Production and Sensory, Textural, Physicochemical Properties of Flavored Spreadable Yogurt

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Abstract: In this study, yogurt was initially flavored with some fruits and herbs groups. The consistency of yogurt was increased by filtration and some stabilizers in order to give spreadable structure. The yogurt samples were analyzed on days 1, 10 and 20 during storage at 4 °C. Dry matter, pH, water holding capacity, a_w and viscosity content of yogurt samples changed from 28.01% to 33.70%, 4.69 to 4.91, 88.44% to 96.10%, 0.856 to 0.960, 27.18P to 218.83P, respectively. Texture profile analysis demonstrated that the hardness, adhesiveness, cohesiveness and fracturability of yogurts significantly showed differences. Color characteristics (*L*, a*, b**) are varied according to the kinds of fruits and herbs used in yogurt. As a result of the organoleptic evaluations, cherry added yogurt sample had the highest overall acceptability. A mean score between five and six indicated that the sample product was "like" accepted. Yogurt samples get spreadable properties. According to these results, yogurt can become more attractive for children. It is also thought this application will increase yogurt consumption and be an important improvement in people's nutrition with a different consumption.

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1.Introduction

Yogurt's nutritional profile has a similar composition to the milk from which it is made but will vary somewhat if fruit, cereal or other components are added. Yogurt is an excellent source of protein, calcium, phosphorus, Vitamin B_2, Vitamin B_1 and Vitamin B_{12}, and a valuable source of folate, niacin, magnesium and zinc. The protein it provides is of high biological value, and the vitamins and minerals found in milk and dairy foods including yogurt are bioavailable. Eating dairy products, such as yogurt, helps to improve the overall quality of the diet and increases the chances of achieving nutritional recommendations (Mckinley, 2005).

Yogurts are classified in various ways according to fat ratio, production technique, aroma, and the procedures after incubation. The yogurts are sold in the market in various ways according to the classification method. For example, creamy yogurt (full fat), homogenized yogurt (fat and different construction technique), light yogurt (nonfat), fruit yogurt, filtration (bags) yogurt and so on. Yogurt, produced in various regions of Turkey is a very traditional type and variety of procedures and methods (eg, filtration, winter, Silivri, silifke, salt, cream, etc.). Among these, preferred is the most produced yogurt torba or süzme type. Other bag or strained type products are manufactured in different countries—for example, laban zeer (in Egypt), Besa (in Bulgaria), skyr (in Iceland), labneh anbaris or yogurt cheese (in the Middle East) and chakka and shrikhand (in India), Than or Tan in Armenia and Ymer in Denmark (Nergiz and Seçkin, 1998; Tamime and Robinson, 2007).

The increase in the per capita annual consumption of yogurt in the majority of the countries has been attributed to both the ever-increasing availability of fruit or flavored yogurt, and to the diversity of presentations of the product. A variety of different flavoring ingredient (fruits, natural flavors or synthetic flavors) are currently added to yogurt. The types of flavoring material used in the yogurt industry are fruits, fruits preserves, canned fruit, frozen fruits and miscellaneous fruit products. Results of recent studies indicated that fruit addition levels play a significant role in acceptability of fruit added yogurt (Tamime and Robinson, 1988). Several yogurt-based products are marketed with the addition of either fruit or vegetables rich in bioactive food ingredients or edible fibers claimed to have beneficial effects on human health (Deeth and Tamime, 1981). The flavorings and their dosage are usually regulated according to the regulations identified say by each country. The FAO/ WHO recommendations for fruit yogurt are a fruit content between 5 and 15 %. In addition, fruit contend suggested for fruit yogurt according to Turkish Food Codex (for fermented milk) was 6% (Anonymous, 2001).

If fruit and herb are added to it, yogurt is more nutritious and functional. The purpose of this study, fortified with fruits and herbs, flavored yogurt is to produce for children and adults or gain spreadable properties to it. The effect of these additives on the physicochemical, color and sensory characteristics of spreadable yogurt was also investigated during storage.

2.Material and Method

The raw cow's milk for the production of spreadable yogurt was obtained from Adamenekşe dairies, Sakarya, Turkey. The milk contained 15.00% non-fat dry matter, 7.70% fat, and 5.65% protein. The acidity and pH of the milk were 6.80 SH, 6.65, respectively. Yogurt cultures (YO-MIXTMYOGURT CULTURES 499 with *L. delbrueckii* subsp. *bulgaricus* and *Str. Thermophilus*) were originally obtained from İstanbul-Turkey distributor of Danisco (Deutschland GmbH Germany/Alemanha). Fruits and herbs added to yogurt, were obtained from local markets commercially. Fruits were freeze-dried and ground using centrifugal mill with 0.12 numbered sieve. Sesame oil, flax seed oil and black cumin oil naturally produced by cold pressing have supplied from ONEVA company- Istanbul. Skimmed milk powder was obtained from Milkon Dairy-Sakarya, Türkey.

Yogurt production: The quantities of fruits and herbs used in the production of yogurt were determined by preliminary tests. The production flow chart is given in **Figure 1** for spreadable flavored yogurt. Yogurts were produced from cows' milk in 2 L stainless steel containers. All yogurts were supplemented with 5% non-fat milk powder and 5% cream. The mixes were homogenized in a stomacher at 45 °C (Tekmar 400, USA), heated at 90°C for 30 min, cooled to 45°C, and then flavoring ingredients were added in **Figure 1**. Milks were then inoculated with 3 % yogurt starter culture, aseptically transferred into the plastic cups, and incubated at 42°C until the pH dropped to approximately 4.95. The yogurts were stored at 5°C. Three replicates of each yogurt were made.

Compositional Analysis: Yogurt samples stored at 5 °C were analyzed in 1, 10 and 20 days. The using AND MX-50 moisture analyzer for the determination of dry matter and titration acidity as lactic acid were carried out according to the standard methods of AOAC (1995). The pH of samples was measured at 6°C using a pH meter (Hanna Instruments pH Meter 211). Water activity (a_w) of the samples was measured using a commercially available a_w meter, measuring system (Model AQUALAB 3TE, Washington). The water holding capacity (WHC) was determined by a procedure adapted from Guzman-Gonzalez et al. (1999).

Sensorial Evaluation: A nine-point facial hedonic scale in which 1 ="dis-liked extremely", 5 = "neither liked nor disliked" and 9 = "liked extremely" was used by each participant for sample evaluation. Approximately 50 ml of each sample was presented in a glass bowl and spread on bread with a plastic spoon (Meilgaard, 1999).

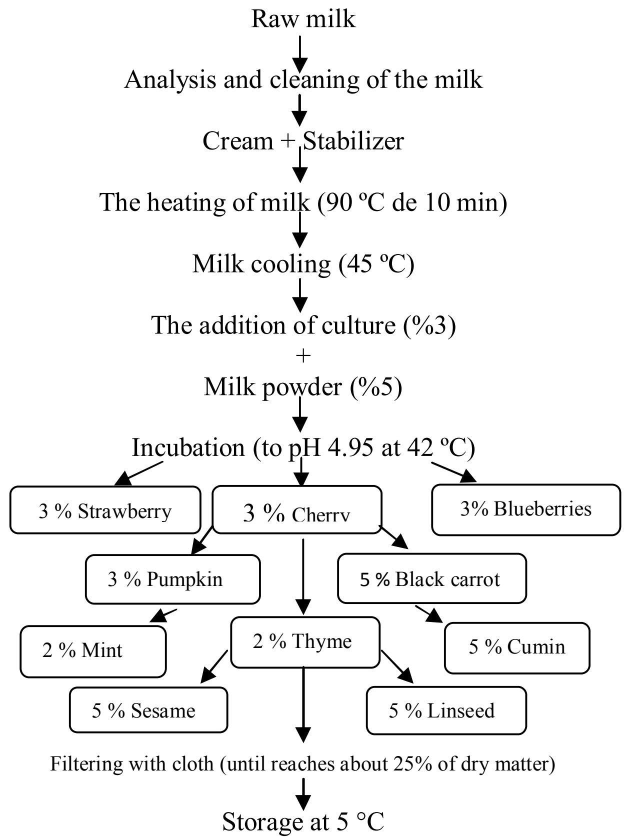

Figure 1. The production flow chart for flavored spreadable yogurt

Viscosity Analysis: The viscosity of yogurt samples after 1, 10 and 20 day of storage at 5°C was measured using a rotational viscometer (Fungilab, ALPHA H, Spain) at the speed of 100 rpm at 30 second with spindle 7 as P.

Texture Analysis: The samples were analyzed by a texture profile analyzer (Texture Analyzer-CT3, Brookfield Engineering Laboratories, Inc.) using TA4/1000 probe.

Texture Analyzer Test Settings;
MODE: Normal
TRIGGER: 4.5g Trigger
DISTANCE: 30mm
SPEED: 1mm/s

The following parameters were quantified and defined by Bourne (1982) as: springiness (the height that the sample recovers during the time that elapses between the end of the first cycle and the start of the second cycle) and adhesiveness (the negative force area for the first cycle, representing the work necessary to pull the compressing plunger away from the sample). The first peak on the curve was considered to be a measure of fracturability (curd tension). Hardness (maximum force as the test cell penetrated 30 mm of penetration into the sample) was also quantified as described by Mohamed and Morris (1987).

Color analysis: A Hunter colorimeter (Hunter Laboratories, Reston, VA, USA) was used to determine of Hunter *L** (black to white), *a** (green to red) and *b** (blue to yellow) color parameters of yogurt samples.

Statistical analysis: The data obtained from the physicochemical, rheological, microbiological and sensory analyses of the samples were statistically evaluated by variance analysis and comparisons were made with Duncan's Multiple Range Test (Minitab, 1991).

3.Results and Discussion

Physicochemical Properties

The physicochemical properties of yogurt samples are given in **Table 1**. As can be seen from the table, the physicochemical properties of the yogurt samples showed significant differences depending on additives (p<0.01). The amount of dry matter in yogurts showed differences according to the amount and the nature of fruits and herbs used. The dry matter in yogurt samples ranged from 28.01 % (mint added) to 33.70% (black carrot added). This difference was statistically significant (p<0.01). The additives and characteristics of their, the filtration is a cause of these differences. In studies on fruit or other additives added yogurt, characterized in that the added additives and fruits increased dry matter in yogurt (Öztürk and Akyüz, Ayar, Hashim, Rahman et al., Yogurt samples displayed significant differences in the average values of a_w (changed from 0.856 in cherry added to 0.960 in mint added). a_w of yogurt samples showed a significant reduction during storage (p<0.01) (**Figure 2**). a_w is directly related to the dry matter.

As can be seen from **Table 1**, the average lowest pH value was in blueberry added yogurt with 4.69, while the highest pH value of 4.91 was found in sesame added yogurt. The overall pH values of yogurt samples were examined, the average determined to be 4.95 in 1st day, 4.73 in 10th day and 4.76 in 20th days. Researches have shown that fruits and other ingredients used in yogurt, affect on pH and viability of culture bacteria. In the results of our study, as well as other researches have found that the pH decreased in yogurt during the storage (Kailasapathy et al., 2008). According to our results, pH of yoghurt samples higher was due to the filtering process and additives.

Table 1. The average physicochemical properties of fruits and spices added spreadable yogurts

Additive	Dry matter (%)	pH	a_w	Viscosity (P)	WHC (%)
Cherry	32.11±0.618 b*	4.70±0.135 d	0.856±0.086 d	27.18±8.927 i	92.77±3.506 bc
Strawberry	31.89±1.156 b	4.71±0.150 c	0.923±0.041 b	82.37±18.746 b	96.00± 3.305 a
Black carrot	33.70±0.943 a	4.91±0.115 c	0.933±0.028 b	218.83±36.186a	95.11±2.812 a
Blueberries	30.37±0.414 a	4.69±0.199 d	0.908±0.048 c	46.75± 9.320 h	88.44±4.584 d
Pumpkin	31.74±1.103 b	4.77±0.125 c	0.931±0.029 b	57.48± 3.585 f	96.10± 2.197a
Linseed	29.32±0.967 cd	4.85±0.105 b	0.948±0.015 a	52.17± 2.849 g	91.73±2.344 c
Sesame	29.21±1.239 cd	4.91±0.112 a	0.954±0.014 a	74.08± 5.363 c	90.93±2.034 c
Cumin	29.35±0.967 cd	4.88±0.082 ab	0.959±0.014 a	62.05± 7.300 e	94.36±2.703 ab
Mint	28.01±0.697 E	4.85±0.067 b	0.960±0.014 a	69.75± 2.803 d	92.06±4.56 bc
Thyme	28.54±1.229 de	4.86±0.063 b	0.954±0.017 a	59.73± 8.421 ef	92.13±2.434 bc

*Means in the same columns of physicochemical properties and factors with different superscripts are significantly different (p<0.01) among applications

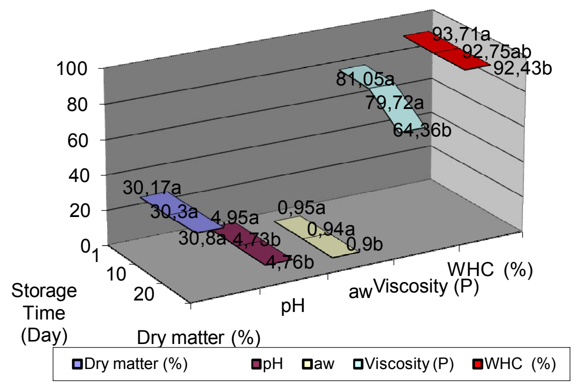

Figure 2. The changes in the physicochemical properties of yogurt samples

Spreadable fruit yogurt with black carrot has the highest viscosity (218.8 P) and significantly higher than the viscosity of other yogurt samples (p<0.01). In general, a substantial reduction in viscosity occurred during the storage of yogurts samples (average from 81.05 P to 64.36 P). The dry matter of yogurt increases with added additives, it also helps to increase the viscosity of the yogurt. The viscosity generally varies depending on the amount of fruit in yogurt (Akin and Konar, 1999). In another research, it was found that pectin in fruits added to yogurt was swollen and caused an increase in consistency (Kamruzzaman et al., 2002). In various trials, viscosity of yogurt had been found to vary from 35 P to 360 P (Kamruzzaman et al., 2002; Ayar et al., 2005; Le et al., 2011). Viscosity of flavored yogurt samples ranged from 27.18 P in cherry added sample to 218.8 P in carrot added sample.

The physicochemical characteristics of yogurt, WHC in the first place, are very different between fruits and herbs added yogurts samples. WHC of a protein gel is an important parameter in yogurt manufacturing. Low WHC, with 88.44% was found in blueberry added spreadable yogurt, the highest was found in the pumpkin added yogurt as the 96.10%. The average WHC of the samples decreased during the storage period. In yogurt added 6% milk powder, WHC was determined to be 90% (Remeuf et al., 2003). Yogurt which was added 3% milk powder, WHC of 57.11%, while the control sample was 39.60% (Le et al., 2011). The results show that the additives have a significant impact on the WHC of yogurt.

Color Properties

Food acceptance and preference are functions of product quality. Often color is the first sensory characteristic perceived by the consumer and color tends to modify other perceptions such as flavor and aroma (Garcia-Perez et al. 2005). Fruits and herbs added to the yogurt samples had a strong effect on the color properties. In the case of all yogurt samples, the $L*$ values were observed to be very high throughout the storage period indicating that the product retained the appealing whiteness. The highest value of $L*$ had been cherry added yogurt samples with 95.73, determined the lowest value of $L*$ in the black carrot added yogurt with 42.77. The black carrot gave a red color to added yogurt. $a*$ value in this example were the highest (17.29). Black Carrots contain anthocyanins, part of the flavonoid family with antioxidant properties. Mint won more green color to the yogurt (-1.35) (**Table 2**). The pumpkin had the distinction of own yellow color in yogurt, so $b*$ value is the higher in this example. In structure, its fruit pulp features golden-yellow to orange color depending up on the poly-phenolic pigments in it. The cherry added yogurt has been negative in the $b*$ value, which means that it consists of more bluish color than yogurt. The color properties showed significant changes during the storage of yogurt samples (**Figure 3**). $a*$ value, the value of foliage or redness in yogurt samples decreased during the storage period. Yogurt samples displayed an increase in yellowness or blueness of the stated value of $b*$. In several studies, depending on the colors of the fruit and other additives added in yogurt, the color properties ($L*$, $a*$, $b*$) of yogurt samples changed (Bartoo and Badrie, 2005). It was also pointed out that the color properties of yogurt were influenced by the pH (Garcia-Perez et al., 2005).

Sensorial Properties

Sensory analysis of flavored spreadable yogurts was carried out by trained 10 people. The sensory properties of yogurt samples were given in **Table 3**. The blueberry showed the greatest positive impact on the color of yogurt with 7.809 point. The color, strawberry added yogurt had the lowest score with 6.380 points. The coagulum hardness of yogurt samples affected depending on characteristics of the additives added. The increased dry matter was supposed to harder structure in yogurt coagulum. The strawberry had the greatest positive impact on the smell of yogurt with 6.857 points. Despite the improvement of the texture and structure, black carrot did not provide an important contribution to the smell of yogurt. Some researchers found in their study on fruit added yogurts that fruits significantly increased the sensory generally acceptability scores of yogurt samples, but reported that it did not increase the odor (Öztürk and Akyüz, 1995; Ayar, 2002). Another research conducted on fruit yogurt, strawberry also was showed that the greatest positive impact on the smell of yogurt. It was identified by other studies conducted on fruit yogurts, which strawberry showed the greatest positive impact on the smell of yogurt (Hurşit and Temiz, 1999).

Table 2. The color properties of fruits and spice added spreadable yogurts

Additive	$L*$	$a*$	$b*$
Cherry	95.731±1.123 a**	1.761±1.081c	-5.731±0.897 i
Strawberry	74.146±1.880c	1.553±0.476d	6.341±0.294 f
Black carrot	42.773±2.311h	17.288±2.282a	-1.633±0.900 h
Blueberries	58.883±1.444g	4.628±0.361 b	-0.963±0.600 g
Pumpkin	73.525±1.441d	0.666± 0.292 e	13.255±1.025a
Linseed	76.351±0.388b	-.321±0.101gh	9.443±0.483 d
Sesame	76.500±0.594b	-1.186±0.070g	7.191±0.245 e
Cumin	76.541±0.506b	-.240±0.095gh	7.230±0.277 e
Mint	60.970± 2.781f	-1.353±0.181h	11.068±1.811b
Thyme	66.090±3.311e	-0.261±0.202 f	10.013±1.461c

-a Greener than standard, +a Redder than standard
+b Yellower than standard, -b Bluer than standard
**Means in the same columns of color properties and factors with different superscripts are significantly different ($p<0.01$) among applications.

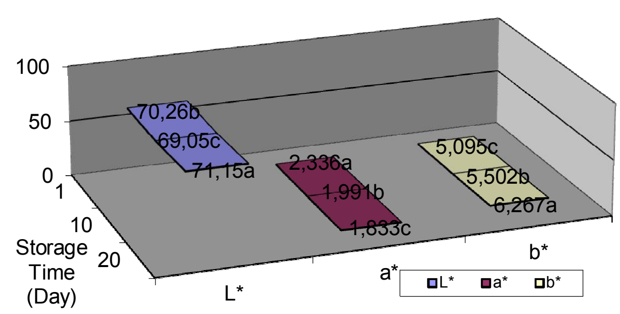

Figure 3. The changes in the average color properties of yogurt samples during storage

Body and texture scores decreased during storage. Yogurt produced by the addition of various types of fruits show a significant difference in the sensory aspects, and building long-term storage has been reported that scores decreased (Tarakçi and Küçüköner, 2003). The spoon (Sesame: 7.428 point) and the mouth consistency (Cumin: 7.476 point) scores in cold-pressed vegetable oil added yogurt samples were the highest. The consistency of yogurt samples was adversely affected during storage.

The fruits added to flavored yogurt, significantly determines the taste (Deeth and Tamime, 1981). According to other flavoring agents, strawberry more increased the taste and aroma of yogurt. The taste and aroma score of yogurt added of thyme was below of 5.00. In general, taste and aroma scores, the first day of storage of yogurt samples was the highest and the lowest was the tenth day. It has been identified in various studies that fruit and other flavorings substances added to yogurts affect flavor and aroma characteristics of yogurt. This effect is more positive (Hashim, 2001; Lutchmedial et al., 2004). Depending to add the materials, fruit flavor in yogurts was felt. 9 points out of a full, fruity taste points of yogurt samples, the highest and the lowest was 7.238 in blueberries added, 5.190 in sesame added, respectively. Yogurts received the highest scores fruity aroma at the beginning of storage. The sweetness shows the degree of concentration of sugar in a food. Out of 9 points, the highest score of the sweetness of with 6.619 point was the pumpkin added yogurt sample. Yogurt supplemented with the thyme got the lowest score with 4.142 point. The sweetness of yogurt samples did not show significant change during storage. The acidic feature points of yogurt samples ranged from 5.476 and 4.000 point (**Table 3**). The acidity was the highest at the end of the storage. So, the acidity property of yogurt samples increased during the storage period.

Table 3. Sensorial properties of fruit and spices added spreadable yogurts

Additive	Color	Smell	Clot hardness	Texture and structure	Consistency with a spoon	The taste and aroma	Fruitiness	Sweetness	Acidic taste	Overall acceptability
Blueberries	7.809±1.030 a*	6.190±1.631 ab	5.571±1.207ab	6.904±1.410a	6.904±1.410a	6.095±1.894 abc	7.238±1.813a	6.000±1.264ab	4.666±1.906ab	6.619±1.203 ab
Black carrot	7.047±1.532 abc	5.523±1.123 bc	6.523±1.289 a	5.952±1.65a	7.142±1.492a	5.095±1.480 c	6.666±1.770ab	5.380±1.116bc	4.238±.047 ab	5.142±1.152 c
Cherry	6.809±1.249 abc	6.523±1.470 ab	5.476±1.077 b	6.476±1.435a	6.761±1.410a	5.952±1.532 abc	6.238±1.338ab	6.285±1.454ab	4.952±1.687ab	7.142±1.424 a
Strawberry	6.380±1.465 c	6.857±1.458 a	5.380±1.116 b	6.428±1.398a	7.000±1.303a	6.761±1.044 a	6.428±1.287ab	6.428±1.164a	4.000±2.121b	6.571±1.207 ab
Pumpkin	7.285±1.230 abc	6.714±1.230 ab	5.523±1.209 b	6.761±1.300a	6.714±1.383a	6.714±1.383 a	6.571±1.207ab	6.619±1.321a	4.238±1.786ab	6.476±1.364 ab
Mint	7.047±1.687 abc	5.857±1.851 abc	6.380±1.395ab	6.619±1.395a	7.285±1.270a	5.190±1.661 bc	7.190±1.860a	4.476±0.928cd	5.190±1.600ab	5.142±1.711 c
Thyme	6.523±1.600 bc	4.761±1.410 c	6±1.140 ab	6.285±1.792a	6.857±1.152a	3.952±1.071 d	5.904±2.643ab	4.142±1.014 d	4.857±1.236ab	3.285±1.707 d
Linseed	6.761±1.578 abc	5.714±1.792 abc	5.904±1.640ab	6.571±1.690a	6.857±1.458a	5.238±1.997 bc	5.904±2.467ab	5.047±1.909cd	5.476±1.536a	5.333±2.287 bc
Cumin	7.666±1.110 ab	6.714±1.383 ab	5.666±1.559ab	6.857±1.236a	7.380±1.244a	6.428±1.660 ab	6.285±2.124ab	4.523±0.813cd	4.809±1.123ab	6.142±2.007 abc
Sesame	7.190±1.600 abc	6.285±1.101 ab	6.238±1.445ab	6.714±1.146a	7.428±0.676a	6.047±1.430 abc	5.190±1.965 b	4.619±0.973cd	5.000±1.264ab	5.380±1.883 bc

*Means in the same columns of sensory properties and factors with different superscripts are significantly different ($p<0.01$) among applications.

The scores of overall acceptability properties of yogurt samples ranged from 3.285 in thyme added sample to 7.142 in cherry added sample. The characteristics of the general acceptability showed significant differences between yogurt samples ($p<0.01$). Fruit added yogurt samples displayed significant reduction in the overall acceptability during storage, did not cause a significant change in herb added samples. Sensory acceptability of yogurt is affected by milk used for production, the culture, additives and production techniques (Ayar et al., 2005).

Textural Properties

Textural characteristics of yogurts have been defined by hardness, adhesiveness, cohesiveness, fracturability and springiness (Megenis et al., 2006). The textural properties of yogurts were also analyzed during storage at 5 °C and the results showed significant differences ($p<0.01$) throughout the shelf-life period, being not similar at 1 and 20 days for each type of yogurt. The texture profile was different according to the treatment, storage and fruits or herbs types used. The results of textural analysis are shown in **Figure 4-7**. The addition of fruit or herbs to milk caused to increase in yogurt parameters such as fracturability, hardness and adhesiveness ($p<0.01$). The fracturability power had the highest in carrot added yogurt and the lowest in strawberry added yogurt. The fracturability did not show any significant change during storage (**Figure 4**).

As the probe returns to its starting position, the negative load values on the graph result from back extrusion. This gives an indication of the adhesiveness/cohesiveness and resistance of the sample. The maximum negative force on the graph indicates sample adhesive force; the more negative the value, the more "sticky" the sample. The higher the value, the more energy required to break the pro be/sample contact as the probe withdraws from the sample. Carrot added yogurt is more adhesive than other yogurt samples. The adhesive properties of yogurt samples showed variations during storage (**Figure 5**).

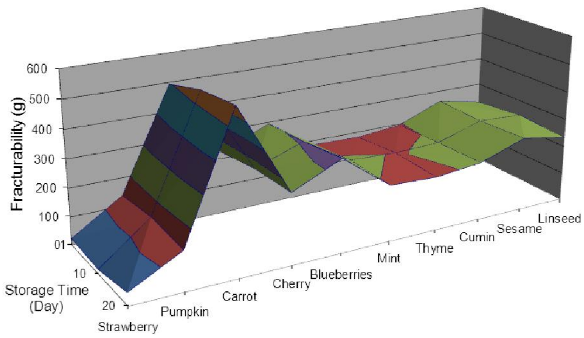

Figure 4. The changes in the fracturability properties of yogurt samples during storage

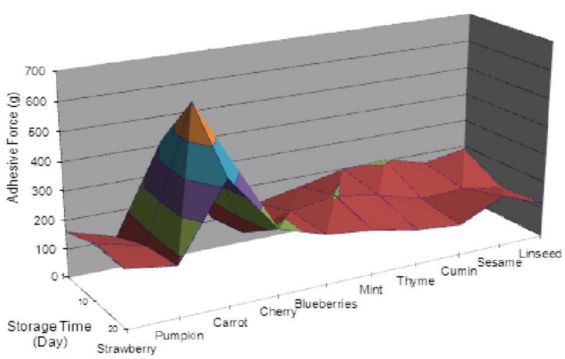

Figure 5. The changes in the adhesive force properties of yogurt samples during storage

Adhesive force has increased in the yogurt samples prepared with carrot between the 1st and 10th days, at the end of the experiment, during the 20th day, a decrease was observed. Similar remarks were reported by Rawson and Marchal (1997) and Katsiari et al. (2002) who reported an increase in adhesiveness of ewe's yogurt during storage. Hardness and adhesiveness of control yogurt increased systematically from 39.77 g to 45.89 g after 21 days of refrigerated storage. The similar effect was observed in the case of yogurts obtained with addition of 1% of resistant starch. The adhesiveness had a positive effect on the thickness of the yogurts, and was an important factor governing the stability of the products. This resulted in the good mouth-feel, improved the texture characteristics and the stability of yogurts during storage. Hardness and adhesiveness of yogurts obtained with the 2% oat-maltodextrin addition increased during refrigerated storage for 21 days (Domagała et al., 2005). Similar results were obtained during storage of probiotic torba yogurt (Kasenkas, 2010).

Cohesiveness indicates structural integrity and is often discussed in terms of the bond strength; adhesiveness indicates adherence of yogurt; whereas springiness reflects the structural integrity of yogurt. Greater cohesiveness and springiness may be related to stronger gel structures, indicating greater structural integrity; perhaps due to increased charged groups on the amino acid groups-a function of whey protein denaturation (Megenis et al., 2006). The springiness (mm) values are reported in **Figure 6**. The interaction of treatment x time was significant ($p<0.01$). The highest flexibility value was determined in carrot added yogurt. Springiness has increased in the yogurt samples prepared with carrot between the 1st and 10th days, at the end of 20th day, a decrease was observed.

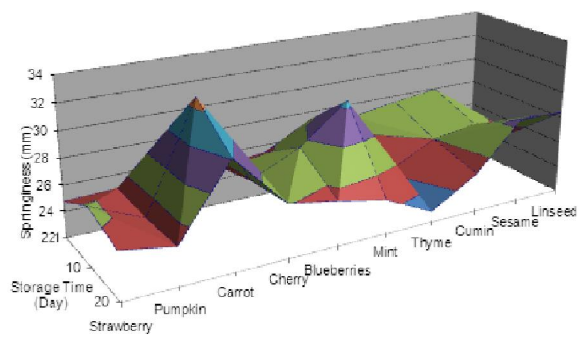

Figure 6. The changes in the springiness properties of yogurt samples during storage

As with other properties of texture, the maximum hardness value was determined in carrot added yogurt sample. Hardness properties increased in the yogurt samples prepared with carrot between the 1st and 10th days, at the end of storage, an important decrease was observed (**Figure 7**). These results show that there is a good correlation between time and synersis in higher total solid concentrations. by increasing the total solid concentration of yogurt hardness increased. The results show that there was correlation between synersis and hardness, as hardness increases the synersis decreased. Cherry added yogurt showed a significant increase in hardness during storage according to other yogurt samples. The hardness of yogurt with increased solids increases. Researchers further found that decreased protein content (3.52 to 3.31%) in yogurt mix decreased casein-casein and casein-whey interactions and decreased hardness of yogurt (Megenis et al., 2006). The addition of some fruit or herbs to milk and the formation of aggregates by interaction with casein micelles created a more rigid gel structure in yogurt. It is known that yogurt texture is highly dependent on total solids content as well as on protein content and type (Puvanenthiran et al., 2002).

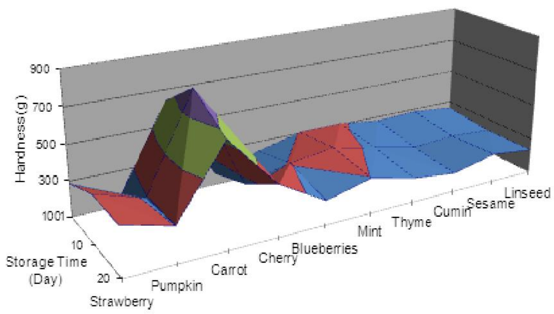

Figure 7. The changes in the hardness properties of yogurt samples during storage

As a result of the study, it can be said that yogurt can be flavored with some fruit or spices and concentrated. This process prolongs its shelf-life. Yogurt samples have a highly acceptable sensory properties and spreadable functionality. The structural properties of the flavored spreadable yogurt samples are better than normal yogurt. Thus, yogurt has been produced as more nutritional and functional.

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