Ardabili and M. Kashaninejad. 2018. Physico-chemical, textural and sensory evaluation of sponge cake supplemented with pumpkin flour. Int. Food Res. J. 25: 854-860.

Goranova, Z., Baeva, M., Stankov, S. and Zsivanovits, G., 2015. Sensory Characteristics and Textural Changes during Storage of Sponge Cake with Functional Ingredients. J. Food Phys. 28-29.

Gutierrez, G. R., J. C. Cardoso, F. Rubio-Senent, A. Serrano, R. Borja, J. F. Bolaños and F. G. Fermoso. 2018. Thermally-treated strawberry extrudate: A rich source of

antioxidant phenols and sugars. Innov. Food Sci. Emerg. Technol. (in press).

Jeon, S.S., P. Ganesan, Y.S. Lee, S.H. Yoo and H.S. Kwak. 2012. Texture and sensory properties of cream cheese and cholesterol-removed cream cheese made from whole milk powder. Korean J. Food Sci. Anim. Resources. 32: 49-53.

Jung, H.J., E.J. Ko and H.S. Kwak. 2013. Comparison of physicochemical and sensory properties between cholesterol-removed gouda cheese and gouda cheese during ripening. Asian-Australasian J. Anim. Sci. *26*: 1773.

Kim, J.N., S. Park and W.S. Shin. 2014. Textural and sensory characteristics of rice chiffon cake formulated with sugar alcohols instead of sucrose. J. Food Qual. 37: 281-290.

Kowalska, H., A. Marzec, J. Kowalska, A. Ciurzynska, K. Czajkowska, J. Cichowska, K. Rybak and A. Lenart. 2017. Osmotic dehydration of Honeoye strawberries in solutions enriched with natural bioactive molecules. LWT-Food Sci. Technol. 85: 500-505.

Meilgaard, M.C., G.V. Civille and B.T. Carr. 2007. Sensory evaluation techniques. In: Memon, N.A. (ed.). Strawberry widely consumed throughout world 4th ed C.R.C. 2014. Pak. Food J. 38-40.

Mendes, M.O., M.F. de Morais and J.F. Rodrigues. 2019. A2A2 milk: Brazilian consumers' opinions and effect on sensory characteristics of Petit Suisse and Minas cheeses. LWT.

Miarka, D., J. Zukowska, A. Siwek, J. Nowacka and D. Nowak. 2015. Microbial hazards reduction during creamy cream cheese production. Production Eng. Arch. 6: 39-44.

Mohamed, A.G. and S.M. Shalaby. 2016. Texture, chemical properties and sensory evaluation of a spreadable processed cheese analogue made with apricot pulp (*Prunus armeniaca* L.). Int. J. Dairy Sci. 1: 161-68.

Montogomery, D. 2008. Introduction to Factorial Designs. In: Design and Analysis of Experiments, John willey and sons, Inc. USA.

Parveen, S., A. Din, M. Asghar, M. R. Khan and M. Nadeem. 2012. Value addition in strawberry: a tool for long term storage-a review. Pak. J. Food Sci. 22: 206-208.

Rajwana, I. A., K. Razzaq, S.B. Hussain, M. Amin, A.S. Khan and A.U. Malik. 2017. Strawberry cultivation in southern Punjab Pakistan. Acta Hortic. 1156: 909-910.

Stavale, M.D.O., R.B.A. Botelho and R.P. Zandonadi. 2018. Apple as sugar substitute in cake. J. Culinary Sci. Technol. 20: 1-8.

Sudha, M., V. Baskaran and K. Leelavathi. 2007. Apple pomace as a source of dietary fiber and polyphenols and its effect on the rheological characteristics and cake making. Food Chem. 104: 686-692.

Yaqoob, S.,W.N. Baba, F.A Masoodi, M. Shafi and R. Bazaz. 2018. Effect of sprouting on cake quality from wheat–barley flour blends. J. Food Measurement Characterization. 12: 1253-1265.