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QUALITY ENHANCEMENT OF LOW-FAT YOGHURT THROUGH STRATEGIC GUM INCORPORATION

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Abstract
Milk is an integral part of diets of millions worldwide. Milk helps the development of cell growth and digestive tube in gastrointestinal tract (GIT) of a baby. Proteins, bioactive saccharides and lipids are essential nutrients of milk which contribution to control the growth of gastrointestinal system of human body. Consumption of Industrially-produced Tran's fatty acids (IPTFAs) has various adverse health hazard. High fat contents because serious illness such as high cholesterol level, arthritis, memory loss, weight gain and obesity which leads to cardiovascular problems. Low fat yoghurt is a vigorous healthy choice for consumer due to its different functional and biological properties. Low fat products are demand of all eras but fell short due to low quality. The current study was objective to prepare the low fat yoghurt by using hydrocolloids like different types of gums such as guar gum and xanthan gum at the ratio 0.1, 0.3, 0.5% evaluation of various compositional analysis, physiochemical properties, texture analysis and sensory profile. During research, result showed that in low fat yoghurt during storage period acidity decreases while pH remained constant. However, synersis of product was increased among storage period on the other hand water holding capacity was decreased. As a texture it was observed that addition of guar gum and xanthan gum with concentration 0.1% was good as compared to 0.5% concentration.

INTRODUCTION

Dairy products play vital role in daily dietary intake. These products have sufficient amount of bioactive components, minerals and many vital nutrients which are found in very less amount in non-dairy food products. These products have many positive physiological activities like anti-cancer, antibacterial action against many infections of digestive system, helps to reduce cholesterol found in blood serum and stimulate body immune mechanism against harmful invaders (Boukria *et al.*, 2020). The recommended intake of milk or equivalent portions of cheese, yogurt, or other dairy products in the United States is three 8-oz (237 ml) servings per day for adults and children 9 years of age or older to fulfill requirements of calcium and reduce the risk of bone fractures. Therefore, the role of dairy consumption in human nutrition and disease prevention warrants careful assessment (Walter *et al.*, 2020). In 2018-19, Pakistan ranked 4th major nation in the entire globe in milk production. According to the United State Department of Agriculture, total production of milk was 218 billion pounds during

2019 and raised the previous year 2018 around about 0.4 to 0.8 percent. After 2010, total production of milk has raised up to 13-15 percent annually (USDA, 2020). Milk components are stimulate and sustain immune homeostasis of baby and also important parts of newborn immune system. Cells like T-lymphocytes, neutrophils and macrophages plays an important role in the protection against pathogenic bacteria due to consumption of milk (Mangwe *et al.,* 2020). Polyunsaturated fatty acids, vitamins and vital minerals are important role in human health and available in camel milk that why camel milk contains high nutritional value and superior quality than other non-human mammal's milk. Therefore, camel milk has coagulation properties, so this types properties camel milk are used in limited food products and faced difficulties in processing section (Kamal-Eldin *et al.,* 2020). Anti-inflammatory, anti-depressant and neuroprotective properties have been described in alpha linoleic acid. Consumption of alpha linoleic acid from milk are prevented risk of stroke (Quang *et al.,* 2019). Fermented dairy product including yoghurt is made by the process of fermentation of milk and addition of culture. The origin of yoghurt occurs before 6000 B.C .Yoghurt is viscous product with flat texture have pleasant flavor and slightly sour taste (Garcia-Burgos *et al.,* 2020). Yoghurt is made by adding natural or using artificial means such as bacterial culture in heated milk (Macori and Cotter, 2018). In recent years, consumption of fermented dairy products are enhanced day by day in all over the world. These products have fulfillment need of nutritional components whose beneficial for human healthy life and also enhance the expectancy of life (Chen *et al.,* 2019). Hydrocolloids or gums are various group of long chain polymers. When hydrocolloids are dissolved in water then viscous properties of dispersions and gels formed. History of hydrocolloids were first found in trees or bushes, seeds or grains flour, plants or seaweeds extracts, fermentation process and natural products (Bryszak *et al.,* 2018). During storage period texture modification, resist water activity, expand moisture holding and keep the quality of products by the addition of hydrocolloids in any kind of food products. In making of gluten free bread procedure hydrocolloids have performed the important role in it. They are enhanced the gas retention volumes in proofing and baking time and reduced the properties of visco-elastic of gluten (Morreale *et al.,* 2019). Hydrocolloid gums are enhancement of viscosity in any type of solution even used in low proportion because natural source of polysaccharides. Some gums are worked as a stabilizer and gelling agents in such types of food products which have also low-pH concentration like yoghurt. Pectin has been used as a stabilizer and gelling agents in food products and also origin of fruit plant cell. Reduction of synersis, texture improvement and enhance firmness in yoghurt due to addition of xanthan gum. Some gums are added in carrageenan to enhance the gel texture and strength of yoghurt and also water binding properties. Guar gums and locust bean have been used to development of texture properties and also enhance the viscosity and gel structure of yoghurt (Young *et al.,* 2019).

The main objectives of this research are as follows;

1. To make novel low fat yogurt
2. To explore gum based low fat yogurt as functional food
3. To investigate the effect of gums on the quality and acceptability of low fat yogurt.
4. To assess the nutritional content of low fat yogurt.
5. To gather consumer feedback and preferences for low fat yogurt in terms of taste and texture.
6. To determine the shelf life of low fat yogurt under different storage conditions.

2. Materials and Methods

2.1. Preparation of low fat yoghurt

According to standard protocol low fat yogurt was prepared under hygienic situation with variation as described by Moreno *et al.,* (2013). After standardization of 2% fat milk was pasteurized for 30 minutes at 63-65 °C and before inoculation to cool at 43-45 °C. After cooling, inoculation was completed and followed by incubation at 37°C for 4-5 days. The slow stirring along with addition hydrocolloids such as guar gum and xanthan gum was conceded out at 4°C for few minutes. Then the yoghurt was packed and stored at temperature of 4-6°C for about 28 days.

2.2. Compositional analysis of low fat yoghurt

According to Igbabul *et al.*, (2014), moisture content was measured by weighing amount of 2g sample and placed in hot air oven at 105±2℃ for 18-24 hrs. Moreover, concentration of crude protein content was obtained by using Kjeldahl method following the protocol recommended by (Oladipo *et al.*, 2014).Fat percentage was assessed by using the Gerber method Obi *et al.*, (2016). Furthermore, percentage of ash was obtained by the burning the sample at 600 ℃ using Muffle furnace for 4-5 hours according to the method of Igbabul *et al.*, (2014).

2.3. Physio-chemical properties of low fat yoghurt

2.3.1. Determination of pH

Yoghurt pH was obtained by numerical pH meter. In pH meter, measurement of calibration with the help of pH 4 and 7 buffers. Note the reading of pH in triplicate manner when probe of pH injected in it as described by Ong *et al.*, (2007).

2.3.2. Acidity determination

Low fat yoghurt acidity was determined according to the standard protocols AOAC (2000). Calculation of acidity percentage by given formula:

$$\textbf{Acidity}(\%) = \frac{\text{Volume of 0.1N NaOH used (mL) x 0.009}}{\text{Weight of Sample}} \times 100$$

2.3.3. Synersis determination

Synersis of samples was examined through centrifugation technique as described by Shekhar *et al.*, (2013). Measurement of synersis of products was obtained by the supernatant volume

2.4. Viscosity determination

Viscosity of low fat yoghurt was observed using viscometer the method by Brennan and Tudorica, (2008).

2.5. Water Holding Capacity determination

Samples were evaluated for water holding capacity by method of Guzman-Gonzalez *et al.*, (1999). Calculation of water holding capacity was given formulas follows:

WHC = [1- Wt/Wi] ×100

"Wt" is Weight (g) of pallet "Wi" is Initial weight (g) of sample

2.6. Texture profile analysis

Texture profile analysis of low fat yoghurt (adhesiveness, cohesiveness, hardness and springiness) was evaluated by the Texture Analyzer according to the method of Brickley *et al.*, (2007).

2.7. Sensory evaluation

Sensory features such as acceptability, flavor, texture, appearance, after taste and overall acceptability of low fat samples was showed by 9 points of hedonic scale as done by Awad *et al.*, (2004) in which nine was highest score while one was lowest score.

2.8. Statistical analysis

All results collected during experiment were evaluated statistically according to method of Steel *et al.*, (1997) by the use of CRD, ANOVA and other suitable statistical practices.

Table 1.Treatment plan used for the production of low fat yoghurt

Treatments	Fat (%)	Guar gum (%)	Xanthan gum (%)
T_0	4	_	_
G1	2	0.1	_
G2	2	0.3	_
G3	2	0.5	_
X1	2	_	0.1
X2	2	_	0.3
X3	2	_	0.5

3. Results and discussions

3.1. Compositional analysis of low fat yoghurt

Food product quality depends upon the eventually fat substances and also prevention of dense matric formation in low fat yoghurt. According to own density, fat can be separated when milk is going on the process of heat treatment process like pasteurization and UHT treatment (Murtaza *et al.*, 2014). Fat contents was noted to be highly significant in storage time and treatment was significant interaction of various hydrocolloids (guar gum and xanthan gum) in low fat yoghurt of statistical results. Fat content treatments were originated between T_0 3.516, G_1 2.104, G_2 2.066, G_3 2.083, X_1 2.080, X_2 2.046 and X_3 2.002 %. Maximum treatment was found at T_0 (4% fat and no gums) and minimum at X_3 (2%fat and 0.5% xanthan gum). Storage period was originated 0th day 2.406, 7th day 2.313, 14th day 2.206, 21th days 2.204 and 28th day 2.225 %. During storage, fat content of low fat yoghurt rise when moisture content of low fat yoghurt was decreased. Flavor of low fat yoghurt increase, vital role in organoleptic attributes and has positive influence on overall acceptability (Anjum *et al.*, 2007). Protein is a vital constituent of milk. Total essential amino acids are present in milk and also useful for the protein development. Yoghurt texture cab be change and decrease the shelf life properties owing to structure of protein degradation. High quantity of protein are present in low fat yoghurt and also directly related to low fat yoghurt yields (Slavin, 2013). Protein contents during period of storage was highly significant and treatment was highly significant in statistical result. Treatments of protein content were originated between T0 3.886, G_1 3.855, G_2 3.788, G_3 3.830, X_1 3.825, X_2 3.860 and X_3 3.826 %. Treatment T_0 (4% fat and no gums) was maximum while minimum treatment X_2 (2%fat and 0.3% xanthan gum). Storage period was invented 0th day 4.318, 7th day 3.904, 14th day 3.769, 21th day 3.654 and 28th day 3.549%. Results displayed in the treatment and storage about protein content are non-significant in accordance with the earlier finding in which increase the protein content of low fat yoghurt with addition of concentration and reduced during storage time (Guinee *et al.*, 2007). Ash is defined as various components of inorganic matter (minerals) that occur in food products. These food products sample are heated at 550-600^{o}C required. After ashing procedure, the residual materials are distant like protein and fat (organic materials) and also water. Storage period and treatments of ash content was highly significant according to statistical results. Treatments of ash content were originated between T_0 0.838, G_1 0.78, G_2 0.779, G_3 0.753, X_1 0.744, X_2 0.742 and X_3 0.726 %. Maximum treatment was created at T_0 (4% fat and no gums) and minimum at X_3 (2%fat and 0.5% xanthan gum). Ash content during storage period was invented 0th day 0.859, 7th day 0.840, 14th day 0.761, 21th day 0.720 and 28th day 0.656%. Results showed that there is some difference of ash value in all treatment. The percentage of ash decrease with the increase storage time. This study results showed the same results in accordance of Amiri *et al.*, (2010) and also stated range of ash 0.7 to 0.9%. The results of fat, protein and ash analysis of low fat yoghurt are given in table 2. Moisture analysis can be defined as eventual water contents of any food products that guidance of entire product quality. Various procedures of moisture analysis to measure amount of moisture contents in food products in high and low level. Storage period and treatments of moisture content was highly significant but combine influence of treatment and storage was non-significant in statistical results. Treatments of moisture content were originated between T_0 78.08, G_1 78.933, G_2 79.057, G_3 79.231, X_1 79.37, X_2 78.701 and X_3 79.057%. Treatment X_3 (2%fat and 0.5% xanthan gum) was maximum and T_0 (4% fat and no gums) minimum treatment. During storage period moisture content was invented 0th day 79.076, 7th day 79.078, 14th day 78.814, 21th day 78.900 and 28th day 78.725%. According to Alnemr (2016), in storage time reduce/ decrease the moisture percentage content of low fat yoghurt is same result of this research results. The results of moisture analysis of low fat yoghurt are given in table 3.

3.2. Physio-chemical properties of low fat yoghurt

3.2.1. Determination of pH

Measurement of pH value can be medium of acidity or alkalinity of any liquid. The scale is measured for pH value is 1-14. Range of pH value is 1-14.If value of pH 7 is neutral point or midpoint, below 7 value of pH indicates that acidity of product while above 7

value of pH indicates that alkalinity of product. According to statistical results, storage period and treatments of pH was highly significant but combine influence of treatment and storage was non-significant in statistical results. Values of mean pH content treatment were originated between T_O 4.368, G_1 4.350, G_2 4.333, G_3 4.314, X_1 4.298, X_2 4.291 and X_3 4.268%. In pH T_0 (4% fat and no gums) was maximum treatment and X_3 (2%fat and 0.5% xanthan gum) minimum treatment. The result of pH this research shows that when increases in storage time then reduce or decrease in pH of low fat yoghurt. Behind reason about decrease the pH is constituents of biochemical degradation and enhance the level of acidity. They are also affected by activity of enzymatic and bacterial. Anjum *et al.*, (2007) is also showed the same result of this research. This study results are accordance with Ramchandran and Shah, (2010) and same range of pH in yoghurt 4.3-4.6. The results of pH are given in table 3.

3.2.2. Acidity determination

Acidity means that formed or exist organic acid in food products through the reaction occurs for the period of storage. The statistical results revealed that acidity throughout storage time was highly significant and treatment was highly significant interaction of different hydrocolloids (guar gum and xanthan gum) in low fat yoghurt. Treatments of acidity were invented T0 1.182, G_1 1.167, G_2 1.161, G_3 1.142, X_1 1.135, X_2 1.119 and X_3 1.123%. T_0 (4% fat and no gums) was maximum treatment and X_2 (2%fat and 0.3% xanthan gum) minimum treatment in acidity. In acidity, storage period was invented 0^{th} day 1.229, 7^{th} day 1.194, 14^{th} day 1.161, 21^{th} day 1.120 and 28^{th} day 1.031%. This research results shows that addition of hydrocolloids like guar gum and xanthan gum in yoghurt then decrease of acidity with the increase of storage time (Panesar, 2011). The result of Mani *et al.*, (2014) represented that reduction of lactic acid bacteria to produce the lactic acid in yoghurt so that reduced the microorganism activity then acidity of yoghurt in storage period decreases. The results of acidity are given in table 3.

3.2.3. Synersis determination

According to chemistry, synersis can be defined as the abstraction or exclusion of a liquid commencing a gel. According to food science, synersis means that water (liquid) is excluded originated a gel. It is extremely objection less. Put the yoghurt pot in the fridge for overnight then layer of white milky occur on the pot that is synersis. In low fat yoghurt, synersis was highly significant during storage period and treatment with relations of hydrocolloids like guar gum and xanthan gum in statistical result. Treatments of synersis were originated between T_0 29.115, G_1 29.297, G_2 29.487, G_3 29.657, X_1 29.836, X_2 30.035 and X_3 30.191%. Maximum treatment was X_3 (2%fat and 0.5% xanthan gum) and minimum treatment T_0 (4% fat and no gums). In synersis, storage period was invented 0^{th} day 1.229, 7^{th} day 1.194, 14^{th} day 1.161, 21^{th} day 1.120 and 28^{th} day 1.031%. The results of this work equal by the way of Salvador and Fiszman (2004) and stated that in storage time synersis increases. When storage time increase then results of synersis also increases. When synersis of yoghurt increases then water holding capacity of yoghurt decreases. The results of synersis are given in table 4.

3.4. Viscosity determination

Viscosity can be defined as yoghurt thickness. Development of yoghurt textural and structural attributes through polysaccrides. Viscosity is a measurement of fluid that opposition of distortion at a specified value. The concept of viscosity is thickness of any liquid. Viscosity may be increase or decrease depending on the milk used for preparation of yoghurt. According to statistical result, viscosity was highly significant of both storage period and treatment with relations of hydrocolloids like guar gum and xanthan gum. Treatments of viscosity were originated between T_0 130.80 Ns/cm^2, G_1 132.72, G_2 134.87, G_3 137.42, X_1 139.28, X_2 140.90 and X_3 143.9 Ns/cm^2. In viscosity, maximum treatment was X_3 (2%fat and 0.5% xanthan gum) and minimum treatment T_0 (4% fat and no gums). In viscosity, storage period was invented 0^{th} day 101.85, 7^{th} day 120.79, 14^{th} day 136.58, 21^{th} day 155.21 and 28^{th} day 171.23 Ns/cm^2. This work results shows that increases in viscosity with the increase the storage time with the presence of hydrocolloids. According to Eissa *et al.*, (2011) stated that increase in viscosity with enhance the storage period as same results of this work. The results of viscosity are given in table 4.

3.5. Water holding capacity

Water holding capacity well-defined as the water capability of water to remain curd portion through adding of hydrocolloids like guar gum and xanthan gum that relates with all components and bind with water. In case of soil, water holding capacity can be defined as soil texture firm capacity bonded with physically hold water compared to gravity force. In low fat yoghurt, storage period and treatment of water holding capacity was examined to be highly significant in statistical result with relations of hydrocolloids like guar gum and xanthan gum. In water holding capacity, treatments were examined between T_0 28.229, G_1 28.093, G_2 27.943, G_3 27.747, X_1 27.581, X_2 27.402 and X_3 27.199. Maximum treatment of water holding capacity was T_0 (4% fat and no gums) and minimum X_3 (2%fat and 0.5% xanthan gum). Storage period of water holding capacity was invented 0^{th} day 29.794, 7^{th} day 29.335, 14^{th} day 28.308, 21^{th} day 26.548 and 28^{th} day 24.723 %. This work results shows reduce/decrease in yoghurt water holding capacity. This result of work is same with Sakandar *et al.*, (2014) that enhance in storage period then decrease in water holding capacity. When synersis of yoghurt increases then water holding capacity of yoghurt decreases. The results of water holding capacity are given in table 4.

3.6. Texture analysis of low fat yoghurt

Various quality attributes of yoghurt but texture is one most important properties of yoghurt. Texture profile analysis of low fat yoghurt samples were examined adhesiveness, cohesiveness, hardness and springiness. Adhesiveness can be defined as force of attraction needed in contacting between food stuff and various other particles. During eating, these forces are needed for material or particle departure. Maximum value of adhesiveness treatment was X_2 48.44±4.72 N and minimum T_0 33.99±2.29 N. The results of texture profile of adhesiveness shows that rise in adhesiveness with the increase of storage time due to its depends upon the following factor and also being same result of Azari-Anpar *et al.* (2017). Cohesiveness is the attributes of cohesive quality and strength and also being constituents of semi-solid or solid food groups. It can be defined as to quantity of product deformation and destruction after occurrence of load. Constituent of yoghurt, quantity of fat, process of preparation and period of time can be depends by cohesiveness. Cohesiveness maximum treatment value was X_2 1.02±0.093 N and minimum treatment X_1 0.54±0.103 N. The results of texture profile of cohesiveness shows that decrease in cohesiveness with the increase of storage time because it depends upon the following factor and also being same result of Mousavi *et al.* (2019). Hardness is an evaluated parameters and quality of yoghurt. Yoghurt bacterial culture can be affected in this kind of texture profile. Period and temperature of incubation of factor can be depend by hardness of yoghurt. X_3 48.32±4.69 N was maximum treatment and G_1 32.89±5.77 N was minimum. The results of texture profile of hardness shows that increase in hardness with the rise of storage period due to its depends upon the following factor and also being same result of Olalla *et al.* (2009). Springiness can be known as that capability to return unique product formation after relaxation/ free of forces. Various factors such as treatment of heat, components of protein and fat, folding and unfolding of matrix protein quantity. T_0 0.96±0.055 N was maximum and X_1 82±0.086N. The results of texture profile of springiness shows that decrease in springiness with the rise of storage period due to its depends upon the following factor and also being same result of Mudgil *et al.*, (2017). The results of texture analysis are given in table 5.

3.7. Sensory evaluation of low fat yoghurt

Sensory features such as color, flavor, texture, appearance, after taste and overall acceptability of low fat samples was showed by 9 points of hedonic scale used. Various faculty members of different department of university and students were judge the low fat yoghurt samples and asked to rank quality yogurt on hedonic scale 1-9 in which nine was highest score while one was lowest score. Acceptability depends upon the color and also significant quality parameters. Almost all customers can be choice the food stuff on the source of color. On the other way, when rejected the acceptability of any products is called discoloration. G_3 (2%fat and 0.5% guar gum) was maximum treatment and G_2 (2%fat and 0.3% guar gum) minimum treatment of acceptability. Flavor is a sanction of food products

through mouth feel, taste and smell. Development of yogurt can be made by acetaldehyde after milk degradation. Maximum value of treatment X_3 (2%fat and 0.5% xanthan gum) and minimum G_3 (2%fat and 0.5% guar gum). Texture is another significant quality parameter in various finish products of food and also being acceptability of customer to the end product. When texture is incomplete then rejected of customers. G_1 (2%fat and 0.1% guar gum) was maximum treatment and X_1 2%fat and 0.1% xanthan gum) minimum treatment of texture. Appearance is an external look of products and also being importance quality parameters of sensory evaluation. Maximum treatment of appearance was observed at G_3 (2%fat and 0.5% guar gum) and minimum treatment T_0 (4% fat no gums). After taste can be defined as that consumption of any food items and their taste excess in the mouth whichever spit out or ingest it. G_1 (2%fat and 0.1% guar gum) was maximum treatment and X_2 (2%fat and 0.3% xanthan gum) minimum treatment. Overall acceptability means that parameter of product quality in sensory evaluation. Maximum treatment was observed at X_1 (2%fat and 0.1% xanthan gum) and minimum treatment at X_2 (2%fat and 0.3% xanthan gum). The results of sensory evaluation are given in fig 1.

4. Conclusion

The present study was lead to prepare the low fat yoghurt with the addition of guar gum and xanthan gum to increase its nutritional properties. Yoghurt which is prepared without guar gum and xanthan gum is T0 while guar gum was added in yoghurt named as G1, G2, G3 while xanthan gum named as X1, X2, X3. Low fat yoghurt has beneficial impact on health problems like obesity and further enhanced nutritional profile by addition of gums has positive effect in terms of nutrients needed by body. Yoghurt preparation with guar gum and xanthan gum was stored in refrigerator for 28 days and then evaluates its compositional analysis, physiochemical properties, texture analysis and sensory profile. After evaluation of every aspect results are with encouraging impacts. In future, if any industry should work on it, they can commercialize it and gain extra income.

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Conflict of Interest

The author declares that no any types of conflict of interest in this research article.

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Table 2. Compositional proximate analysis of low fat yoghurt

Treatment	Fat (%)		Protein (%)		Ash (%)	
	0 day	28th day	0 day	28th day	0 day	28th day
T_0	3.846±0.094	3.386±0.008	4.340±0.069	4.233±0.118	0.920±0.005	0.693±0.008
G_1	2.220±0.005	2.476±0.059	4.520±0.100	3.730±0.165	0.936±0.038	0.663±0.057
G_2	2.130±0.075	2.263±0.082	4.276±0.182	3.643±0.175	0.963±0.083	0.593±0.071
G_3	1.986±0.017	2.200±0.073	4.420±0.154	3.673±0.206	0.910±0.065	0.553±0.067
X_1	2.186±0.057	2.073±0.121	4.446±0.142	3.530±0.011	0.920±0.052	0.510±0.129
X_2	2.116±0.146	1.960±0.064	4.523±0.178	3.426±0.113	0.946±0.043	0.530±0.067

X_3	2.120±0.176	1.991±0.038	4.580±0.094	3.350±0.087	0.910±0.028	0.526±0.078

Each value is expressed as the **mean ± standard deviation** (*n*=3) of a triplicate analysis

Table 3. Physio-chemical properties of low fat yoghurt

Treatment	Moisture (%)		pH (%)		Acidity (%)	
	0 day	28th day	0 day	28th day	0 day	28th day
T_0	78.180±0.14	78.090±0.10	4.570±0.005	4.15±0.041	1.260±0.005	1.25±0.037
G_1	79.307±0.18	78.700±0.08	4.273±0.170	4.10±0.083	1.240±0.048	1.19±0.043
G_2	78.927±0.02	78.970±0.04	4.486±0.143	4.08±0.051	1.216±0.062	1.12±0.067
G_3	79.427±0.22	79.880±0.05	4.418±0.138	4.05±0.089	1.210±0.053	1.11±0.046
X_1	80.450±0.13	78.810±0.07	4.336±0.067	4.04±0.090	1.303±0.072	1.04±0.079
X_2	79.617±0.08	78.053±0.10	4.216±0.101	4.10±0.121	1.186±0.087	0.97±0.091
X_3	80.163±0.08	78.507±0.04	4.113±0.057	4.003±0.067	1.302±0.133	0.843±0.081

Each value is expressed as the **mean ± standard deviation** (*n*=3) of a triplicate analysis

Table 4. Viscosity, water holding capacity and synersis of low fat yoghurt

Treatment	Viscosity (Ns/cm^2)		Water holding capacity (%)		Synersis (%)	
	0 day	28th day	0 day	28th day	0 day	28th day
T_0	99.95±0.008	163.96±0.76	29.87±0.05	25.26±0.032	27.36±0.011	32.20±0.039
G_1	100.89±0.82	165.99±0.83	30.42±0.33	26.52±0.71	28.31±0.049	32.45±0.058
G_2	100.08±1.28	168.92±0.60	30.36±1.26	26.60±1.12	29.66±2.08	34.33±1.20
G_3	102.99±1.80	171.22±0.93	29.44±0.84	27.66±1.59	28.57±0.899	34.82±0.82
X_1	100.81±1.61	173.66±0.67	30.15±0.72	25.09±0.97	27.10±0.902	35.78±1.002
X_2	102.08±1.41	174.87±1.58	30.01±1.84	27.85±1.37	29.68±0.407	34.93±0.932
X_3	109.41±2.06	176.98±2.33	28.94±1.11	28.85±2.07	28.92±0.923	35.68±1.21

Each value is expressed as the **mean ± standard deviation** (*n*=3) of a triplicate analysis

Table 5. Texture profile analysis of low fat yoghurt

Treatment	Adhesiveness	Cohesiveness	Hardness	Springiness
T_0	33.99±2.29	0.58±0.729	43.88±4.41	0.96±0.055
G_1	37.14±3.48	0.56±0.119	32.89±5.77	0.84±0.126
G_2	40.98±4.59	0.69±0.183	36.53±8.05	0.83±0.108
G_3	36.84±2.97	0.87±0.145	37.76±4.26	0.92±0.077
X_1	45.93±1.39	0.54±0.103	40.88±4.88	0.82±0.086
X_2	48.44±4.72	1.02±0.093	37.62±5.88	0.87±0.093
X_3	35.65±2.76	0.70±0.151	48.32±4.69	0.93±0.053

Each value is expressed as the **mean ± standard deviation** (*n*=3) of a triplicate analysis

Fig 1. Sensory evaluation of low fat yoghurt