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Pasteurization Effects on Drinking Yogurt Quality Containing Aloe Vera Gel Extract and Strawberry Pulp

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ABSTRACT: *Popularity of drinking yogurts is increasing due to significant health benefits, on the go lifestyle and unique valuable ingredients. For the production of drinking yogurt, the present study was being carried out. Effect of various times and temperatures of pasteurization was studied in respect of stability of the product as well as concentration of Aloe Vera gel extract and strawberry pulp was being optimized. A varying heating times and different temperatures of pasteurization (70oC, 80oC, 90oC and 100oC for 5 and 10 minutes) were used in this process. With the storage at refrigeration temperature, evaluation of product for various attributes was carried out including physicochemical (pH, total solids, acidity and viscosity), microbiological (total plate count) and sensory. Effect of storage, time and temperature was seen on yogurt pH that decreased during storage while DY100/10 showed minimum decrease (0.39). Whereas, significant increase was observed in acidity during storage, as DY100/10 showed minimum increase (0.17) while reduction in viscosity was observed and DY100/10 showed minimum reduction (46.33). DY70/5 showed the maximum reduction in viscosity (50) and highest increase in acidity (0.22). During storage, non-significant increase in total solids was seen while DY100/10 showed maximum increase (0.3). Increase in storage time led to the decrease in number of total plate count and the sensory attributes (appearance, flavor, sensory acidity, body and texture) were affected significantly. During 20 days of storage, maximum scores were awarded to DY100/10 while minimum scores were obtained by DY70/5. From the present investigation it can be concluded that the best drinking yogurt with respect to shelf life and its sensory acceptance is DY100/10 with a storage period of 20 days.*

Keywords: *Drinking yogurt, Strawberry pulp, Aloe Vera, Pasteurization*

INTRODUCTION

Many high- and low-income countries are effectively contributing towards overcoming micronutrient deficiencies by producing fortified products especially dairy products (Yeh et al., 2017, Itkonen et al., 2018) Ever-growing preferences of consumers for not only nutritious and natural food ingredients but also convenience in usage has triggered the progress in fortified foods and functional beverages. Now days, consumers prefer the foods that encourage good health by preventing disease. Moreover, these foods must be economical, refreshing and fit into present-day lifestyles (Chandan, 2006). Cultured milk products such as cultured butter milk, creams, and yogurts are making the second popular fermentation industry. Yogurt, because of its health benefits, is among the most consumed fermented milk products worldwide. (Oroian et al., 2011). For yogurt preparation. Lactobacillus bulgaricus and Streptococcus thermophilus are commonly used starter culture (Younus et al., 2002). The health benefits of yogurts are greatly varied with type and viability of the starter culture (Miller, 2008). It is not only a healthier and quick snack, but it also adds years to life by supplying numerous proteins, vitamins and protein allergies (Kolarset, 2004). Moreover yogurt being anti-inflammatory, anti-mutagenic and anti-carcinogenic is a complete health package (Agarwal, 2009).

In recent years, drinking yogurt is the quickest emerging beverage picked up by consumers. This is a stirred liquid, less viscos and supply all health benefits (Thompson et al., 2007). Production techniques and savor of the final drinking yogurt products vary significantly worldwide (Kocak and Avsar, 2010). In Balkans, Anatolia, Central Asia and the Middle East, it is used simply just adding salt while fruit additives and flavors are trendier among people of UK and US. (Lee et al., 2003). The frequent consumption of such products raises high density lipoprotein, boosts our immunity, lowers body fat and lowers low density lipoprotein, increases the body's ability of bone development and protect against ulcers (Gill et al., 2001; Wang et al., 2004; Fabian and Elmadfa, 2006).

The practice to use various fruit-flavors in yogurt manufacturing has increased yogurt choices for buyer. (Erdogan and Zekai, 2003). Regular consumption of vegetables and fruits is recommended by World Health Organization i.e. at least 400 g/day (WHO, 2005).

The strawberry (Fragaria ananassa, Duch.), is a kind of fruit belongs to Rosaceae family. This fruit is rich in antioxidant micronutrients i.e. ascorbic acid and folic acid and antioxidant polyphenols such as phenolic acids, flavonoids and tannins (Seeram et al., 2006; Pinto et al., 2010). The vitamin C content is significantly high i.e. 60 mg/100 g that is dependent on cultivation conditions (Bardonaba and Terry, 2010; Kawanobu et al., 2010). However, it is extensively used in yogurt flavor and most liked by consumers than the other fruit flavors

(Thompson et al., 2007).

Plants are the source of therapeutic agents with minor side effects since time immemorial. Aloe Vera is used as a natural therapeutic agent because of its various bioactive components. Out of 250 species of Aloe Vera only two species i.e. Aloe aborescens and barbadensis are grown for commercial point of view (Cock, 2008). Aloin, is an important component of this plant used as a laxative agent and common in use for the pharmaceutical products. Gel of this plant produced healing effects and also used for manufacturing of nutritional drinks. It contains multi-vitamins proteins, minerals, polysaccharides and life stimulators. It also has growth inhibitory capacity for Gram-positive bacteria i.e. Shigella flexneri and Streptococcus progenies. Seven out of the eight essential amino acids are present in Aloe Vera gel (Rajeswari et al., 2012).

Aloe Vera gel containing a lot of anti-properties so can be used against viruses, inflammation, bacterias,tumors and fungus. Due to these properties the plant has gained much popularity in pharmaceutical, cosmtic and food industries. (Djeraba and Quere 2000, Choi and Chung, 2003, Eshun and He 2004, Boudreau and Beland 2006, Maenthaisong et al., 2007, Surjushe et al., 2008; Alemdar and Agaogln, 2009, Yu et al., 2009).

Considering the therapeutic significance of yogurt and Aloe Vera, the current study was designed to investigate effect of temperature and time combinations on the quality of drinking yogurt with strawberry and Aloe Vera gel extract.

MATERIALS AND METHODS

All experimental work was carried out at Dairy Laboratory, National Institute of Food Science and Technology (NIFSAT), University of Agriculture, Faisalabad (UAF). Fresh buffalo milk was obtained from Dairy Farm of University of Agriculture Faisalabad. Yogurt starter (Nestle yogurt), sugar, maltodextrin (stabilizer) and strawberry fruit were purchased from local market. Aloe Vera was obtained from university fields.

Crude fat, acidity, pH, total solids, ash and crude protein were analyzed in milk sample and respective methodology of AOAC (2000) was followed. All the experiments were carried out in triplicates. Fine pulp of fresh strawberry fruit was obtained by blending fresh, cleaned fruits. Aloe Vera gel extract was picked up as the inner gel spitted out from the leaf and homogenized by blending and then filtered.

Suitable quantities of sugar (10g), Aloe Vera gel extract (3 mL), Mltodextrin (0.5 %), strawberry pulp (10g), and that of water and yogurt (100 mL) were optimized for manufacturing a high quality drinking yogurt. Best treatment regarding texture, flavor, and overall acceptance was selected after sensory evaluation.

Milk was standardized to 11% SNF (Solid Not Fat) and 3% fat with pH 6.6-6.7 were homogenized to improve quality at 2.5 MPa. 0.5% maltodextrin along with milk was incubated for 5 minutes in a water bath at 90oC and then cooled at 42°C followed by inoculation with 2.5% starter. The mixture was incubated at 42°C for 3-4 hours so the 4.6pH reached. To prevent the further fermentation, immediate cooling was carried out. Finally, sugar, strawberry pulp, water and Aloe Vera gel were thoroughly mixed in a blender to get homogenous mixture. Final product was filled in sterilized glass bottles and pasteurized at different temperatures for different durations (Table 1).

Table 1: Pasteurization at different temperature and durations

Treatments	Temperature (°C)	Time (minutes)
DY70/5	70	5
DY70/10	70	10
DY80/5	80	5
DY80/10	80	10
DY90/5	90	5
DY90/10	90	10
DY100/5	100	5
DY100/10	100	10

After cooling the prepared product was kept for 20 days at 6±2?. During stowage, the product was considered for a number of analyses. The pH was determined using electronic digital type pH meter. Acidity was monitored using Titrimetric method of AOAC 947.05 (2000). Total solids were recorded by following the methods mentioned in AOAC 925.23 (2000). Microbial count was carried out following pour plate method of Dave and Shah (1996). Viscosity was measured using viscometer as described by Gassem and Frank (1991). Sensory analysis was carried out following the methodology of Nelson and Trout (1964). Complete Randomized Design (3-factor factorial) was used to analyze data R statistical design was used to calculate level of significance.

RESULTS AND DISCUSSION

According to the investigations

of El-Aziz et al. (2012) buffalo milk consists of 6.83% fat, 4.34% protein, 17.45% total solids, 0.81% ash containing the pH of 6.76. For the purpose of yogurt manufacturing, standardization of milk was carried out at a level of 3% fat and 11% SNF. By the analysis of milk it was observed that milk had 6.74 pH. The values of acidity, crude protein, crude fat, ash and total solids were 0.12, 3.80, 2.96, 0.46 and 12.74 respectively.

Physicochemical Analysis

Highly significant effect was seen of time, temperature and storage by the statistical analysis on the pH of drinking yogurt. While viscosity and titratable acidity showed significant effect of storage and temperature showed significant effect on them. Whereas, as shown in Table. 2 non-significant effect was observed of all factors on the total solids of drinking yogurt. The detailed results are discussed below.

pH:

During storage the reduction was seen in pH within all samples of drinking yogurt. A decline in pH may be due to breakdown of lactose into lactic acid. DY80/10 had undergone highest decrease in pH (0.7) while DY100/10 showed slightest change in pH which is 0.39. As shown in Fig.1 and Fig. 2, in DY80/10 minimal pasteurization temperature causes more reduction in pH and in DY100/10 elevated time and temperature combinations of pasteurization cause less variation in pH. The present study depicts the results in agreement to the findings of Joseph et al. (2011) who observed a decrease in pH as a result of lactic acid production during yogurt storage. Moreover, Kim et al. (2003), Hassan and Amjad (2010) and Kauser et al. (2011) reported the same findings of yogurt.

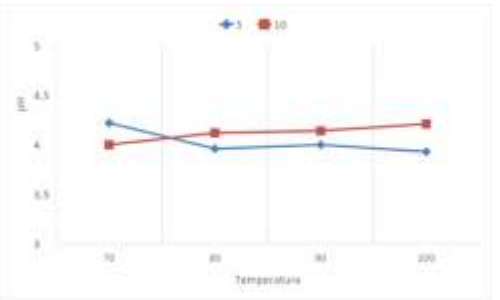

Fig. 1: The effect of various times and temperature combinations of pasteurization during the storage period of 20 days on the pH of drinking yogurt at different treatments

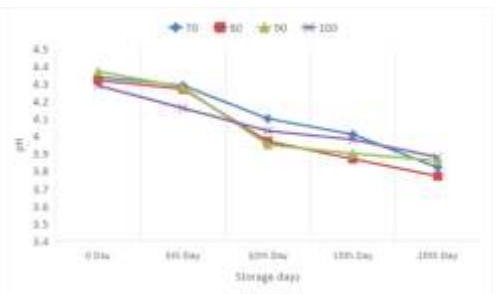

Fig. 2: The effect of days of storage and temperatures of pasteurization during the storage period of 20 days on the pH of drinking yogurt at different treatments

Acidity:

During the time period of storage

acidity increased. DY70/5 showed highest increase in acidity (0.22) while DY100/10 showed lowest increase in acidity which is 0.17. Elevated pasteurization time and temperature had significant effect on acidity as the reduction was seen on the activity of lactic acid bacteria at high temperature and an increase in activity was found at low temperature. As shown in Fig. 3, an increase in acidity was observed with the storage time due to the production of more lactic acid. During the entire storage time DY100/10 indicated the minimum increase in acidity while DY70/5 showed the maximum increase in acidity. Conversion of lactose into lactic acid followed by increase in acidity was also found in studies of Kim et al. (2003), Hassan and Amjad (2010) and Kauser et al. (2011). The study results are also in line with the previous findings.

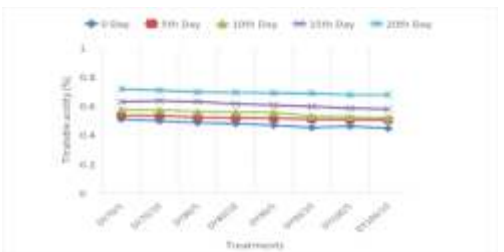

Fig. 3: The effect of various times and temperature combinations of pasteurization during the storage period of 20 days on the percent treatable acidity of drinking yogurt at different treatments

Total solids: During the entire storage time non-significant increase was occurred in total solids. DY100/10 showed highest increase (0.3) in total solids. Fig. 4 indicates the rising trend of total solids with time period of storage. As described by Hassan and Amjad (2010), due to the activity of starter culture moisture content decreased and total solids increased during storage. Increase in non-significant difference in total solids was also observed by Kavas et al. (2003).

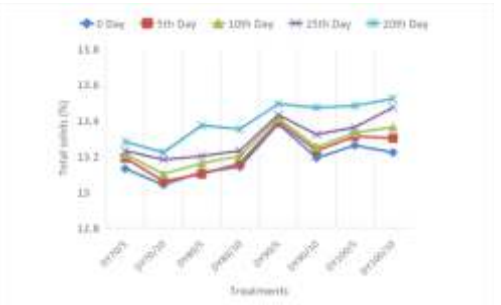

Fig. 4: The effect of various times and temperature combinations of pasteurization during the storage period of 20 days on the percent total solids of drinking yogurt at different treatments

Viscosity:

A decline in viscosity of the drinking yogurt was occurred with the passage of storage time. DY70/5 showed the maximum reduction in viscosity (50) whereas DY100/10 showed the minimum reduction in viscosity which is 46.33 during the whole time period of storage. As viscosity decrease with the rise in temperature, thus the rise in temperature caused the reduction in viscosity. With the passage of storage time, different times and temperature combinations has the effect on viscosity and make a decreasing trend as indicated in Fig. 5. The rise in the rate of whey separation and reduction in the strength of stabilizing power might be

the reason behind the reduction in viscosity. The results of the present research work was in line with the findings of Kim et al. (2003), Chandan and O'Rell, (2006) and Patel (2011).

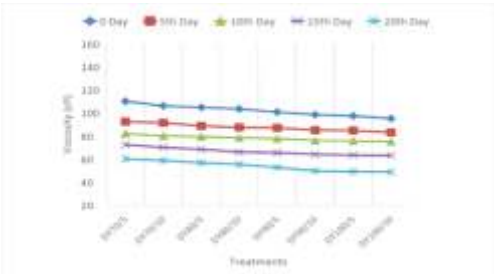

Fig. 5: The effect of various durations and temperature combinations of pasteurization during the storage period of 20 days on the viscosity of drinking yogurt at different treatments

Microbiological analysis:

At the closing stage of storage period, total plate count was significantly decreased. Fig. 6 depicts the reduction in the total plate count in all the treatments during the whole time period of storage. This phenomenon can be occurred at the closing stage of storage due to the production of lactic acid as a result of which acidity increases and pH decreases. Due to the unfavorable conditions, the activity of microbes as well as total plate count decreases. Wherever, with the increase in time and temperature of pasteurization, the number of total plate count was also increased. At 0 day DY100/10 had 5.11×108 and DY70/5 had 4.57×108 total plate count. It was gradually increased with the passage of storage time and was highest at 20th day. During the storage process, the reduction in total plate count was also observed by Allgeyer et al. (2009) and Panesar and Shinde, (2012).

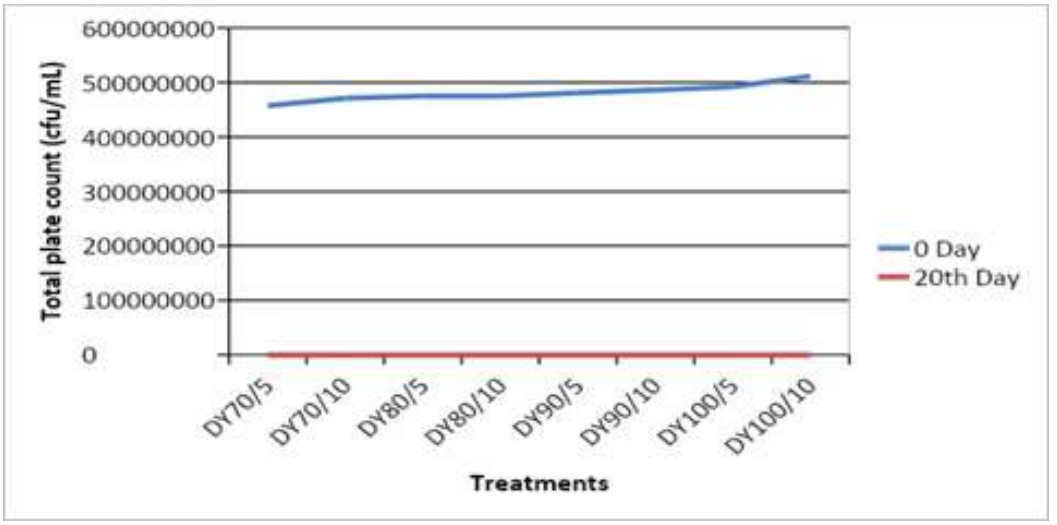

Fig. 6: The effect of various times and temperature combinations of pasteurization during the storage period of 20 days on the total plate count of drinking yogurt at different treatments

Table 2: Analysis of variance (ANOVA) for chemical analysis of the drinking yogurt

S.O.V.	d.f.	pH M.S.S	Acidity M.S.S	Viscosity M.S.S	Total Solids M.S.S
Storage	4	1.05943**	0.17323**	0.55651**	0.55651 ^{NS}
Temperature	3	0.02530**	0.01044**	0.43349**	0.43349 ^{NS}
Time	1	0.24300**	0.00149 ^{NS}	1.30250*	1.30250 ^{NS}
Storage*Temperature	12	0.01797**	0.00023 ^{NS}	0.84600 ^{NS}	0.84600 ^{NS}
Storage*Time	4	0.00141 ^{NS}	0.00007 ^{NS}	0.91981 ^{NS}	0.91981 ^{NS}
Temperature*Time	3	0.35546**	0.00007 ^{NS}	1.04974 ^{NS}	1.04974 ^{NS}
Storage*Temperature*Time	12	0.02394**	0.00006 ^{NS}	0.80921 ^{NS}	0.80921 ^{NS}
Error	80	0.00064	0.00045	0.97305	0.97305
Total	119				

*= Significant

**= Highly Significant

^{NS}= Non-Significant

SENSORY ANALYSIS

Sensory analysis of drinking yogurt was done by a jury consisting of five judges. These include the selective students and staff members of the National Institute of Food Science and Technology, University of Agriculture, Faisalabad. With reference to the prescribed methods of Nelson and Trout (1964), all judges were skilled for the sensory evaluation of all attributes of yogurt i.e. body and texture, sensory acidity, flavor and appearance. Highly significant effect of storage was seen on the appearance, flavor, sensory acidity and body and texture, whereas significant effect of temperature was observed on all these attributes as shown in Table. 3.

Table 3: Analysis of variance for sensory analysis of drinking yogurt

S.O.V.	d.f.	Sensory acidity M.S.S.	Appearance M.S.S.	Body and texture	Flavor M.S.S.
Storage	4	86.0456**	86.7067**	344.620**	259.430**
Temperature	3	2.5833*	2.7511*	7.218*	6.933*
Time	1	0.6050^{NS}	0.4812^{NS}	1.125^{NS}	1.620^{NS}
Storage*Temperature	12	0.1698^{NS}	0.1300^{NS}	0.477^{NS}	0.550^{NS}
Storage*Time	4	0.0394^{NS}	0.0709^{NS}	0.075^{NS}	0.120^{NS}
Temperature*Time	3	0.0017^{NS}	0.0022^{NS}	0.005^{NS}	0.020^{NS}
Storage*Temperature*Time	12	0.0069^{NS}	0.0136^{NS}	0.005^{NS}	0.020^{NS}
Error	160	0.9450	0.9247	2.690	1.748
Total	199				

*= Significant

**= Highly Significant

^{NS}= Non-Significant

Sensory Acidity

All the treatments indicated the reduction in scores with the passage of time during the rating of the sensory acidity. An increase in the lactic acid production can be a cause of the rise in sensory acidity. At the end of storage time (20 days) DY100/10 scored maximum points that are from 8 to 4.8 whereas DY70/5 scored minimum points (from 8 to 4). Fig. 7 indicates the results for sensory acidity in which the effect of various times and temperature combinations is depicted during 20 days of storage on the sensory acidity of the drinking yogurt. A reduction in scores of sensory acidity was also observed by Allgeyer (2009) and Cakmakci et al. (2012) during storage period and our present study findings are in co-ordinance with these reports as well.

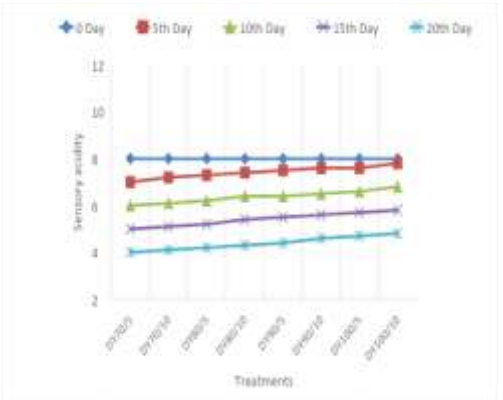

Fig. 7: The effect of various times and temperature combinations of pasteurization during the storage duration of 20 days on the sensory acidity of drinking yogurt at different treatments

Appearance

In context of the appearance, with the passage of storage period, DY100/10 scored highest points i.e. from 7 to 3.8 whereas DY70/5 scored lowest points i.e. from 7 to 3. On the other hand, an increase in appearance points was seen with increase in various times and temperature combinations of pasteurization as indicated in Fig. 8. Quality of the yogurt was deteriorated during storage as the appearance did not meet the said standards. Salwa et al. (2003) reported that during storage of yogurt, mold and yeast count rises that can destroy the quality of appearance. Same results were found by Tarakci and Kuckoner (2003) and Hanif et al. (2012) during yogurt storage.

Body and Texture

During the storage period, reduction in scoring points for body and texture was observed in the product. From 0 day to 20th day, DY70/5 showed the maximum reduction in scoring points which is 8 points whereas DY100/10 showed the minimum reduction i.e. 6.6 points as indicated in Fig. 9. Irrespective of the 0 day points, an increase in scoring points was also observed with the increase in different times and temperature combinations of pasteurization. The findings of the present study are supporting the results reported by El-Owni and Mahgoub (2012) and Hanif et al. (2012).

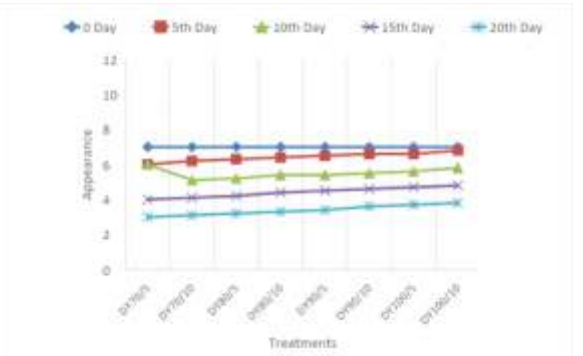

Fig. 8: The effect of various time durations and temperature combinations of pasteurization during the storage period of 20 days on the appearance of drinking yogurt at different treatments

Flavor

During storage the attribute of flavor showed the reduction in scoring points of the product. Fig. 10 indicates a gradual declining trend of storage means. DY70/5 showed the highest reduction in flavor i.e. 7 points whereas DY100/10 showed the lowest

reduction in flavor i.e. 6 points. Irrespective of the 0 day points, an increase in the scores was observed with the increase in different times and temperature combinations of pasteurization in all the treatments. During cold storage, Ekinci and Gurel (2008), Fadela et al. (2009) and Radi et al. (2009) observed the reduction in the levels of carbonyl compounds and agreed the results with the present findings.

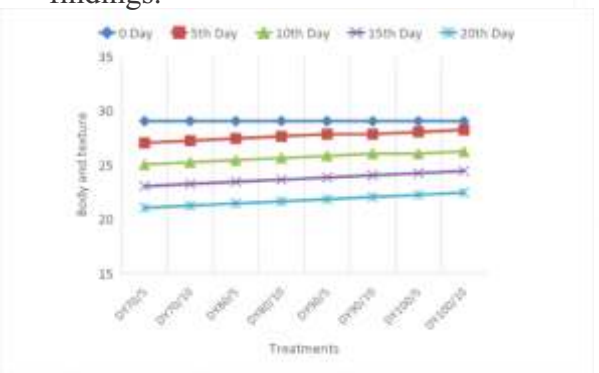

Fig. 9: The effect of various time and temperature combinations of pasteurization during the storage period of 20 days on drinking yogurt quality at different treatments

Flavor

During storage the attribute of flavor showed the reduction in scoring points of the product. Fig. 10 indicates a gradual declining trend of storage means. DY70/5 showed the highest reduction in flavor i.e. 7 points whereas DY100/10 showed the lowest reduction in flavor i.e. 6 points. Irrespective of the 0 day points, an increase in the scores was observed with the increase in different times and temperature combinations of pasteurization in all the treatments. During cold storage, Ekinci and Gurel (2008), Fadela et al. (2009) and Radi et al. (2009) observed the reduction in the levels of carbonyl compounds and agreed the results with the present findings.

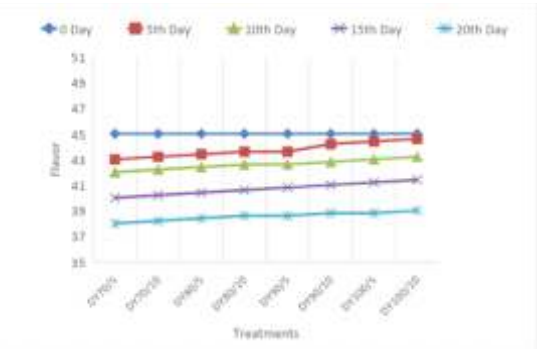

Fig. 10: The effect of various times and temperature combinations of pasteurization during the storage period of 20 days on the flavor of drinking yogurt at different treatments

Correlation matrix for drinking yoghurt:

Correlation matrix among different variables derived from physic-chemical analysis and sensory evaluation have been presented in Table. 4. The pH of drinking yoghurt exhibited linear relationship with viscosity, sensory acidity, appearance, texture and flavor whereas, an inverse association was observed for acidity and total solids.

Likewise, viscosity showed linear relationship with sensory acidity, appearance, texture and flavor however, this parameter exhibited an inverse relationship with titratable

acidity and total solids. Moreover, titratable acidity delineated positive relationship with total solids and negative association was observed with rest of the variables. It has been observed that the value for total solids had negative association with sensory acidity, appearance, texture and flavor. Similarly, sensory acidity exhibited positive relationship with appearance, texture and flavor. A linear association was observed for texture and flavor as a function of appearance. Texture of drinking yoghurt also delineated positive relationship with flavor.

Table 4: Correlation matrix among different variables derived from physic-chemical analysis and sensory evaluation

	pH	Viscosity	Titratable acidity	Total solids	Sensory acidity	Appearance	Texture	Flavor
pH	1.00							
Viscosity	0.80	1.00						
Titratable acidity	-0.79	-0.87	1.00					
Total solids	-0.42	-0.68	0.39	1.00				
Sensory acidity	0.81	0.92	-0.98	-0.48	1.00			
Appearance	0.82	0.93	-0.97	-0.48	0.99	1.00		
Texture	0.81	0.94	-0.98	-0.49	0.99	0.99	1.00	
Flavor	0.68	0.93	-0.98	-0.49	0.99	0.98	0.99	1.00

Aloe vera has been reported to be used in Chinese and Ayurvedic herbal medicines for the treatment of haemorrhoids, dermatologic problems, wounds, constipation, eczema, psoriasis and as digestive system protective herb (Panahi et al., 2015). Sánchez et al., 2020 has studied the clinical properties of various metabolite of Aloe Vera on different conditions and pathologies of human and found promising results. Therefore, considering the individual health benefits of Aloe Vera and yogurt, a food product of their combination and addition of antioxidants rich fruit i.e. strawberry makes it a healthier food product with medicinal properties.

CONCLUSION

DY100/10 awarded maximum scores with respect to the sensory acceptance. In addition, an improved quality drinking yogurt could have high storage life of 20 days especially at refrigeration temperature. Furthermore, good aroma, a smaller amount of whey separation, pleasing taste and improved appearance can be achieved by treating the drinking yogurt at 100ºC for 10 minutes. Thus, the current study has revealed the best physical parameters for storage of drinking yogurt i.e. temperature, pH and duration, keeping its nutritional value and quality maintained. Moreover, combination of fruits having good aroma and taste e.g. strawberry, mangoes and others along with Aloe Vera makes it more appealing for kids and adults as well. Use of natural ingredients for wellbeing of human can lead to reduction in many health deteriorating factors.

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