Determination of Texture Profile Analysis of Yogurt Produced By Industrial and Traditional Method

Yagmur Erim Kose (Corresponding author)
Van Yuzuncu Yil University, Engineering Faculty,
Department of Food Engineering, 65080, Van, Turkey
E-mail: yagmurerim@gmail.com

Ibrahim Altun
Van Yuzuncu Yil University,
Özalp Vocational High School, 65080, Ozalp, Van, Turkey

Senol Kose
Van Yuzuncu Yil University, Engineering Faculty,
Department of Food Engineering, 65080, Van, Turkey

Abstract
In the current study, the textural parameters of traditional and industrial yogurt samples sold in markets in Van province of Turkey were determined. The texture profile analysis result of traditional yogurt samples were different from industrial yogurt samples, especially based on processing steps in the production as well as composition of raw milk, incubation time, incubation temparature, storage conditions of yogurt samples and etc. The hardness, adhesiveness, gumminess, chewiness values of industrial yogurt samples were determined higher, springiness, and cohesiveness and resilience values were lower than traditional yogurt samples. These findings indicated that the textural parameters of yogurt might be affected by production methods.
Keywords: Texture analysis, yogurt, industrial and traditional method

Introduction

Yogurt is a fermented dairy product and gained more and more attention all over the world (Kose and Ocak, 2011) due to its high nutritional, therapeutic and sensory properties (Cakmakci et al., 2014). It is obtained from fermentation of milk with lactic acid bacteria consisting of a mixture of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus* subsp. *thermophilus* (Eren Karahan, 2016). These cultures produce lactic acid from lactose by fermentation, which reduces the pH from 6.3-6.5 to below 4.6, and creates a hard clot that gives the final product stability and viscosity (Kose and Ocak, 2014). Recently, It was determined that yogurt has antimicrobial, anti-cholesterolemic, anticarcinogenic and therapeutic effects (Cakmakci *et al.*, 2014).

The production processes of yogurt may vary from country to country. It is normally retailed in one of the three physical states namely set, stirred and drinking yogurt. Most of the basic plain yogurts are set yogurts, which are fermented in a retail container that they are eventually sold in (Ozcan, 2013), while fermentation occurs in tanks and the gel is broken before cooling and packaging by stirring due to flavors and fruit added after fermentation (Baran, 2012). Yogurt can be manufactured from different animal milks such as cow, goat, buffalo, ewe, yak and camel (Yilmaz-Ersan *et al.*, 2017) by traditional and industrial methods. In traditional methods, the raw milk is filtered through a cloth filter and is boiled in medium heat with occasional stirring using wooden spoon and then milk is cooled until it is just warm to touch. A measuring cup of yogurt are mixed into the cooled milk and milk incubated overnight at room temperature. Subsequently, the yogurt is cooled to +4°C to stop the fermentation process and storage.

In industrial methods, the raw milk is filtered and standardized in terms of fat and dry matter content. The standardized milk is homogenized at 10–20 and 5 MPa at first and second stage respectively with a temperature changing between 55 and 65 °C. After homogenization, the milk is pasteurized at 85 ºC for 10 minutes or 90-95 ºC for 10 minutes, cooled at 43-45 ºC and (1 to 3%) starter culture of mixture of *Lactobacillus delbrueckii* subs. *bulgaricus* and *Streptococcus thermophilus* was inoculated. The

inoculated milk is packaged and incubated until the pH values reached 4.6. At the end of the incubation time, yoğurt samples cooled to +4°C to storage (Karam et al., 2013).
One of the most essential parameters of yogurt quality is texture. Yoghurt texture is influenced by milk composition, type of starter culture (Wen et al., 2014), stabilizers type, homogenization conditions, incubation temperature, storage conditions and other factors (Ozcan, 2013).
The aim of this research was to examine and compare the texture profile analysis (TPA) of yogurt produced by traditional and industrial methods.

Materials and Methods

Materials

The most preferred twenty seven traditional and industrial yogurt samples were obtained retail markets in Van for texture profile analysis. The freshest 12 traditional yogurt and 15 industrial yogurt (full fat) samples were chosen depend on its labeled shelf life. The collected samples were storaged for 12 h at 4 ºC until they used for TPA analysis.

Methods

Textural parameters

The texture profile analysis of yogurt samples were determined using texture analyzer (Texture Technologies Corp., Hamilton, MA, USA) equipped with load cell of 5 kg and a cylindrical probe (25.4 mm in diameters) supplied with texture exponent programs (Exponent, Version 6.0.6.0., Texture Technologies Corp.). Before TPA analysis, the samples were left at 25 ºC. TPA was performed by compressed twice using probe to make 10-mm penetration with the speed of 5 mm/s. Hardness, springiness, adhesiveness, cohesiveness, chewiness, gumminess and resilience were determined from TPA by using software. All measurements were carried out in triplicate for each samples.

Statistical Analysis

All data were analysed using SPSS (V.20) packaged program. Results were recorded as means± standard deviation of triplicate measurements.

Results and Discussion

It is well known that various properties (texture, functionality and appearance) of foods were greatly affected by their structure. Rheological and texture properties of the fermented dairy products are depend on their structural arrangement and microstructure of the protein network (Delikanli and Ozcan, 2017). TPA parameters (Hardness, springiness, adhesiveness cohesiveness, chewiness, gumminess, and resilience) of the yogurt samples are given in Table 1.
Hardness, or firmness, is the most important characteristic in determining of yogurt texture. It is regarded as the force required to attain a certain deformation and is considered as a measure of hardness of the yogurt (Mudgil et al., 2017). As seen Table 1, whereas hardness values of traditional yogurt samples ranged from 22.32 to 154.78 g, industrial yogurt samples ranged from 94.94 to 224.62 g. As shown in the table, industrial yogurt samples have higher hardness values than traditional yogurt samples. It is thought that the homogenization process is not applied in the yogurt produced by the traditional method. Because, large fat globules as present in unhomogenised milk may decrease hardness of fermented products by interrupting the gel network (Aguilera and Kessler, 1988).
When the hardness values are compared with the literature, our results were similar with the values were determined by Wen et al. (2014) and higher than the value determined by Eren Karahan (2016). These differences are thought to be due to the incubation temperature, time and the amount of culture. Thus, Mudgil et al. (2017) observed that as the culture level used in yoghurt production increases, the hardness of the yoghurt increases and approximately 2–2.5% of culture level showed highest level of hardnes in samples. In addition to this, Sah et al. (2016) reported that a higher hardness of yogurt samples has also been related to a longer incubation time. Specially, lower yogurt incubation time can negatively affect the texturel properties of yogurt. An accelerated release of colloidal calcium phosphates from casein micelles due to a faster acidification rate induces early release of individual caseins from the micelles facilitating early development of the casein network. This situation leads to fast protein aggregation resulting in the formation of a small number of protein-protein bonds and extensive rearrangement of the particles/clusters and consequently a weak gel with large pores and greater whey separation (Sah et al., 2016). In another study, Lee and Lucey (2003) determined that higher temperatures during the incubation could give rise to a weaker protein network and a lower gel firmness.
Adhesiveness is the force necessary to remove the material that adheres to the mouth during eating (Ganesh, 2006). it can be seen from Table 1, the maximum and minimum adhesiveness values (g.s) have

been determined in traditional yogurts and values of the samples ranged from -2.13 to -44.13. These values were lower than the value determined by Hashim et al. (2009).

Springiness value of the sample represents the recovery ability of the sample against first deformation applied during analysis. As known, food products are subjected to different forces, resulting in deformation of the product, during transportation and storage. Hence, springiness value of the product is very important for the product quality with desired level (Yildiz et al., 2015). Springiness (%) values of the yogurt samples ranged from 48.27 to 84.03. Ocak and Kose (2010) expressed that the protein matrix is responsible for the springiness and hardness of yogurt.

The cohesiveness indicates the strength of internal bonds making up the body of food and the degree to which a food can be deformed before it breaks (Chandra and Shamasundar, 2015). The maximum and minimum cohesiveness values have been determined in industrial yogurt samples and the values of the yogurt samples are changed between 0.46 to 0.89. Cohesiveness is defined as the ratio of the positive force area during the second penetration to that of the first penetration. It may be measured as the rate at which the material is disintegrated under mechanical action. Tensile strength is a manifestation of cohesiveness. The cohesiveness indicates the ability of the product to hold together (Chandra and Shamasundar, 2015).

Table 1 TPA parameters of traditional and industrial yogurt samples (Means±SD)

		Hardness (g)	Adhesiveness (g.s)	Springiness (%)	Cohesiveness	Gumminess	Chewiness	Resilience (%)
Traditional Yogurt Samples	1	33.38±4.44	-44.13±6.23	84.03±1.23	0.87±0.01	29.92±2.18	25.38±1.11	47.57±0.28
	2	59.35±0.24	-2.39±0.23	72.90±0.52	0.84±0.00	49.68±0.03	36.30±0.17	54.29±0.04
	3	82.93±2.55	-6.71±0.50	72.15±1.93	0.74±0.01	61.72±2.49	44.51±0.61	41.40±1.37
	4	133.12±0.35	-4.68±1.10	71.91±1.22	0.67±0.05	89.23±7.44	65.19±5.05	41.36±2.04
	5	108.68±0.89	-2.13±0.10	71.16±1.93	0.78±0.01	84.34±2.18	60.04±3.17	47.02±0.98
	6	61.62±1.89	-3.77±0.07	63.12±1.05	0.82±0.00	50.62±1.56	31.96±1.52	54.48±0.26
	7	63.69±2.73	-4.41±0.02	66.21±2.63	0.76±0.01	46.71±0.66	28.14±2.28	40.97±0.85
	8	22.32±0.16	-7.50±0.95	73.27±0.00	0.79±0.02	17.61±0.30	11.87±1.25	37.50±0.87
	9	87.80±0.85	-5.06±0.53	69.43±3.68	0.69±0.05	63.47±0.41	41.76±1.20	37.78±2.45
	10	103.18±4.03	-3.39±0.07	63.12±5.25	0.68±0.03	70.09±6.14	44.08±0.20	40.65±3.71
	11	130.67±3.69	-2.79±0.67	65.84±6.65	0.73±0.05	95.04±9.57	62.26±0.02	44.68±3.74
	12	154.78±2.35	-3.27±1.14	64.73±1.23	0.68±0.03	104.53±5.5	67.69±4.84	35.28±1.53
	13	36.52±0.63	-4.96±1.36	69.55±1.40	0.73±0.01	26.47±0.92	19.46±0.47	39.50±0.60
	14	35.89±2.58	-5.00±1.15	70.17±1.81	0.80±0.03	28.57±2.54	20.08±2.26	41.36±3.68
	15	92.04±10.26	-7.95±1.26	56.93±1.05	0.54±0.02	49.46±3.52	28.18±2.52	23.10±2.49
Average		80.40±40.46	-7.21±10.36	68.97±6.18	0.74±0.08	57.83±26.73	39.13±17.95	41.80±7.65
Industrial Yogurt Samples	1	174.57±1.8	-17.90±3.27	68.94±6.13	0.46±0.03	80.19±3.81	55.16±2.29	16.26±3.88
	2	207.07±2.79	-11.76±1.12	48.27±0.70	0.61±0.01	126.97±0.42	61.29±1.09	31.18±0.01
	3	153.90±4.53	-11.32±0.05	57.30±0.88	0.58±0.00	88.69±1.88	50.82±0.30	25.74±0.40
	4	224.62±14.95	-2.83±1.60	54.95±12.95	0.84±0.07	207.72±23.58	112.61±13.95	56.32±0.17
	5	132.91±7.10	-16.49±0.34	68.19±5.08	0.56±0.02	74.52±1.85	49.43±3.03	21.65±1.74
	6	126.30±3.22	-4.93±0.01	38.00±2.62	0.89±0.01	112.32±4.01	42.73±4.47	60.22±2.23
	7	198.36±0.07	-19.89±0.43	63.74±1.57	0.57±0.00	113.26±0.68	73.11±0.04	25.22±0.14
	8	96.28±1.50	-7.57±0.90	59.90±1.05	0.64±0.06	56.48±0.32	36.15±2.50	33.49±4.06
	9	130.36±0.10	-30.58±0.78	88.99±5.08	0.74±0.02	91.04±5.83	80.86±0.57	27.82±0.99
	10	198.94±6.88	-31.03±1.54	68.07±2.10	0.60±0.01	115.49±0.90	80.85±6.19	22.96±0.48
	11	178.78±6.79	-25.90±1.88	69.55±1.05	0.59±0.04	105.08±2.53	71.55±0.66	22.72±0.24
	12	94.94±2.93	-13.33±2.16	72.65±0.17	0.59±0.00	56.29±1.46	40.90±1.16	22.39±0.46
Average		159.75±43.70	-16.13±9.39	63.21±13.00	0.64±0.12	102.34±40.35	1.96±21.90	30.50±13.76

Gumminess values of traditional and industrial yogurt samples are shown Table 1. Gumminess is defined as the product of hardness and cohesiveness. Yogurt with high hardness value also has a high gumminess value. Gumminess is a characteristic of semisolid foods with a low degree of hardness and high degree of cohesiveness (Yildiz et al., 2015).
Chewiness is measured in terms of the energy required to masticate a solid food and should be calculated in TPA of solid food. It is calculated as the product of hardness xspringiness x cohesiveness of sample (Mehta et al., 2012) and is affected by change any of these parameters. The chewiness value of the yogurt samples are changed between 11.87 to 112.61. Chewiness is the most difficult characteristic to measure distinctly. Because mastication involves compressing, shearing, piercing, tearing, grinding and cutting along with adequate lubrication by saliva at body temperatures.
Another textural parameter of yogurt samples determined from TPA analysis is resilience. It is related with the ability of the product regaining its original position after deformation applied (Yildiz et al., 2015). The resilience values of yogurt samples are given also Table 1.

Conclusions

In Turkey, yogurt is traditionally produced in the small dairy farms of families and small-scale dairies. The composition of raw milk, pH of milk, manufacturing process, starter culture and storage conditions, could affect the texture profiles of yogurt samples. It has been determined that the textural parameters of industrial yogurt samples were closer to each other and there is a standard among samples according to the results of yogurt samples. According to TPA results, industrial methods should be preferred in yogurt production for consumer acceptability and to provide a standard quality production.
It has been determined that there is not enough study to determine the textural and rheological properties of yogurt samples and more TPA studies are needed to resolve these gaps in the literature and to ensure a quality production.

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