TEXTURE AND VISCOSITY FOR SOME DIFFERENT TYPES OF YOGURT

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Abstract

Yogurt is included into mankind diet for millennia. The aim of the current research was to study the texture and viscosity of different yogurt types (fat yogurt with 3.8% fat and skimmed yogurt with 0.1% fat) function of fat and protein content. Determinations on yogurts' texture and viscosity, were effectuated in order to study which is the effect of fat content difference on yogurts' texture and viscosity. In the case of texture determination, after processing of data provided by texture analyser were determined the values of quality parameters. At the end of effectuated analysis for determining texture and viscosity for those two yogurt assortments was observed the fact that exist very significant differences, physically speaking, between yogurt assortments, mainly due to fat and protein content which exist into acid-dietetic dairy products.

Key words: *analysis, physical parameters, texture, viscosity, yogurt*

INTRODUCTION

Mankind has a long tradition regarding milk consumption or in using milk as raw material for many dairy products, such as pasteurised milk, skimmed milk, acidophilus products, cream, butter, cheeses or ice-cream.

Milk is a complete food with a high nutritive value, all its nutrients being very good for human health. Milk contains all the necessary elements for developing and function of human organism, being a source of proteins, lipids, carbohydrates, vitamins and minerals. Also in milk can be founded more bioactive compounds like, immunoglobulins, hormones, cytokines and nucleotides (Alganesh and Fekadu, 2012). Milk fermentation is one of the oldest methods practiced by mankind for milk preservation offering in this way a longer valability. The exact origin of milk fermentation is not quite clear, but seems to start early in the civilisations' dawns (Fisberg and Machado, 2015). Was reported that ancient civilizations such as Sumerians, Babylonians, Egyptians and Indians, were highly advanced in regarding agricultural practices and animals' rearing. This thing is also sustained by the discoveries made by (Copley et al., 2003), who discovered fat residues in pottery fragments from Bronze and Iron Age Neolithic settlements, fact which suggest dairying practice existed in Britain with almost 6500 years ago. Historians accepted the variant that milk fermentation was accidentally discovered by a Neolithic population from Central Asia, when they stored milk through primate methods, like in sheep skin "sacks" which were deposited at heat (Tamime and Robinson, 1999). Regarding yogurt, this one is included into mankind diet for millennia, and seems that the word "yogurt" derived from the Turkish verb "jugurt" (Trachoo, 2002) or from the Turkish word "yoğurmak" (Fisberg and Machado, 2015; McGee, 2004; Tamime and Robinson, 2007), which means "to thicken, coagulate, or curdle". Yogurt is a product which can be described "as a non-Newtonian fluid with shear-thinning characteristics, exhibiting time-dependent changes of viscosity" (Afonso and Maia, 1999; Loveday et al., 2013 cited by Najgebauer-Lejko et al., 2020). Yogurt is an acid dairy, and for its obtaining is utilised a starter culture in which are two lactic bacteria, as follows *Streptococcus salivarius* subsp. *Thermophilus* and *Lactobacillus delbrueckii* subsp. *Bulgaricus* (Lee and

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Lucey, 2010). Those two species of bacteria utilised for yogurt making had a thermophile character and had a very good development at an insemination thermal level between +40 and +45°C. The main difference between assortments is given by fat content reported to total dry matter content (Aryana and Olson, 2017).

The aim of the current research was to study the texture and viscosity of different yogurt types (fat yogurt with 3.8% fat and skimmed yogurt with 0.1% fat) function of fat and protein content.

MATERIAL AND METHOD

The studied material was represented by two types of yogurt. The first one was a classic (fat) yogurt with 3.8% fat and the second one was a skimmed yogurt with a fat percentage of 0.1%. Our goal was to determine the effect of fat and protein on yogurts' texture and viscosity.

Determination of texture for yogurt was realised with a column type texture analyser for solicitations at compression and elongation with a 25 N digital dynamometer with a 0.005 N resolution (fig. 1 and fig. 2). For obtaining better and more conclude results, determination of texture for acid-diet products was realised on 5 samples of yogurt from each assortment, and at the end was realised a mean of the results for those 3 samples.

Fig. 1 Column type texture analyser (rear view)

Fig. 2 Column type texture analyser (side view)

Methods' principle: texture determination for yogurts is realised by applying of a pressure produced by texture analyser (expressed in N or kgf) to crack the product curd.

Working mode: during experiment the device will exercise different forces function of layers' number which succeeded to destroy. At the first data recording (represented by the first portion of the graphic on positive number axis), probe is introduced (pushed) by the device inside the container in which is the product, for destroying the curd in order to obtain data which will be used for determination of curds' cohesiveness, hardness, resilience and breakage. The second reading of data is realised when probe is extracted from container, and is graphically represented by the second area of the final graph, area placed on the negative number axis. And the third and last reading is realised when the probe in introduced for the second time into curd to determine how well curd recovers after the first action exerted by the probe. At the end by correlation of the data obtained from those three readings could be also gained information regarding products' elasticity and gumminess.

Working stages:

In order to determine the yogurts' texture were made the following steps:

- calibration of texture analysed by introducing of necessary data for carrying out the experiment, mentioning the value of superior and inferior limit at which the devices' probe starts and ends. The superior limit was settled at value of 24.72 and is the point from which probe start to descend and penetrate the curd, being settled with 1-2 cm higher that containers' height. Inferior limit was settled at the value of -10.82, representing the point till probe enter into curd (could be also defined as the limit at which is perforated all the products' curd);
- are introduced in computer the necessary data for experiment (probes' velocity as well the duration in which probe moves into product content);
- placing containers with sample of analysis support of the device;
- starting the computer software which will record the data;
- starting of texture analyser for beginning of experiment;
- data downloading and processing;

- calculus of necessary indexes for determination of quality parameters;
- calculus of quality parameters for studied indexes.

Determination of viscosity

Working stages:

- plug is the USB cable to viscometer to connect the device to computer to be able to read the data obtained during experiment;
- turn on the viscometer (fig. 3 and fig. 4) and wait for 10 seconds till the device automatically adjust itself to the standard settings;
- are introduced all the necessary dates for the experiment (measure units, sample density, experiments' date and hour);

Fig. 3 Viscometer (rear view)

Fig. 4 Viscometer (side view)

- the device is reconfigured by setting the specific parameters for yogurt viscosity analysis (select shaft R4, setting the rotation speed at 30 rpm as initial rotation speed and 60 rpm as maximum rotation speed which must be reached and also is introduced the experiment duration in minutes);
- from OPTIONS software menu, in order to realise the communication between software and computer must be selected command COMMUNICATION;
- the same dates are settled up also for computer software, with the mention that experiment duration will be in seconds;
- yogurt sample is placed under the device probe (fig. 4), probe is manually moved down till a distance of 10-20 mm between device protection and containers' inferior part;
- probes' shaft is introduced into yogurt sample through containers' side part not to damage the products' curd and shaft is guided to the fixing rod to be able to be thread on device (due to the fact that the shaft will be moved through the curd to be mounted on the device, the process of introduction, moving through curd and threading with be realised as fine as possible to destroy in curd only in a minimum rate);
- software is turned on to start the reading of data and is also turned on the device for starting the experiments;
- data are collected, processed and interpreted by correlation with the interpretations of the results obtained for texture.

RESULTS AND DISCUSSIONS

Determinations on yogurts' texture and viscosity, were effectuated on samples of classic (fat) yogurt and skimmed yogurt, in order to study which is the effect of fat content difference on yogurts' texture and viscosity. In the case of texture determination, after processing of data provided by texture analyser were determined the values of quality parameters.

In figure 5 is presented the mean graph for texture determination on classic (fat) yogurt and in figure 6 is presented the mean graph for skimmed yogurt sample.

Texture determination for those two analysed yogurt assortments was realised based on calculation of some physical quality indicators, using the graphs presented in figures 5 and 6. So, based on area calculus for some well determined surfaces from those two graphs, we were able to apply a series of formulas to determine the physical indicators for those two analysed yogurt assortments.

At the end of effectuated analysis for determining the texture for those two yogurt assortments was observed the fact that exist very significant differences, physically speaking, between yogurt assortments, mainly due to fat and protein content which exist into acid-dietetic dairy products.

In table 1 are presented the applied calculus formulas in order to determine all the physical parameters, the used measure units and the values for quality indexes for the determinations realised on texture of those two analysed yogurt assortments.

In table 2 are presented the viscosity values for 5 yogurt samples function of temperature.

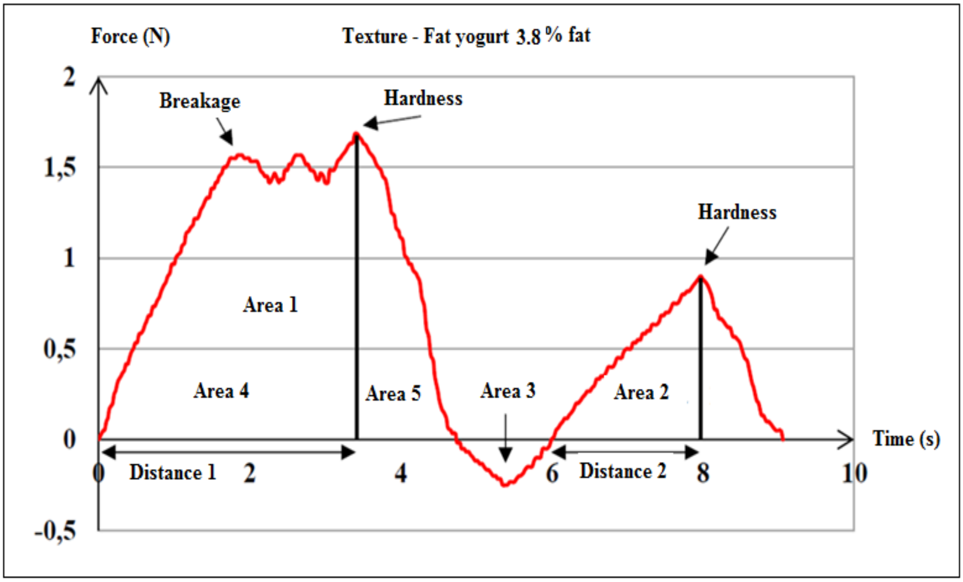

Fig. 5 Mean graph for texture determination at classic yogurt (3.8% fat)

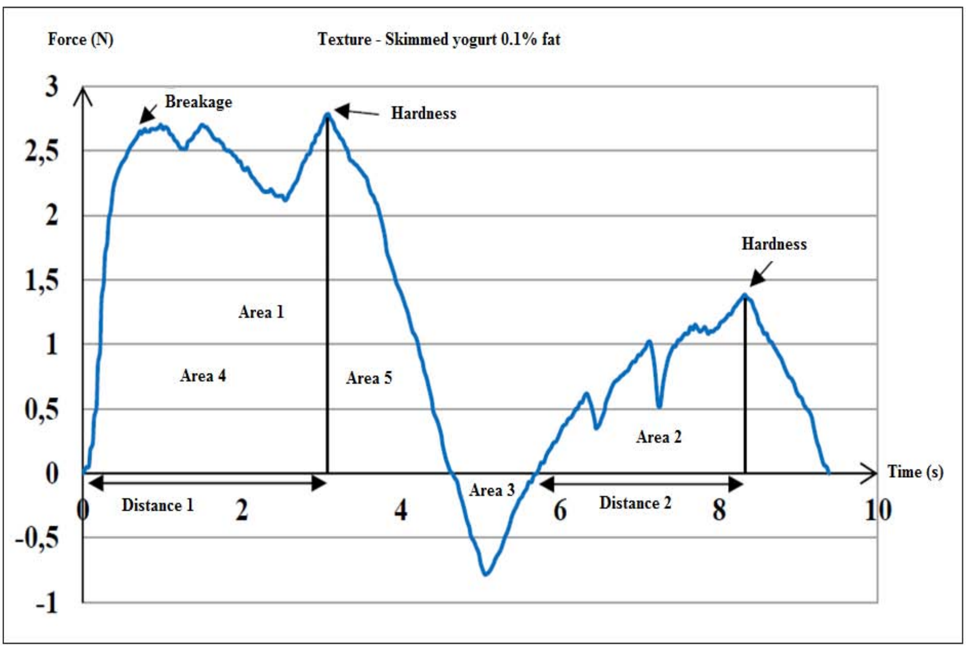

Fig. 6 Mean graph for texture determination at skimmed yogurt (0.1% fat)

Table 1. Values of physical parameters resulted after texture and viscosity determinations for classic yogurt (3.8% fat) and skimmed yogurt (0.1% fat)

Parameter	Calculus formula	Unit	Classic yogurt	Skimmed yogurt
Cohesiveness	Area 2/Area 1	-	0.26±0.01	0.29±0.02
Elasticity	Distance 2/Distance 1	-	0.56±0.03	0.85±0.03
Hardness	Maximum positive force recorded in area 1	N	1.68±0.02	2.78±0.01
Gumminess	(Area 1/Area 2)*Hardness	N	0.43±0.04	0.80±0.02
Firmness	Area 1	mJ	5.24±0.05	9.51±0.09
Resilience	Area 5/Area 4	-	0.30±0.01	0.34±0.02
Adhesiveness	Area 3	N*s or mJ	-0.17±0.02	-0.41±0.01
Adhesive force	Maximum negative force recorded in area 3	N*s or mJ	-0.25±0.04	-0,78±0.03
Breakage	Maximum positive point recorded before first decreasing of values	N	1.56±0.03	2.65±0.04

Table 2. Viscosity values for classic yogurt (3.8% fat) and skimmed yogurt (0.1% fat)

Parameter	Calculus formula	Unit	Classic yogurt		Skimmed yogurt at 8°C
			Sample at 6°C	Sample at 8°C	
Density	Ratio between yogurt mass and volume (M/V)	g/cm^3	1.0979±0.05	1.0908±0.03	1.0620±0.02
Viscosity	Mean value of difference between maximum and minimum point of viscosity graph	cP	12507.60±0.15	12448.75±0.25	12400.25±0.35
		Pa*s	12.50760±0.15	12.44875±0.25	12.40025±0.35

Cohesiveness is the physical parameter which indicate how well resist the curd at second action of probe, in relation with the first deformation provoked by the action exercised by probe on curd. This parameter is influenced by the protein content, being defined as the strengthens of internal liaisons of protein structure which form the curd. In comparison with classic (fat) yogurt which had a cohesiveness of 0.26±0.01, skimmed yogurt had a higher value for this parameter (0.29±0.02) due to the fact that this one had more protein in relation with fat. But the values are not significant different because protein level of those two products is also not very different. Due to the fact that parameter's value is much closer to 0 for both analysed yogurt assortments, results that both yogurt assortments had a low resistance at the second deformation in comparison with the first one, because the liaisons are weaker.

Elasticity is the physical parameter which indicate how well resist the curd after first deformation or in other words how elastic is. In comparison with classic (fat) yogurt, at which was recorded a value of 0.56±0.02 skimmed yogurt had a value of 0.85±0.03 for this parameter, and is more elastic, having a better resistance at first action of the probe in comparison with the classic (fat) yogurt. But due to the fact that mean value recorded for classic (fat) yogurt is above the mean (over 0.5) we could affirm that classic (fat) yogurt had a moderate elasticity.

Hardness express how well curd resist to the action exercised by. Curd's hardness is also influenced by product's elasticity, so due to the higher elasticity of skimmed yogurt also its hardness is higher in comparison with classic (fat) yogurt. The recorded values for both yogurt types are under the level of 60 N, being of 1.68±0.02 N for classic (fat) yogurt and 2.78±0.01 N for the skimmed one, so yogurts are placed in the category of food products with a soft texture.

Gumminess represent mechanical work necessary to compress the curd, or adhesion degree of curd to probe. Due to higher protein content, in comparison with fat content, skimmed yogurt had a better adhesion on probe surface in comparison with classic (fat) yogurt. Through values determination for gumminess, resulted that classic (fat) yogurt had a mean adhesion to probe surface being slightly sticky, recording a value of 0.43±0.04 mJ, and skimmed yogurt due to its value for this parameter of 0.80±0.02 mJ, is much sticky having a better adherence on probe surface.

Firmness represent, physically speaking, the forces' impulse which probe must done in order to change yogurt's state/movement direction. Was observed the fact that classic (fat) yogurt, had a lower firmness in comparison with skimmed yogurt due to protein liaisons which are stronger at skimmed yogurt. For classic (fat) yogurt this parameter was 5.24±0.05 mJ, being with 4.27 mJ lower face to firmness of skimmed yogurt which recorded a value of 9.51±0.09 mJ.

Resilience is curd's capacity to recover its initial height after compression. At both analysed yogurt assortments were recorded values closer to 0 for resilience, respectively 0.30±0.01 for classic (fat) yogurt and 0.34±0.02 for skimmed yogurt, so in both cases curd didn't recover its initial height. However, skimmed yogurt presented a better recover capacity for curd's height in comparison with classic (fat) yogurt due to its higher elasticity.

Adhesiveness of products show how well curd adhere to probe, when this one is extracted from product. For both analysed yogurt assortments, adhesiveness is low in relation with cohesiveness, but could be observed a better value for skimmed yogurt (-0.41±0.01 N), in comparison with classic (fat) yogurt which obtained a value of -0.17±0.02 N. This difference is due the rate between chemical components (especially fat and proteins) which could be founded in those two products. Adhesiveness difference between those two yogurt assortments is given by the difference between protein content and fat percent, being higher at skimmed yogurt due to higher level of proteins in relation with fat.

Adhesive force is the physical indicator which show hoe well and how long the curd adheres to probe surface, expressing the force exercised by texture analyser to take off the probe from analysed product. In the case of current paper was observed the fact that dynamometer recorded a higher force at skimmed yogurt, for probe extraction from product curd being recorded a value of -0.78±0.03 N ("-" indicate the placement for this value on the graph from negative axis). In comparison with skimmed yogurt, for classic (3.8% fat) yogurt was recorded a value of -0.25±0.04 N at adhesive force analysis, a much lower value in comparison with skimmed yogurt. So, for classic (fat) yogurt was necessary a lower effort to take off the probe from curd, due to high fat content which not allow to curd to adhere to probe surface so well as skimmed yogurt, where fat content is much lower (almost 0%).

Breakage express the maximum value recorded before realisation of the first crack in curd. Due to high elasticity, skimmed yogurt resisted for a longer period and to a higher pressure before realisation of the first crack in curd, being recorded a value of 2.65±0.04 N, in comparison with classic (fat) at which was recorded a value of 1.56±0.03 N.

Viscosity was determined in order to analyse the difference between those two yogurt assortments which are different from chemical point of view through fat and protein content, and also to determine which differences are recorded between two samples from the same assortment, but which have different temperatures inside curd during analysis, knowing the fact that temperature is the physical parameter which directly influence products' viscosity.

Viscosity was analysed at different temperatures (+6°C and +8°C). For calculus of viscosity was necessary determination of density for yogurt samples.

Between those two samples of classic (fat) yogurt which were subjected to viscosity analysis at different temperatures, were obtained higher values when the temperature was lower. For the first sample which was analysed at a temperature of +6°C, viscosity value was of 12507.60±0.15 cP, or 12.50760±0.15 Pa*s, being with 58.85 cP higher in comparison with the value obtained at the temperature of +8°C, which was 12448.75±0.25 cP (or 12.44875±0.25 Pa*s). So was observed that function of thermal level at which viscosity was determined, the values for this physical parameter could fluctuate, being recorded higher values for viscosity if samples are analysed at temperatures closer to 0°C, and lower values if analyses are realised at a temperature closer to +20°C (ideal temperature at which are determined milk properties).

Between the yogurt assortments with a different fat content were determined different viscosity values, mainly due to samples' fat content. The classic (fat) yogurt sample, analysed at +8°C temperature had a higher viscosity in comparison with the skimmed yogurt sample which was analysed at the same temperature. For classic (fat) yogurt was obtained a viscosity of 12448.75±0.25 cP (12.44875±0.25 Pa*s), with 48.50 cP higher face to skimmed yogurt which obtained a value of 12400.25±0.35 cP (12.40025±0.35 Pa*s). This difference is due to dry matter content, viscosity being higher in products with more dry matter.

CONCLUSIONS

Classic (fat) yogurt had a cohesiveness of 0.26±0.01 and skimmed yogurt had a higher value for this parameter (0.29±0.02) due to the fact that this one had more protein in relation with fat.

In comparison with classic (fat) yogurt, at which was recorded a value of 0.56±0.02 skimmed yogurt had a value of 0.85±0.03 for elasticity, and is more elastic.

Curd's hardness recorded values for both yogurt types are under the level of 60 N, being of 1.68±0.02 N for classic (fat) yogurt and 2.78±0.01 N for the skimmed one, so yogurts are placed in the category of food products with a soft texture.

Classic (fat) yogurt had a mean adhesion to probe surface being slightly sticky, recording a value of 0.43±0.04 mJ for gumminess, and skimmed yogurt due to its value of 0.80±0.02 mJ, is much sticky having a better adherence on probe surface.

Classic (fat) yogurt, had a lower firmness in comparison with skimmed yogurt due to protein liaisons which are stronger at skimmed yogurt. For classic (fat) yogurt this parameter was 5.24±0.05 mJ, being with 4.27 mJ lower face to firmness of skimmed yogurt which recorded a value of 9.51±0.09 mJ.

At both analysed yogurt assortments were recorded values closer to 0 for resilience, respectively 0.30±0.01 for classic (fat) yogurt and 0.34±0.02 for skimmed yogurt, so in both cases curd didn't recover its initial height.

For both analysed yogurt assortments, adhesiveness is low in relation with cohesiveness, but could be observed a better value for skimmed yogurt (-0.41±0.01 N), in comparison with classic (fat) yogurt at which was recorded a value of -0.17±0.02 N.

Adhesive force recorded a higher value of -0.78±0.03 N at skimmed yogurt and for classic (fat) yogurt was recorded a value of -0.25±0.04 N, a much lower value in comparison with skimmed yogurt.

For breakage was recorded a value of 2.65±0.04 N for skimmed yogurt while for classic (fat) yogurt was recorded a value of 1.56±0.03 N.

Function of thermal level at which viscosity was determined, the values for this physical parameter could fluctuate, being recorded higher values for viscosity if samples are analysed at temperatures closer to 0°C, and lower values if analyses are realised at a temperature closer to +20°C (ideal temperature at which are determined milk properties).

Classic (fat) yogurt, analysed at +8°C temperature had a higher viscosity in comparison with the skimmed yogurt sample which was analysed at the same temperature. This difference is due to dry matter content, viscosity being higher in products with more dry matter.

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