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https://doi.org/10.17113/ftb.64.04.26.9425 original scientific paper

Changes in Physicochemical, Bioactive, Microbiological, and Sensory Properties of Yogurts with Fresh and Dried Grapes During Storage

Running head: Properties of Yogurts with Fresh and Dried Grapes

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Received: 17 October 2025
Accepted: 2 November 2026

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SUMMARY

Research background. Growing consumer distrust of synthetic antioxidants has heightened the demand for natural alternatives. This study utilizes grapes-a rich natural source of antioxidants-to diversify less commonly consumed dairy products and encourage their consumption. Fresh and dried grapes sourced from Köprübaşı, Manisa, Türkiye were incorporated into the milk used in yogurt production.

Experimental approach. The study evaluated key properties of yogurts supplemented with fresh or dried grapes at concentrations of 6, 8 and 10 %, as well as a plain control yogurt, over a 21-day storage period (analyzed on days 1, 7, 14 and 21). Physicochemical, bioactive, microbiological, and sensory parameters were assessed across all formulations.

Results and conclusions. The incorporation of grapes increased dry matter, ash, titratable acidity, viscosity, mineral content, and bioactive properties, while decreasing fat content, protein

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levels, and pH. Syneresis increased in fresh grape yogurts but decreased in dried grape formulations. The highest concentrations of Al, Mn, Fe, Zn, Mg, and K were detected in yogurt containing 10 % dried grapes, whereas Na, Ca, and P peaked in the control sample. Antioxidant activity correlated positively with the fruit ratio. During storage, total aerobic mesophilic bacteria counts increased as grape concentrations rose, while lactic acid bacteria counts declined. Yeast and mold were detected exclusively in grape-supplemented samples on day 21 of storage. Coliform bacteria were absent in all treatments. Regarding overall acceptability, the control sample received the highest sensory scores, closely followed by the yogurt containing 8 % dried grapes.

Novelty and scientific contribution. Although fruit-supplemented yogurts are documented in the literature, no prior studies have investigated the combined physicochemical, bioactive, and sensory profile of yogurts formulation with fresh or dried grapes. This study contributes to the literature by adding value to regional grape crops and developing a novel functional dairy product to encourage yogurt consumption.

Keywords: yogurt; grape; sultani; *Vitis vinifera*; antioxidant activity; functional food

INTRODUCTION

Yogurt is a probiotic-rich fermented dairy product consumed for centuries due to its high nutritional value, including essential vitamins and minerals. Historically, its origin is widely attributed to Turkic populations. While yogurt shares a macronutrient and micronutrient composition similar to that of milk, its specific profile varies depending on the raw milk source and processing techniques [*1*]. Fermented dairy products, particularly yogurt, are abundant in high-quality proteins, bioactive peptides, vitamins, and minerals, all of which exhibit enhanced bioavailability as a result of the fermentation process [*2*]. Lactic acid fermentation generates bioactive metabolites that confer various health benefits. During this process, lactose is hydrolyzed into monosaccharides, providing a key energy source and making yogurt suitable for lactose-intolerant individuals. Furthermore, the conversion of milk into yogurt increases the total dry matter content, thereby concentrating its protein levels [*3*].

As raisins gained popularity beyond their native regions, the development and optimization of drying techniques became increasingly critical. Traditional methods, such as open sun drying, have long been employed to reduce moisture content and extend shelf life. However, recent technological advancements have introduced modern and hybrid drying techniques that enhance process efficiency, accelerate drying times, and allow precise environmental control [*4*].

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The 'Sultani' grape (a *Vitis vinifera* cultivar belonging to the Vitaceae family) is a small, seedless, pale green fruit native to the Aegean Region. Consumed both fresh and dried (as raisins), this variety features a mild aromatic profile, with a must sugar content ranging from 13 to 14 % and a total acidity of 0.5 to 0.6 %. Beyond fresh consumption and raisin production, 'Sultani' grapes are widely utilized in winemaking, vinegar production, and preserve processing [*5*]. Grapevines exhibit remarkable adaptability to diverse soil conditions, including high pH, acidic, clayey, and saline soils, as well as varying climate conditions. Cultivation practices directly influence the end-use of the crop; for instance, while irrigation is generally omitted in wine grape production, it plays a vital role in table and raisin grape cultivation to maximize yield [*6*].

Although harvest periods vary by cultivar, 'Sultani' grapes are typically harvested between July and October. Beyond conventional uses, there is growing interest in utilizing grape processing by-products and extracts for nutraceutical and health applications, which are rapidly gaining market share. For example, grape seed extracts are increasingly incorporated into fruit-flavored beverages, cereals, and dietary snacks, while grape skin and seed extracts are used in functional applications in cosmetics and personal care products [*7*].

Grapes combine a high energy content with a low glycemic index, making them a suitable dietary component for individuals with diabetes. They are a rich source of potassium, manganese, vitamins C, B1, and B6, and bioactive polyphenols. Among these, flavonoids exhibit potent biological activity, conferring cardioprotective, neuroprotective, antimicrobial, and anti-aging properties. Evidence suggests that polyphenols in grapes and grape-derived products reduce the risk of cardiovascular diseases and help prevent the onset of obesity and type 2 diabetes [*8*].

Furthermore, grapes bolster immune function through their balanced profile of amino acids, B vitamins, and essential minerals (potassium, magnesium, and iron). Fructose derived from grapes provides a readily available metabolic energy source, while dietary fibers present in the grape skin support gut motility and microbiota health. Organic acids within the fruit facilitate liver and kidney detoxification, promote skin regeneration, and exert protective effects against gastric ulcers. Additionally, the rich antioxidant capacity of grapes mitigates cancer risk, while their anti-inflammatory action helps reduce low-density lipoprotein (LDL) levels. Bioflavonoids in grapes also enhance the bioavailability of vitamin C [9].

To stimulate consumer demand and develop novel functional foods, various ingredients-including fresh fruits, purees, and fruit seed powders-have increasingly been incorporated into yogurt matrices [*10*,*11*]. While a wide array of fruits can be utilized in fruit-flavored yogurt production, selection depends on consumer acceptability, processing capabilities, and regional economic or

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geographical constraints. These fruit additives may be processed and introduced as fresh fruit, pulp, jam, canned preparations, or frozen fruit [*12*].

The primary aim of this study is to promote yogurt consumption by developing a novel functional product that combines the proven health benefits of yogurt with grapes, a widely popular fruit. Furthermore, processing locally sourced grapes into value-added products benefits the domestic agricultural market. To assess the functional enhancements imparted by grape addition and identify consumer-preferred formulations, yogurts supplemented with varying proportions of both fresh and dried grapes were evaluated and compared. This study builds upon the framework established in our previous work [*13*].

MATERIALS AND METHODS

Materials

For yogurt production, raw cow's milk was sourced from local producers, and grapes were obtained from Köprübaşı, Manisa, Türkiye. The raw milk (12.34 % total solids, 4.30 % fat, 3.38 % protein, and pH=6.72) was pasteurized at 90 °C for 10 min.

To prepare the dried grapes, fresh grapes were oven-dried at 60 °C for 48 h. The drying temperature was set at 60 °C because higher temperatures induce undesirable biochemical reactions in fruits, and 60 °C represents the standard commercial drying temperature [*13*]. Both fresh and dried grapes were chopped into ~0.5 cm pieces and pasteurized at 90 °C for 5 min.

The prepared fruits were incorporated into the pasteurized milk at mass fractions of 6, 8 and 10 %. The mixture was then cooled to the inoculation temperature of 43 °C and inoculated with a commercial starter culture (CHR Hansen DVS YC-350). The inoculated milk was portioned into 100 mL sterile containers and incubated at 43 °C until the pH reached 4.6. The resulting yogurt samples were stored at 4 °C throughout the analysis period.

In accordance with national regulations in Türkiye, which mandate a minimum fruit content of 6 % for fruit-supplemented yogurts [*14*], all formulations in this study were prepared with fruit addition levels of at least 6 %. Some physicochemical and bioactive properties of the grapes used in yogurt production are summarized in Table 1.

(Table 1 here)

Physicochemical properties

Total solids content was determined gravimetrically by drying a 5 g yogurt sample in a forced-air oven (MEMMERT UN 110, Büchenbach, Germany) at 100–105 °C for 1.5–2 h, followed by cooling in a desiccator to a constant mass. Fat content was determined using the Gerber method by digesting

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the sample matrix with concentrated sulfuric acid in a butyrometer, centrifuging in a Gerber centrifuge (FUNKE, Gronau, Germany), and directly reading the fat volume from the scale [*15*]. Crude protein content was determined via the Kjeldahl method (BUCHI, K-355, Flawil, Switzerland); nitrogen was converted to ammonium by sulfuric acid digestion, distilled, titrated against a standard acid, and multiplied by a conversion factor of 6.38 [*15*]. Ash content was measured by incinerating 3 g of yogurt in pre-weighed porcelain crucibles using a muffle furnace (CARBOLITE, Hope, Derbyshire, UK) at 550 °C until a constant mass was reached.

Titratable acidity (expressed as % lactic acid) was determined by diluting the sample with distilled water and titrating it against 0.1 N NaOH using phenolphthalein as an indicator until a persistent faint pink endpoint was reached [*15*]. The pH was recorded directly using a calibrated pH meter (HORIBA Laqua F-72G, Kyoto, Japan) [*15*]. Viscosity was measured using a digital viscometer (Fungilab Expert, Barcelona, Spain) equipped with an R6 spindle [*16*]. Water-holding capacity was evaluated using a centrifugal method (NUVE NF 800R, Ankara, Türkiye) [*17*]. Syneresis was quantified by transferring 25 g of yogurt onto standard filter paper and measuring the volume of separated serum after incubation at 4 °C for 2 h [18]. Color parameters (*L*, *a*, *b*) were monitored throughout storage using a colorimeter (Precision NR145, Shenzhen, China) [*19*]. Elemental composition was analyzed following the procedure described by Sujka *et al.* [*20*]. Samples were homogenized under sterile conditions using a laboratory grinder (Isolab) and digested using a microwave digestion system (CEM MARS6, Charlotte, North Carolina, USA). Briefly, 0.5 g of homogenized sample was digested with 10 mL of concentrated HNO_3 (67 % *V*/*V*) according to the instrument's standard digestion program. Upon completion, the digestates were cooled to room temperature. Mineral concentrations were quantified using an ICP-OES instrument (SpectroBlue). Calibration standards were prepared using a multi-element stock solution. All measurements were performed in triplicate (*N*=3), and results were reported as mean values with standard deviations.

Bioactive properties

A mass of 3 g sample was homogenized using an Ultra-Turrax homogenizer (T 25, IKA-Werke GmbH & Co. KG, Staufen, Germany) mixed with 30 mL of acidified methanol, and extracted in an ultrasonic bath (Elma-S 100H, Singen, Baden-Württemberg, Germany) for 30 min (ultrasonic power: 150 W, frequency: 37 kHz, heating power: 60 W). The resulting extract was centrifuged (NUVE NF 800R, Ankara, Türkiye) at 8000×*g* for 15 min. This extraction procedure was performed in triplicate; the collected supernatants were pooled and stored at −20 °C until further analysis [*13*].

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Folin–Ciocalteu reagent, gallic acid, quercetin, 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS), and 2,4,6-tris(2-pyridyl)-s-triazine (TPTZ) were purchased from Sigma-Aldrich (St. Louis, MO, USA). All other chemicals and reagents were of analytical grade and obtained from local commercial suppliers.

Total phenolic content (TPC) was determined using the Folin–Ciocalteu assay. Briefly, a 200 µL aliquot of the extract was mixed with 1 mL of Folin–Ciocalteu reagent, followed by the addition of 2 mL of a 7.5 % (*m*/*V*) Na_2CO_3 solution. The total volume was adjusted to 7 mL with distilled water. After incubating the reaction mixture in the dark at room temperature for 2 h, its absorbance was measured at 765 nm using a UV-Vis spectrophotometer (Shimadzu, Kyoto, Japan). Gallic acid was used to construct a standard calibration curve, and TPC results were expressed as gallic acid equivalents [*21*].

To determine the total flavonoid content, an equal volume of the extract was mixed with 2 mL of a 2 % (*m*/*V*) $AlCl_3$ solution and allowed to stand at room temperature for 10 min. Absorbance was measured at 415 nm using a spectrophotometer (Shimadzu, Kyoto, Japan). The same procedure was performed using quercetin solutions at various concentrations to generate the standard calibration curve [*22*].

A volume of 0.3 mL of the sample extract was added to 1.5 mL of a DPPH (2,2-diphenyl-1-picrylhydrazyl) solution and incubated in the dark at 37 °C for 10 min. Absorbance was then measured at 517 nm using a Shimadzu spectrophotometer, and the reading was recorded as A_i. The procedure was repeated by replacing the sample extract with the extraction solvent, and the reading was recorded as A_0. These values were substituted into the formula below to calculate the inhibition percentage [*23*]:

$$\text{Inhibition}=[(A_0-A_i)/A_0]\cdot 100 \qquad /1/$$

The ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) solution, which had been kept in the dark for 16 h, was diluted with phosphate buffer to yield an absorbance of 0.7±0.02 at 734 nm. A volume of 1.7 mL aliquot of the diluted ABTS solution was mixed with 0.1 mL of the sample. After 6 min at room temperature, the absorbance at 734 nm was measured using a Shimadzu spectrophotometer and recorded as A_i. The value obtained by replacing the sample with the extraction solvent was recorded as A_0. Inhibition percentage was calculated using Eq. 1 [*23*].

An aliquot of 1.8 mL FRAP (ferric reducing antioxidant power) solution was added, and the mixture was incubated at 37 °C for 10 min. FRAP solution was prepared daily by mixing 10 volumes of 300 mM sodium acetate buffer (pH=3.6) with 1 volume of 10 mM TPTZ solution and 1 volume of 20 mM ferric chloride. Measurements were then made at 573 nm using a Shimadzu

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spectrophotometer. These operations were performed with a previously prepared $FeSO_4$ standard solution to construct a standard curve. Calibration was performed by plotting absorbance against standard concentration. The sample absorbances were substituted into this calibration curve to determine the corresponding $FeSO_4$ concentrations of the samples, and the results were expressed as mmol/L [*23*].

Microbiological properties

To determine the total aerobic mesophilic bacteria count, incubation was performed on PCA (Plate Count Agar) at 30–32 ºC for 48 h. For the determination of lactic acid bacteria, incubation was performed on MRS and M17 agars at 37 ºC for 48 and 24 h, respectively. For the determination of yeast and mold count, incubation was performed on Dichloran Rose Bengal Chloramphenicol (DRBC) agar for 4–5 days at 25 ºC. For coliform bacteria count, incubation was performed on Violet Red Bile (VRB) agar at 35–37 ºC for 24 h [*15*].

Sensory properties

Sensory analysis of the fruit yogurt samples was conducted by a panel of 12 semi-trained assessors (7 females and 5 males, aged 25 to 45 years), comprising faculty members and postgraduate students from the Department of Food Engineering at Kastamonu University [*24*]. The panelists were non-smokers, well-versed in fermented dairy products, and informed about the evaluation procedure, scoring scale, and sensory descriptors prior to testing. Samples (150 mL) were served in glass jars at (4±1) ºC. Color, odor, taste, appearance, texture, and overall acceptability were evaluated using a 9-point hedonic scale: 1 (very bad), 2–3 (lacking), 4–5 (slightly bad), 6–7 (good), and 8–9 (very good). Drinking water and bread were provided between samples to cleanse the palate [*25*].

Statistical analysis

The research trial design was 7 (samples: control, 6 %, 8 %, and 10 % yogurt with fresh grapes, and 6 %, 8 %, and 10 % yogurt with dried grapes) $\times$ 4 (storage period: 1st, 7th, 14th, and 21st days) $\times$ 2 (repetitions), with a total of 56 samples, and was carried out according to a completely randomized factorial trial design. For the statistical evaluation of the data, variance analyses were performed using SPSS for Windows v. 13.0 [*26*], and the main sources of variation found to be significant were analyzed using the Duncan multiple-comparison test.

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RESULTS AND DISCUSSION

Physicochemical properties

Dry matter contents in the control sample, yogurts with 6, 8 and 10 % fresh grapes, and yogurts with 6, 8 and 10 % dried grapes were determined to be 12.52–13.55, 14.35–14.53, 14.77–15.29, 15.05–15.96, 17.16–17.74, 19.12–19.40 and 20.80–21.21 %, respectively (Table 2). When the dry matter contents of all yogurts were compared, the lowest was observed in the 1st day control sample (12.52 %), while the highest was observed in the yogurt with 10 % dried grapes on the 1st day (21.21 %). The dry matter content of yogurts with grapes increased in direct proportion to the mass fraction of added fruit. Other studies have also shown that substances added to yogurt increase its dry matter content [*27–29*].

(Table 2 here)

Fat contents in the control sample, yogurts with 6, 8 and 10 % fresh grapes, and yogurts with 6, 8 and 10 % dried grapes were determined to be 3.95–4.10, 3.90–3.95, 3.80–3.90, 3.75–3.80, 3.60–3.70, 3.55–3.65 and 3.45–3.55 %, respectively (Table 2). The control sample had the highest fat content. A clear decrease in fat content occurred as the fruit content increased; however, the fat contents of yogurts with fresh grapes were statistically indistinguishable from each other across all storage periods. The same trend was observed in yogurts containing dried grapes, where fat content decreased as grape mass fraction increased. This decrease in fat content may be attributed to the low fat content of the added fruits. Other studies have similarly reported that substances added to yogurt reduce its overall fat content [*10,28*].

Among the fruit yogurts, the highest protein content was observed in the control sample on day 1 at 4.32 %, followed by 3.57 % in yogurt with 6 % fresh grapes, 3.35 % in yogurt with 8 % fresh grapes, 3.22 % in yogurt with 10 % fresh grapes, 3.017 % in yogurt with 6 % dried grapes, 2.99 % in yogurt with 8 % dried grapes and 2.85 % in yogurt with 10 % dried grapes (Table 2). The highest protein content was recorded on the 1st day of storage in the control sample. As the fruit mass fraction increased, the protein content decreased. This may be attributed to the low protein content of fruits. Furthermore, the decrease in protein levels observed during storage is thought to be due to proteolytic activity by the starter cultures in the yogurt. Similar results have been reported in other studies [*27,30*].

It was determined that the ash content in fruit yogurts was lowest in the control sample (0.61 %) and highest in yogurt with 10 % dried grapes (0.91 %) on the first day of storage (Table 2). Considering the storage period, differences in ash content among yogurt samples were generally not statistically significant. Based on the ash analysis, ash content increased with increasing fruit

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concentration. This may be attributed to inorganic substances originating from the added fruits. Results from other study also support these findings [*30*].

During storage, the pH values ranged between 4.44–4.58 for the control sample; 3.98–4.10 for yogurt with 6 % fresh grapes, 3.93–4.06 for yogurt with 8 % fresh grapes, 3.90–4.01 for yogurt with 10 % fresh grapes, 4.03–4.14 for yogurt with 6 % dried grapes, 4.00–4.11 for yogurt with 8 % dried grapes, and 3.98–4.06 for yogurt with 10 % dried grapes (Table 2). Due to the low pH of the added fruits, the pH of all samples decreased as fruit mass fraction increased. Furthermore, it was determined that the pH values of all samples decreased during storage, likely due to ongoing bacterial activity even at low storage temperatures. In a study by Nguyen and Hwang [*31*], the authors evaluated the effects of fruit on yogurt properties by producing yogurt fortified with aronia juice. They observed that the pH values of yogurts produced with 1, 2 and 3 % aronia juice decreased across all groups over a 24-hour period. It was found that the decreases in pH were directly proportional to the aronia juice concentration. While the initial pH values were 6.46, 6.43, 6.38, and 6.33 for the control sample and yogurts with 1, 2 and 3 % aronia juice, respectively, these values decreased to 4.39, 4.29, 4.29 and 4.25 at the end of 24 h.

Titratable acidity values ranged from 0.81 to 1.26 %. The titratable acidity values of the control sample were determined to be 0.81, 0.83, 0.89 and 0.97 % on the 1st, 7th, 14th, and 21st days, respectively (Table 2). An increase in titratable acidity was observed in yogurts with added fruit throughout the storage period, similar to that of the control sample. When all samples were evaluated, the titratable acidity of the control sample was significantly different from that of the yogurts with added fruit. As shown by the values, titratable acidity increased with the addition of fruit. This may be attributed to the high acidity of fruit. Similar results have been reported in other studies [*11,32,33*].

Viscosity values were 2802.03–3532.44 cP for the control sample, 2977.25–3692.27 cP for yogurt with 6 % fresh grapes, 3141.55–3871.33 cP for yogurt with 8 % fresh grapes, 3435.58–4126.98 cP for yogurt with 10 % fresh grapes, 4010.08–4520.23 cP for yogurt with 6 % dried grapes, 4256.30–4935.84 cP for yogurt with 8 % dried grapes, and 4492.69–5325.59 cP for yogurt with 10 % dried grapes (Table 2). The differences in viscosity among the yogurt samples were statistically significant. During storage, viscosity increased in all yogurt samples up to the 14th day and decreased on the 21st day. As the fruit ratio increased, viscosity increased, with the highest values observed in yogurts containing dried grapes. Similar results were reported in a previous study [*34*].

The lowest water-holding capacity was observed in yogurt with 10 % fresh grapes on the 21st day (39.05 %), while the highest was observed in yogurt with 10 % dried grapes on the 1st day (51.63 %) (Table 2). When yogurts with added fruit and control yogurts were evaluated, the differences in

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water-holding capacity were found to be statistically significant. It was observed that the water-holding capacity of yogurts with fresh grapes decreased as the grape mass fraction increased. Conversely, an increase in water-holding capacity was observed in yogurts containing dried grapes as the fruit mass fraction increased. This difference can be attributed to the tendency of dried grapes to reabsorb lost water. In another study, the water-holding capacity of apricot yogurts produced by adding olive leaf extract (at concentrations of 0.1, 0.2 and 0.4 %) was investigated, and the water-holding capacities in yogurts with 0.1, 0.2 and 0.4 % olive leaf extract were determined to be 57.54, 56.95 and 57.62 %, respectively, on the 1st day [*27*]. As in the present study, water-holding capacity decreased during storage.

When the syneresis values were examined, the lowest value was observed in yogurt with 10 % dried grapes on the 7th day of storage (7.00 %), while the highest was observed in yogurt with 10 % fresh grapes on the 21st day of storage (7.87 %) (Table 2). Consequently, syneresis values increased in yogurts supplemented with fresh grapes, whereas a decrease was observed in those containing dried grapes. When the fruit type was considered, the values for yogurts with dried grapes and those with fresh grapes differed statistically. However, these values were statistically indistinguishable from each other across different storage periods. Syneresis decreased as fruit concentration increased in yogurts containing dried grapes. This decrease is attributed to the higher water-holding capacity of dried fruit compared to fresh fruit. A previous study obtained similar results [*35*].

While the highest *L* value was observed in the control sample on the 1st day of storage (89.79), the lowest *L* value was observed in yogurt with 10 % dried grapes on the 21st day of storage (76.63) (Table 3). *L* values decreased in parallel with the increase in fruit ratio. When storage periods were taken into account, all samples were statistically indistinguishable from one another ($p>0.05$). In contrast, when the sample types were compared, the differences among the control sample, yogurts with fresh grapes, and yogurts with dried grapes were statistically significant ($p<0.01$).

(Table 3 here)

The *a* values of yogurts with fresh grapes were determined as (−) (greenness), whereas the *a values* of yogurts with dried grapes were determined as (+) (redness) (Table 3). On the first day of storage, the *a* values were determined as (−)16.05 in yogurt with 6 % fresh grapes, (−)18.01 in yogurt with 8 % fresh grapes and (−)19.15 in yogurt with 10 % fresh grapes, (+)13.05 in yogurt with 6 % dried grapes, (+)16.28 in yogurt with 8 % dried grapes and (+)18.91 in yogurt with 10 % dried grapes, and (+)2.56 in the control sample. During storage, *a* values decreased in all samples, but the differences were not statistically significant ($p>0.05$).

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The *b* value of all yogurt samples was determined as (+) (yellowness) (Table 3). The *b* values in the control sample, yogurts with 6, 8 and 10 % fresh grapes and 6, 8 and 10 % dried grapes were determined to be (+)9.54–9.86, (+)14.40–14.90, (+)16.59–17.21, (+)18.66–19.29, (+)20.91–21.50, (+)22.81–23.45, and (+)24.50–25.15, respectively. Although *b* values decreased in all samples during storage, the differences were not statistically significant ($p>0.05$). When the yogurt varieties were evaluated, differences in *b* values were statistically significant, showing that *b* values increased with increasing fruit mass fraction ($p<0.01$).

A study indicated that, in addition to decreases in *L* and *b* values as drying progressed, the *a* value served as a significant indicator of browning during grape drying. This can be explained by the fact that when cell integrity is disrupted, the substrate becomes accessible to polyphenol oxidase, thereby initiating enzymatic browning reactions [*36*].

Pădureţ *et al.* [*33*] found that inclusion of 1 and 2 % black chokeberry juice led to an elevation in the *L* values of yogurt samples relative to the control, whereas higher incorporation levels and all other formulations exhibited a decline in lightness. Samples fortified with whole black chokeberry fruit displayed a more prominent red chromaticity (*a* value) compared to those containing pomace or juice. Furthermore, while the addition of fruit and pomace matrices reduced the *b* values parameters, lower juice concentrations (1 and 2 %) yielded a slight upward shift in yellowness. Overall, the dark purple pigmentation of black chokeberry imparted a distinct darkening and reddening effect on the yogurt matrix, characterized by diminished *L* and *b* values alongside enhanced *a* levels. Tarakçı and Demirkol [*34*] evaluated the physicochemical properties of goji berry-fortified yogurts. In their study, which included color evaluations, they determined that *L* values decreased significantly, whereas *a* and *b* values increased. In a study by Albayati *et al.* [*37*], the authors investigated properties of probiotic yogurts produced by adding prickly pear and inulin. They attributed the lower *L* values of yogurts with prickly pear and inulin compared to the control samples to the disruption of the yogurt natural white color by the addition of the fruit. Furthermore, they determined that *b* values decreased toward the end of storage for each product. In another study, fruit yogurts produced with grape, aronia, and blueberry juices were stored for 28 days, and color values were measured; the control sample exhibited the highest *L* value compared to the fruit juice-fortified yogurts [*38*].

Across all yogurt types with added grapes, mineral levels were higher than in the control yogurt (except for Na, Ca, and P), and the differences among the samples were statistically significant ($p<0.01$). It was determined that adding grapes to yogurt increased the overall mineral content, with the highest levels observed in the sample containing 10 % dried grapes (Table 4). In a study examining the mineral content of fruit yogurts with 0, 4, 8, 12 and 16 % taflan molasses added, it was

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determined that the Ca, Mg, Na, and K mineral contents of the yogurts with added molasses increased compared to the control sample. Furthermore, it was observed that the levels of minor minerals (Cu, Fe, Mn, and Zn) decreased in yogurt with a 16 % molasses addition [*35*]. In another study by Kulaitienė *et al.* [*39*], lyophilized yogurt bites were prepared with the addition of beetroot, mulberry leaf, nettle leaf, and rosehip fruit powders to determine their effects on composition, mineral content, and total phenolic content. The authors reported that the yogurt bites fortified with nettle leaf had the highest levels of K, P, Mg, Fe, and Zn.

(Table 4 here)

Bioactive properties

Grapes are among the most widely produced and consumed fruits worldwide and serve as a rich source of polyphenols, particularly proanthocyanidins, anthocyanins, and resveratrol. These bioactive polyphenols significantly contribute to the diverse biological activities of grapes, including antioxidant, anti-inflammatory, antidiabetic, anticancer, and cardioprotective effects [*40*]. While the lowest total phenolic content was 0.96 mg GAE/g on the 21st day in the control sample, the highest value was determined to be 1.87 mg GAE/g on the 1st day in the yogurt with 10 % dried grape (Table 5). A decrease in phenolic compound content was observed in all yogurt samples during storage; however, these differences were not statistically significant. It was determined that the total phenolic content increased in direct proportion to the grape concentration in the yogurts. The lowest antioxidant activity was observed in the control yogurt (Table 5); nevertheless, yogurt inherently exhibits notable antioxidant activity as a fermented food product. Fermentation significantly influences the antioxidant capacity of food products by releasing, promoting, and generating antioxidant compounds [*41*]. In a study conducted by Pădureţ *et al.* [*33*], the addition of 1 and 3 % chokeberry fruit resulted in approx. 1.66- and 2.68-fold higher TPC values than the control yogurt, respectively. The highest phenolic enrichment was observed in samples containing chokeberry pomace, where a 3 % supplementation level yielded up to a 4.62-fold increase compared to the control. Furthermore, a 3 % juice addition led to a nearly 2.05-fold increase in total phenolics. Linear regression analysis revealed high correlation coefficients between the dose of fruit, juice, or pomace and the resulting TPC. Consequently, chokeberry processing by-products-most notably pomace-represent valuable functional ingredients for fortifying dairy formulations with bioactive phenolics. Likewise, Kulaitienė *et al.* [*39*] determined that the phenolic content of yogurt bites produced with rosehip fruit powder increased in direct proportion to the added powder. Peker and Arslan [*27*] also reported that the total phenolic content increased with higher extract concentrations in yogurts supplemented with olive leaf extract.

(Table 5 here)

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When the yogurts were evaluated for total flavonoid content, the lowest value was 1.09 mg QE/g in the control sample on the 21st day, and the highest was 1.59 mg QE/g in the yogurt with 10 % dried grapes on the 1st day (Table 5). Total flavonoid content in the control sample, yogurts with 6, 8 and 10 % fresh grapes, and 6, 8 and 10 % dried grapes were determined to be 1.09–1.16, 1.16–1.24, 1.17–1.27, 1.19–1.29, 1.28–1.41, 1.36–1.48 and 1.46–1.59 mg QE/g, respectively. It was determined that the flavonoid content generally increased with increasing grape mass fraction, and yogurts with dried grapes exhibited higher flavonoid levels than those with fresh grapes. While the differences in flavonoid content among yogurts with fresh grapes were statistically insignificant ($p>0.05$), the differences among yogurts with dried grapes were statistically significant ($p<0.05$) (Table 5). Osman *et al.* [*42*] reported that fruit yogurts formulated with persimmon, guava, and mango at varying mass fractions (5, 10 and 15 %) showed statistically significant increases in phenolic and flavonoid contents, as well as antioxidant activity, compared to the control sample. In another study, yogurts were produced by adding basil seed gum at mass per volume ratios of 0.5 % and 1 %, and the flavonoid content of the yogurts increased with increasing gum content, confirming that adding 1 % basil seed gum significantly enriched the yogurts in flavonoid content relative to the control sample [*43*].

When DPPH inhibition values were compared, the highest value was observed in yogurt containing 10 % dried grapes on the 1st day of storage (35.03 %), while the lowest value was observed in the control sample on the 21st day of storage (19.19 %) (Table 5). During storage, DPPH inhibition percentage decreased; however, the differences in values were not statistically significant ($p>0.05$). When the yogurt samples were evaluated, DPPH inhibition percentage increased with increasing fruit mass fraction, and yogurts with dried grapes exhibited higher values than those with fresh grapes. Dimitrellou *et al.* [*38*] produced yogurts supplemented with grape, aronia, and blueberry juices and stored them for 28 days. They determined that phenolic content and antioxidant activity increased by 30 % for grape juice, 33 % for aronia juice, and 49 % for blueberry juice additions.

ABTS inhibition values in the control sample. yogurts with 6, 8 and 10 % fresh grapes, and 6, 8 and 10 % dried grapes were 28.86–29.20, 33.24–33.69, 35.31–35.75, 36.97–37.50, 41.89–42.33, 44.82–45.24 and 47.82–48.10 %, respectively (Table 5). Considering the storage periods, ABTS inhibition percentage decreased during storage; however, the differences between values were not statistically significant ($p>0.05$). When the yogurt samples were evaluated, ABTS inhibition percentage increased with increasing fruit mass fraction, and yogurts with dried grapes exhibited higher values than those with fresh grapes.

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The lowest FRAP value (0.43 mM/mL) was observed on the 21st day of storage in the control sample, whereas the highest value (1.28 mM/mL) was recorded on the 1st day in the yogurt sample with 10 % dried grapes (Table 5). Regarding storage periods, the FRAP values of the yogurt samples did not differ significantly. While FRAP values increased with higher fruit mass fractions, each sample decreased during storage. Feng *et al.* [*44*] produced fruit yogurts by adding 3, 6 and 9 % jujube to goat milk and evaluated key quality criteria and antioxidative effects, reporting that jujube fortification significantly enhanced the antioxidant activity of the yogurts.

Microbiological properties

TAMB counts decreased in all yogurts with added fruit during storage. The lowest value was 4.03 log CFU/g on the 21st day of storage in the control sample, whereas the highest value was 5.61 log CFU/g on the 1st day of storage in the yogurt with 10 % fresh grapes (Table 6). In their study, Güney and Ertürk [*45*] determined the total aerobic mesophilic bacteria counts of yogurts produced by adding propolis at different fractions (0.001 %, 0.003 %, 0.10 %, and 0.20 %) over a 7-day storage period, stating that an increase in TAMB count occurred on the 7th day, consistent with the control sample in the present study.

(Table 6 here)

When the *Lactobacillus delbrueckii* subsp. *bulgaricus* counts were examined, a decrease occurred throughout storage across all yogurts with fruit addition. Following an initial increase on the 7th day of storage in the control sample, a subsequent decline was observed (Table 6). The lowest *Lactobacillus delbrueckii* subsp. *bulgaricus* count was 6.72 log CFU/g in yogurt with 10 % fresh grapes on the 21st day of storage, while the highest count was 7.06 log CFU/g in the control sample on the 7th day of storage. Considering the storage period, although there was an overall decrease in *Lactobacillus delbrueckii* subsp. *bulgaricus* counts in fruit yogurts, these differences were not statistically significant among the samples.

There was a decrease in *Streptococcus thermophilus* counts in all yogurts with added fruit during storage. The lowest count was 7.75 log CFU/g in yogurt with 10 % dried grapes on the 21st day of storage, while the highest count was 8.22 log CFU/g in the control sample on the 7th day of storage (Table 6). Across storage periods, *Streptococcus thermophilus* counts decreased in fruit yogurts overall, and the differences among samples were not statistically significant. Ayar and Gürlin [*46*] produced spreadable fruit- and spice-fortified yogurts in their study. They formulated yogurt samples by adding strawberry, sour cherry, blueberry, pumpkin, black carrot, mint, thyme, sesame, and flaxseed, subsequently evaluating their physicochemical, microbiological, and sensory

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properties. In their microbiological evaluation, they observed a continuous decrease in lactic acid bacteria counts throughout the storage period and reported that no coliform-group bacteria were detected in spice-fortified yogurts. Peker and Arslan [*27*] determined certain microbiological properties of yogurts produced by adding olive leaf extract. Their findings demonstrated that *Lactobacillus delbrueckii* subsp. *bulgaricus* counts decreased during storage, whereas higher olive leaf addition increased overall counts. In cultivations on M17 agar, bacterial counts peaked on the 7th day across all yogurt samples and subsequently declined.

Yeast and mold counts were not detected in any yogurt sample on the 1st, 7th, and 14th days of storage. However, on the 21st day, yeast and mold counts were determined to be 2.38, 2.76, 2.97, 2.53, 2.86 and 3.09 log CFU/g in yogurts with 6, 8 and 10 % fresh grapes, and 6, 8 and 10 % dried grapes, respectively (Table 6). As the fruit mass fraction increased, the yeast and mold counts increased as well. It is thought that the detection of yeast and mold counts on the final day of storage in yogurts with added fruit may be attributed to the presence of yeast and mold that were undetected during the initial days of storage and reached countable levels by the last day. No growth was observed in the control sample.

Coliform group bacteria were not detected in any yogurt sample (Table 6).

Sensory properties

It was determined that the color scores for the yogurt samples ranged from 7.12 to 8.37 (Table 7). When comparing the color scores of yogurts prepared with varying grape mass fractions, the control sample received the highest preference. Following the control sample, yogurts supplemented with dried grapes were the most appreciated. Across all evaluated samples, color scores decreased during storage. The highest color score was observed in the control sample (8.37) on the 1st day of storage, whereas the lowest score was recorded in yogurt with 10 % fresh grapes (7.12) on the 21st day of storage.

(Table 7 here)

The average odor scores of the yogurt samples ranged from 7.18 to 8.43 (Table 7). When comparing the odor scores of yogurts prepared with varying grape mass fractions, the control sample received the highest preference, followed by the yogurt containing 10 % dried grapes. Across all evaluated samples, odor scores decreased over the course of storage. The highest odor score was observed in the control sample (8.43) on the 1st day of storage, whereas the lowest odor score was recorded in yogurt with 10 % fresh grapes (7.18) on the 21st day of storage. Ganje *et al.* [*32*] conducted sensory evaluations of yogurts produced with the addition of carob molasses and reported

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that the highest odor scores were obtained for the control yogurt, followed by yogurts with 3, 4 and 5 % carob molasses. Similarly, Tarakçı and Demirkol [*34*] conducted sensory evaluations of fruit yogurts supplemented with 2, 3 and 4 % goji berry, finding that the control sample was the most preferred based on odor scores.

The yogurt samples taste scores ranged from 6.25 to 8.31 on average (Table 7). When comparing taste scores for yogurts produced with varying grape mass fractions, the control sample was preferred most, followed by yogurts supplemented with dried grapes. Across all evaluated samples, taste scores decreased over the course of storage. The highest taste score was observed in the control sample (8.31) on the 1st day of storage, whereas the lowest score was recorded in yogurt with 10 % fresh grapes (6.25) on the 21st day of storage. Tarakçı and Demirkol [*34*] produced fruit yogurts by adding goji berries and reported that in the taste and aroma evaluation, the most preferred yogurt was the sample with 2 % fruit addition, while the lowest score was received by the yogurt with 4 % fruit addition. Following the 2 % fruit-supplemented sample, the control sample was the most liked. In another study, the highest sensory acceptability scores were awarded to yogurts fortified with 3 and 2 % black chokeberry fruit, respectively, whereas the lowest score was recorded for the formulation incorporating 3 % black chokeberry pomace. The 3 % pomace-fortified sample exhibited noticeable sensory defects, falling below the minimum threshold established by the product quality standard. Similarly, yogurts containing 1 and 2 % pomace displayed only marginally outlined characteristic attributes and minor defects, placing them at the lowest permissible limit of quality standards. These observations suggest that reducing the concentration of added chokeberry pomace could significantly enhance consumer acceptability scores [*33*].

When appearance scores were compared, the control sample received the highest score (8.43) on day 1, while the yogurt with 10 % fresh grapes received the lowest score (7.06) on day 21 (Table 7). Appearance scores decreased toward the end of the storage period. The control sample, which was the most appreciated for its appearance, received the highest scores throughout all weeks. As with color, odor, and taste, the yogurt with 10 % fresh grapes was the least-preferred sample in terms of appearance. In a study evaluating the sensory attributes of fruit yogurts produced with taflan molasses, the control sample received the highest scores for appearance, consistency, and odor, whereas, in taste scoring, the yogurt containing 4 % molasses received the highest score on the first day of storage [*35*].

When texture scores were compared during storage, the lowest-scoring sample was the yogurt with 10 % fresh grapes on the 21st day of storage (6.87), whereas the most appreciated sample was the control yogurt on the 1st day of storage (8.50) (Table 7). When texture scores were evaluated

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over the storage period, only the control sample maintained a score above 8.0 points. Yogurts with fresh grapes received the lowest texture scores. In another study evaluating the textural properties of yogurts produced by adding taflan molasses, textural attributes were reported to decrease with increasing molasses concentrations [*35*].

The general acceptability scores for the yogurt samples ranged from 7.00 to 8.62 on average (Table 7). When comparing the general acceptability scores of yogurts produced with varying grape concentrations, the control sample received the highest preference, followed by the yogurt containing 8 % dried grapes. Across all evaluated samples, general acceptability scores decreased over the course of storage. The highest acceptability score was observed in the control sample on the 1st day of storage (8.62), whereas the lowest acceptability scores were recorded in yogurts with 8 and 10 % fresh grapes on the 21st day of storage (7.00).

CONCLUSIONS

When the yogurt samples were evaluated for their physicochemical properties, the addition of fresh grapes decreased the water-holding capacity compared with the control yogurt, whereas yogurts fortified with dried grapes exhibited higher water-holding capacity than the control. Overall, the addition of grapes enhanced numerous physicochemical properties of the yogurt samples. A notable increase in bioactive properties was observed as fruit mass fraction increased, with dried grape-fortified yogurts showing higher values than those with fresh grapes. Regarding microbiological attributes during storage, TAMB counts increased across all fruit-added samples with higher grape mass fractions, whereas lactic acid bacteria counts declined. Yeast and mold counts were detected exclusively in grape-containing samples on the 21st day of storage, while coliform bacteria were not detected in any sample. According to the sensory analysis results, the control yogurt received the highest preference across all evaluation categories. Specifically, the control sample and the yogurt with 10 % dried grapes received the highest scores for color, odor, and taste; the control sample and the yogurt with 6 % dried grapes were most preferred for texture; and the control sample and the yogurt with 8 % dried grapes achieved the highest ratings for appearance and general acceptability. In recent years, yogurt enriched with fruits or functional ingredients has become increasingly popular as a functional food matrix. Furthermore, consumer interest in natural antioxidants has heightened due to safety concerns regarding synthetic additives. Considering both the health-promoting benefits and the expanding commercial market, functional fortified yogurts are expected to play an increasingly vital role in dairy innovation.

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ACKNOWLEDGEMENTS

This article was prepared using data from the first author's master's thesis, titled "Investigation of Some Properties of Sultani Grape Yogurt".

SUPPLEMENTARY MATERIAL

All supplementary material is available at www.ftb.com.hr

FUNDING

This research was supported by Kastamonu University Scientific Research Projects Coordination Department (Project No: KÜ-BAP03/2021-02 “Investigation of Some Properties of Yogurt Enriched with Sultani Grapes”).

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

ETHICS APPROVAL

This study involved the sensory evaluation of yogurt supplemented with grapes by healthy adult volunteers. All panelists participated voluntarily and declared that they had no food allergies. No personal, medical, or identifying information was collected. Since the research posed no risk to participants, formal ethical approval was not required in accordance with national and institutional guidelines for food sensory studies.

AUTHORS’ CONTRIBUTION

F. Çelikahmetoğlu conducted the project analyses, organized the data, and wrote the manuscript. D. Tahmas-Kahyaoğlu conceptualized the study, managed the project, reviewed, and edited the manuscript.

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Table 1. Characteristics of grapes used in yogurt production

Property				Fresh grapes				Dried grapes
w(TSS)/%				20				-
w(dry matter)/%				-				94.27
pH				3.24				4.33
Titratable acidity/%				1.05				0.895
w(total phenolics as GAE)/(mg/g)				0.51				2.80
w(total flavonoid as QE)/(mg/g)				0.69				2.52
DPPH inhibition/%				42.64				55.48
ABTS inhibition/%				45.32				70.84
FRAP/(mM/mL)				1.10				1.25
w(mineral)/(mg/kg)								
Al	Mn	Fe	Zn	Na	Mg	Ca	P	K
0.176	0.291	1.475	0.211	0.0387	0.360	0.1129	0.0633	2.5037

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Table 2. Physicochemical properties of yogurt samples

Property	*t* / day	Y	6 % FG	8 % FG	10 % FG	6 % DG	8 % DG	10 % DG
	1	(12.52±0.10)^{aA}	(14.35±0.09)^{aB}	(14.77±0.03)^{aC}	(15.09±0.07)^{aD}	(17.16±0.09)^{aE}	(19.40±0.06)^{aF}	(21.21±0.04)^{bG}
w(dry	7	(12.56±0.09)^{aA}	(14.36±0.15)^{aB}	(14.93±0.12)^{abC}	(15.05±0.27)^{aC}	(17.17±0.21)^{aD}	(19.24±0.07)^{aE}	(21.01±0.14)^{abF}
matter)/%	14	(12.77±0.10)^{aA}	(14.53±0.06)^{aB}	(15.21±0.24)^{bC}	(15.36±0.12)^{aC}	(17.40±0.35)^{aD}	(19.12±0.18)^{aE}	(20.80±0.08)^{aF}
	21	(13.55±0.44)^{bA}	(14.51±0.19)^{aB}	(15.29±0.09)^{bC}	(15.96±0.15)^{bD}	(17.74±0.19)^{aE}	(19.12±0.18)^{aF}	(20.81±0.19)^{aG}
	1	(4.05±0.07)^{abD}	(3.90±0.00)^{aC}	(3.85±0.07)^{aC}	(3.80±0.00)^{aC}	(3.65±0.07)^{aB}	(3.60±0.00)^{aAB}	(3.50±0.00)^{aA}
w(fat)/%	7	(4.00±0.00)^{abE}	(3.95±0.07)^{aE}	(3.90±0.00)^{aDE}	(3.80±0.00)^{aCD}	(3.70±0.00)^{aBC}	(3.65±0.07)^{aAB}	(3.55±0.07)^{aA}
	14	(4.10±0.00)^{bE}	(3.95±0.07)^{aD}	(3.80±0.00)^{aC}	(3.75±0.07)^{aC}	(3.60±0.00)^{aB}	(3.55±0.07)^{aAB}	(3.45±0.07)^{aA}
	21	(3.95±0.07)^{aD}	(3.90±0.00)^{aCD}	(3.80±0.00)^{aBC}	(3.75±0.07)^{aB}	(3.60±0.00)^{aA}	(3.55±0.07)^{aA}	(3.50±0.00)^{aA}
	1	(4.32±0.07)^{cF}	(3.57±0.12)^{bE}	(3.35±0.02)^{cD}	(3.22±0.05)^{cCD}	(3.07±0.01)^{aBC}	(2.99±0.04)^{bAB}	(2.85±0.02)^{bA}
w(protein)/	7	(3.96±0.07)^{bE}	(3.36±0.12)^{abD}	(3.17±0.04)^{bC}	(3.18±0.04)^{bcC}	(3.06±0.02)^{aBC}	(2.96±0.05)^{bAB}	(2.82±0.04)^{bA}
%	14	(3.91±0.04)^{bF}	(3.27±0.04)^{aE}	(3.14±0.08)^{bDE}	(3.06±0.05)^{bCD}	(2.95±0.04)^{aBC}	(2.91±0.04)^{abB}	(2.75±0.06)^{abA}
	21	(3.54±0.08)^{aE}	(3.14±0.05)^{aD}	(2.97±0.04)^{aC}	(2.90±0.02)^{aBC}	(2.95±0.06)^{aC}	(2.81±0.04)^{aAB}	(2.68±0.04)^{aA}
	1	(0.61±0.04)^{aA}	(0.73±0.04)^{aB}	(0.78±0.04)^{aBC}	(0.85±0.02)^{aCD}	(0.79±0.01)^{cBC}	(0.82±0.03)^{aBCD}	(0.91±0.03)^{bD}
w(ash)/%	7	(0.57±0.03)^{aA}	(0.70±0.04)^{aB}	(0.80±0.02)^{aCD}	(0.81±0.03)^{aCD}	(0.76±0.00)^{bcBC}	(0.79±0.03)^{aC}	(0.88±0.02)^{abD}
	14	(0.56±0.02)^{aA}	(0.68±0.03)^{aB}	(0.76±0.02)^{aC}	(0.78±0.03)^{aC}	(0.73±0.02)^{abBC}	(0.78±0.02)^{aC}	(0.86±0.02)^{abD}
	21	(0.54±0.02)^{aA}	(0.66±0.03)^{aB}	(0.74±0.03)^{aC}	(0.77±0.04)^{aCD}	(0.70±0.00)^{aBC}	(0.76±0.02)^{aCD}	(0.83±0.01)^{aD}
	1	(4.58±0.02)^{bD}	(4.10±0.00)^{cBC}	(4.06±0.04)^{bAB}	(4.01±0.02)^{cA}	(4.14±0.02)^{bC}	(4.11±0.01)^{bBC}	(4.06±0.02)^{bAB}
pH	7	(4.55±0.03)^{bD}	(4.06±0.02)^{bB}	(3.99±0.00)^{abA}	(3.97±0.01)^{bcA}	(4.12±0.02)^{bC}	(4.09±0.02)^{bBC}	(4.06±0.01)^{bB}
	14	(4.51±0.01)^{abE}	(4.01±0.01)^{aB}	(3.97±0.01)^{aAB}	(3.93±0.02)^{abA}	(4.08±0.02)^{abD}	(4.06±0.01)^{bCD}	(4.02±0.00)^{abBC}
	21	(4.44±0.02)^{aD}	(3.98±0.00)^{aBC}	(3.93±0.02)^{aAB}	(3.90±0.00)^{aA}	(4.03±0.02)^{aC}	(4.00±0.02)^{aC}	(3.98±0.02)^{aBC}
	1	(0.81±0.02)^{aA}	(0.94±0.02)^{aBCD}	(0.96±0.02)^{aCD}	(1.00±0.02)^{aD}	(0.89±0.01)^{aB}	(0.91±0.03)^{aBC}	(0.93±0.03)^{aBC}
Titratable	7	(0.83±0.02)^{abA}	(1.00±0.02)^{abC}	(1.11±0.02)^{bD}	(1.17±0.01)^{bD}	(0.92±0.03)^{abB}	(0.96±0.01)^{abBC}	(1.02±0.04)^{abC}
acidity/%	14	(0.89±0.02)^{bA}	(1.06±0.02)^{bcC}	(1.15±0.02)^{bcD}	(1.23±0.03)^{bcE}	(0.97±0.02)^{bcB}	(1.01±0.03)^{bBC}	(1.07±0.02)^{bC}
	21	(0.97±0.02)^{cA}	(1.11±0.03)^{cC}	(1.21±0.03)^{cD}	(1.26±0.02)^{cD}	(1.03±0.02)^{cAB}	(1.09±0.02)^{cBC}	(1.20±0.03)^{cD}
	1	(2802.03±87.83)^{aA}	(2977.25±50.05)^{aB}	(3141.55±53.02)^{aC}	(3435.58±56.09)^{aD}	(4010.08±97.34)^{aE}	(4265.30±47.83)^{aF}	(4492.69±43.58)^{aG}
Viscosity/cP	7	(3147.29±139.05)^{bA}	(3433.62±94.51)^{bB}	(3568.23±79.07)^{bB}	(3849.97±147.56)^{bC}	(4119.61±95.80)^{abD}	(4315.16±70.77)^{aDE}	(4500.20±18.02)^{aE}
	14	(3532.44±43.22)^{cA}	(3692.27±51.42)^{cB}	(3871.33±70.55)^{cC}	(4126.98±39.08)^{cD}	(4520.23±82.14)^{cE}	(4935.84±94.07)^{bF}	(5325.59±54.63)^{cG}
	21	(3429.37±64.86)^{cA}	(3556.89±60.21)^{bcAB}	(3705.70±26.09)^{bcB}	(4010.63±15.16)^{bcC}	(4295.61±99.46)^{bcD}	(4876.49±124.24)^{bE}	(5063.80±83.65)^{bF}
Water	1	(44.47±0.33)^{bD}	(43.52±0.12)^{cC}	(42.54±0.31)^{cB}	(41.25±0.14)^{dA}	(45.54±0.31)^{cE}	(47.67±0.37)^{bF}	(51.63±0.24)^{cG}
holding	7	(44.03±0.11)^{bD}	(42.97±0.12)^{bC}	(41.99±0.05)^{bB}	(40.80±0.04)^{cA}	(44.99±0.02)^{bE}	(47.09±0.34)^{bF}	(51.21±0.27)^{bcG}
capacity/%	14	(43.86±0.16)^{bD}	(42.75±0.10)^{bC}	(41.89±0.04)^{bB}	(40.41±0.13)^{bA}	(44.93±0.08)^{bE}	(46.82±0.28)^{bF}	(50.87±0.12)^{bG}
	21	(42.82±0.24)^{aC}	(41.18±0.09)^{aB}	(40.71±0.13)^{aB}	(39.05±0.12)^{aA}	(43.57±0.15)^{aD}	(45.13±0.29)^{aE}	(48.43±0.31)^{aF}
	1	(7.75±0.079)^{bCD}	(7.72±0.03)^{bcC}	(7.82±0.03)^{aCD}	(7.87±0.03)^{aD}	(7.45±0.07)^{aB}	(7.35±0.07)^{bAB}	(7.30±0.00)^{cA}
	7	(7.60±0.07)^{abD}	(7.82±0.03)^{cE}	(7.82±0.03)^{aE}	(7.87±0.03)^{aE}	(7.37±0.03)^{aC}	(7.20±0.07)^{aB}	(7.00±0.14)^{aA}

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Syneresis/ %	14	(7.55±0.07)^{aC}	(7.50±0.07)^{aBC}	(7.72±0.03)^{aD}	(7.82±0.03)^{aD}	(7.47±0.03)^{aBC}	(7.40±0.00)^{bB}	(7.22±0.03)^{bcA}
	21	(7.42±0.03)^{aB}	(7.62±0.03)^{abC}	(7.72±0.03)^{aD}	(7.87±0.03)^{aE}	(7.47±0.03)^{aB}	(7.42±0.03)^{bB}	(7.07±0.03)^{abA}

Mean values followed by the same letter in each row are not significantly different ($p<0.01$). The differences between the storage periods indicated by different lowercase letters (a, b, c *etc.*) in the same yogurt variety are significant. Differences between yogurt varieties shown with different capital letters (A, B, C *etc.*) in the same storage period are significant ($p<0.05$). Y=control sample (grape-free), 6 % FG=yogurt with 6 % fresh grapes, 8 % FG=yogurt with 8 % fresh grapes, 10 % FG=yogurt with 10 % fresh grapes, 6 % DG=yogurt with 6 % dried grapes, 8 % DG=yogurt with 8 % dried grapes, and 10 % DG=yogurt with 10 % dried grapes

Table 3. Color parameters of yogurt samples

Parameter	*t*/day	Y	6 % FG	8 % FG	10 % FG	6 % DG	8 % DG	10 % DG
L	1	(89.79±0.62)^{aE}	(84.50±0.07)^{aD}	(83.50±1.62)^{aCD}	(82.00±0.70)^{aC}	(79.21±0.33)^{aB}	(78.14±0.43)^{aAB}	(77.17±0.10)^{bA}
	7	(89.61±0.57)^{aE}	(83.73±0.12)^{aD}	(83.28±1.60)^{aCD}	(81.74±0.67)^{aC}	(79.07±0.33)^{aB}	(77.98±0.47)^{aAB}	(77.07±0.05)^{abA}
	14	(89.50±0.51)^{aE}	(83.58±0.09)^{aD}	(83.14±1.56)^{aCD}	(81.62±0.68)^{aC}	(78.89±0.33)^{aB}	(77.83±0.53)^{aAB}	(76.86±0.16)^{abA}
	21	(89.39±0.48)^{aE}	(83.42±0.12)^{aD}	(82.59±0.91)^{aCD}	(81.55±0.65)^{aC}	(78.77±0.33)^{aB}	(77.69±0.62)^{aAB}	(76.63±0.29)^{aA}
a	1	(+2.56±0.16)^{aA}	(−16.05±0.58)^{aC}	(−18.01±0.61)^{aD}	(−19.15±0.28)^{aD}	(+13.05±0.84)^{aB}	(+16.28±0.77)^{aC}	(+18.91±0.50)^{aD}
	7	(+2.43±0.13)^{aA}	(−15.68±0.66)^{aB}	(−17.70±0.65)^{aD}	(−18.74±0.41)^{aD}	(+12.76±0.86)^{aB}	(+16.04±0.75)^{aC}	(+18.65±0.57)^{aD}
	14	(+2.33±0.11)^{aA}	(−15.50±0.66)^{aC}	(−17.45±0.55)^{aD}	(−18.48±0.45)^{aD}	(+12.41±0.66)^{aB}	(+15.84±0.67)^{aC}	(+17.83±1.15)^{aD}
	21	(+2.26±0.16)^{aA}	(−15.24±0.55)^{aC}	(−17.22±0.50)^{aD}	(−18.22±0.50)^{aD}	(+12.12±0.62)^{aB}	(+15.60±0.67)^{aC}	(+17.53±1.11)^{aD}
b	1	(+9.86±0.57)^{aA}	(+14.90±0.64)^{aB}	(+17.21±0.48)^{aC}	(+19.29±0.48)^{aD}	(+21.50±0.25)^{bE}	(+23.45±0.29)^{aF}	(+25.15±0.36)^{aG}
	7	(+9.74±0.53)^{aA}	(+14.69±0.65)^{aB}	(+17.03±0.53)^{aC}	(+19.02±0.42)^{aD}	(+21.25±0.16)^{abE}	(+23.21±0.23)^{aF}	(+24.94±0.45)^{aG}
	14	(+9.63±0.53)^{aA}	(+14.55±0.65)^{aB}	(+16.81±0.61)^{aC}	(+18.84±0.43)^{aD}	(+21.08±0.10)^{abE}	(+23.02±0.19)^{aF}	(+24.67±0.51)^{aG}
	21	(+9.54±0.51)^{aA}	(+14.40±0.78)^{aB}	(+16.59±0.64)^{aC}	(+18.66±0.48)^{aD}	(+20.91±0.10)^{aE}	(+22.81±0.23)^{aF}	(+24.50±0.52)^{aG}

Mean values followed by the same letter in each row are not significantly different ($p<0.01$). The differences between the storage periods indicated by different lowercase letters (a, b, c *etc.*) in the same yogurt variety are significant. Differences between yogurt varieties shown with different capital letters (A, B, C *etc.*) in the same storage period are significant ($p<0.05$). Y=control sample (grape-free), 6 % FG=yogurt with 6 % fresh grapes, 8 % FG=yogurt with 8 % fresh grapes, 10 % FG=yogurt with 10 % fresh grapes, 6 % DG=yogurt with 6 % dried grapes, 8 % DG=yogurt with 8 % dried grapes, 10 % DG=yogurt with 10 % dried grapes

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Table 4. Mineral mass fractions determined in yogurt samples

	w(mineral)/(μg/kg)						
Mineral	Y	6 % FG	8 % FG	10 % FG	6 % DG	8 % DG	10 % DG
Al	(313.40±0.30)^{a}	(341.10±11.77)^{b}	(423.46±11.64)^{c}	(453.26±2.95)^{d}	(537.43±13.47)^{e}	(634.33±3.11)^{f}	(662.00±10.16)^{g}
Mn	(63.16±1.24)^{a}	(68.40±2.04)^{b}	(83.93±1.70)^{c}	(89.03±1.44)^{d}	(102.16±0.89)^{e}	(113.43±0.64)^{f}	(115.90±0.80)^{g}
Fe	(192.23±22.49)^{a}	(556.06±13.55)^{b}	(1161.63±85.40)^{c}	(1363.80±15.92)^{d}	(1655.30±20.27)^{e}	(2448.70±14.03)^{f}	(2804.90±29.92)^{g}
Zn	(270.10±10.61)^{a}	(392.26±7.15)^{b}	(408.80±4.81)^{c}	(430.26±7.45)^{d}	(698.93±10.78)^{e}	(835.03±10.66)^{f}	(914.56±4.19)^{g}
	w(mineral)/(mg/kg)						
Na	(468.16±2.82)^{g}	(368.93±1.69)^{a}	(379.80±2.80)^{b}	(394.76±1.70)^{c}	(407.90±2.62)^{d}	(421.13±1.18)^{e}	(430.96±0.64)^{f}
Mg	(609.46±1.73)^{a}	(663.90±13.58)^{b}	(714.86±11.52)^{c}	(805.13±5.02)^{d}	(828.96±1.02)^{e}	(842.00±1.74)^{f}	(859.76±5.35)^{g}
Ca	(1367.46±3.75)^{g}	(1029.33±8.33)^{a}	(1044.26±5.25)^{b}	(1113.50±11.93)^{c}	(1142.63±8.55)^{d}	(1202.33±1.30)^{e}	(1225.80±1.82)^{f}
P	(639.50±0.51)^{g}	(296.56±2.04)^{a}	(334.26±2.019^{b}	(406.83±4.19)^{c}	(418.96±4.74)^{d}	(430.00±4.10)^{e}	(445.73±1.98)^{f}
K	(2044.23±11.27)^{a}	(2267.63±28.04)^{b}	(2296.46±9.70)^{c}	(2438.60±11.77)^{d}	(2780.80±5.74)^{e}	(2952.66±7.89)^{f}	(3118.56±13.54)^{g}

Mean values followed by the same letter in each row are not significantly different ($p<0.01$). Y=control sample (grape-free), 6 % FG=yogurt with 6 % fresh grapes, 8 % FG=yogurt with 8 % fresh grapes, 10 % FG=yogurt with 10 % fresh grapes, 6 % DG=yogurt with 6 % dried grapes, 8 % DG=yogurt with 8 % dried grapes, 10 % DG=yogurt with 10 % dried grapes

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Table 5. Bioactive properties of yogurt samples

Property	*t* /day	Y	6 % FG	8 % FG	10 % FG	6 % DG	8 % DG	10 % DG
w(total phenolics as GAE)/(mg/g)	1	(1.10±0.02)^{bA}	(1.23±0.02)^{cB}	(1.36±0.02)^{cC}	(1.50±0.01)^{cD}	(1.62±0.07)^{bE}	(1.74±0.04)^{bF}	(1.87±0.07)^{aG}
	7	(1.02±0.03)^{abA}	(1.17±0.03)^{bcB}	(1.32±0.02)^{bcC}	(1.45±0.03)^{bcD}	(1.58±0.03)^{abE}	(1.70±0.03)^{bF}	(1.83±0.06)^{aG}
	14	(1.01±0.02)^{aA}	(1.12±0.01)^{abB}	(1.26±0.02)^{abC}	(1.37±0.02)^{abD}	(1.50±0.04)^{abE}	(1.66±0.01)^{abF}	(1.80±0.02)^{aG}
	21	(0.96±0.02)^{aA}	(1.09±0.01)^{aB}	(1.20±0.02)^{aC}	(1.32±0.04)^{aD}	(1.46±0.05)^{aE}	(1.59±0.02)^{aF}	(1.78±0.06)^{aG}
w(total flavonoid as QE)/(mg/g)	1	(1.16±0.02)^{bA}	(1.24±0.01)^{cB}	(1.27±0.01)^{cB}	(1.29±0.03)^{aB}	(1.41±0.04)^{bC}	(1.48±0.03)^{bD}	(1.59±0.03)^{bE}
	7	(1.13±0.02)^{abA}	(1.21±0.02)^{bcB}	(1.23±0.01)^{bcB}	(1.25±0.04)^{aB}	(1.33±0.02)^{abC}	(1.42±0.02)^{abD}	(1.51±0.03)^{aE}
	14	(1.12±0.01)^{abA}	(1.18±0.02)^{abB}	(1.20±0.00)^{abB}	(1.22±0.02)^{aB}	(1.31±0.02)^{aC}	(1.39±0.02)^{aD}	(1.49±0.02)^{aE}
	21	(1.09±0.00)^{aA}	(1.16±0.00)^{aB}	(1.17±0.02)^{aB}	(1.19±0.03)^{aB}	(1.28±0.02)^{aC}	(1.36±0.02)^{aD}	(1.46±0.01)^{aE}
DPPH inhibition/%	1	(19.29±0.08)^{aA}	(21.50±0.00)^{aB}	(22.28±0.04)^{aC}	(23.02±0.48)^{aD}	(25.66±0.28)^{aE}	(30.00±0.21)^{aF}	(35.03±0.26)^{aG}
	7	(19.27±0.10)^{aA}	(21.45±0.09)^{aB}	(22.00±0.09)^{aC}	(22.59±0.23)^{aD}	(25.58±0.26)^{aE}	(29.89±0.19)^{aF}	(34.96±0.24)^{aG}
	14	(19.24±0.07)^{aA}	(21.43±0.07)^{aB}	(21.94±0.09)^{aC}	(22.44±0.09)^{aD}	(25.54±0.29)^{aE}	(29.86±0.19)^{aF}	(34.87±0.31)^{aG}
	21	(19.19±0.07)^{aA}	(21.38±0.06)^{aB}	(21.85±0.16)^{aC}	(22.33±0.02)^{aD}	(25.49±0.31)^{aE}	(29.74±0.16)^{aF}	(34.79±0.28)^{aG}
ABTS inhibition/%	1	(29.20±0.50)^{aA}	(33.69±1.47)^{aB}	(35.75±0.16)^{aC}	(37.50±0.54)^{aD}	(42.33±0.30)^{aE}	(45.24±0.53)^{aF}	(48.10±0.30)^{aG}
	7	(29.10±0.48)^{aA}	(33.48±1.66)^{aB}	(35.53±0.30)^{aC}	(37.28±0.40)^{aD}	(42.20±0.26)^{aE}	(45.15±0.45)^{aF}	(48.04±0.31)^{aG}
	14	(28.96±0.46)^{aA}	(33.40±1.66)^{aB}	(35.35±0.16)^{aC}	(37.08±0.24)^{aD}	(42.03±0.26)^{aE}	(44.98±0.43)^{aF}	(47.94±0.24)^{aG}
	21	(28.86±0.43)^{aA}	(33.24±1.66)^{aB}	(35.31±0.27)^{aC}	(36.97±0.20)^{aD}	(41.89±0.26)^{aE}	(44.82±0.44)^{aF}	(47.82±0.27)^{aG}
FRAP/(mM/mL)	1	(0.63±0.07)^{aA}	(0.78±0.06)^{bB}	(0.86±0.07)^{aB}	(1.01±0.05)^{aC}	(1.11±0.06)^{aCD}	(1.20±0.02)^{cDE}	(1.28±0.03)^{aE}
	7	(0.59±0.11)^{aA}	(0.75±0.03)^{bB}	(0.81±0.09)^{aBC}	(0.97±0.04)^{aCD}	(1.06±0.06)^{aDE}	(1.15±0.04)^{bcEF}	(1.24±0.03)^{aF}
	14	(0.52±0.12)^{aA}	(0.71±0.00)^{abB}	(0.74±0.09)^{aB}	(0.93±0.04)^{aC}	(1.03±0.05)^{aCD}	(1.10±0.05)^{abDE}	(1.20±0.03)^{aE}
	21	(0.43±0.04)^{aA}	(0.58±0.06)^{aB}	(0.68±0.07)^{aB}	(0.87±0.04)^{aC}	(1.00±0.06)^{aCD}	(1.05±0.04)^{aD}	(1.18±0.03)^{aE}

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Table 6. Microbiological properties of yogurt samples

Property	*t*/day	Y	6 % FG	8 % FG	10 % FG	6 % DG	8 % DG	10 % DG
	1	$(4.09\pm0.03)^{abA}$	$(5.28\pm0.02)^{cB}$	$(5.39\pm0.09)^{bBC}$	$(5.61\pm0.04)^{cD}$	$(5.29\pm0.13)^{aB}$	$(5.35\pm0.04)^{cB}$	$(5.54\pm0.04)^{bCD}$
TAMB	7	$(4.32\pm0.09)^{cA}$	$(5.15\pm0.06)^{bB}$	$(5.29\pm0.13)^{abBCD}$	$(5.49\pm0.02)^{bD}$	$(5.12\pm0.11)^{aB}$	$(5.25\pm0.00)^{bBC}$	$(5.41\pm0.03)^{abCD}$
	14	$(4.20\pm0.02)^{bcA}$	$(5.09\pm0.02)^{abB}$	$(5.20\pm0.08)^{abBC}$	$(5.41\pm0.00)^{bD}$	$(5.07\pm0.09)^{aB}$	$(5.21\pm0.02)^{bBC}$	$(5.31\pm0.07)^{aCD}$
	21	$4.03\pm0.03)^{aA}$	$(5.01\pm0.02)^{aB}$	$(5.10\pm0.05)^{aB}$	$(5.31\pm0.03)^{aC}$	$(5.01\pm0.07)^{aB}$	$(5.09\pm0.02)^{aB}$	$(5.25\pm0.08)^{aC}$
	1	$(7.00\pm0.02)^{aC}$	$(6.94\pm0.02)^{aBC}$	$(6.89\pm0.02)^{bABC}$	$(6.80\pm0.08)^{aA}$	$(6.97\pm0.01)^{bBC}$	$(6.93\pm0.06)^{bBC}$	$(6.86\pm0.02)^{bAB}$
Lactobacilli	7	$(7.06\pm0.01)^{aE}$	$(6.89\pm0.05)^{aCD}$	$(6.79\pm0.02)^{aAB}$	$(6.76\pm0.02)^{aA}$	$(6.95\pm0.02)^{abD}$	$(6.87\pm0.02)^{abBC}$	$(6.81\pm0.02)^{abAB}$
	14	$(7.04\pm0.02)^{aC}$	$(6.85\pm0.04)^{aB}$	$(6.76\pm0.02)^{aA}$	$(6.73\pm0.03)^{aA}$	$(6.89\pm0.02)^{aB}$	$(6.82\pm0.02)^{aAB}$	$86.75\pm0.04)^{aA}$
	21	$(7.00\pm0.04)^{aC}$	$(6.85\pm0.04)^{aB}$	$(6.74\pm0.04)^{aA}$	$(6.72\pm0.03)^{aA}$	$(6.88\pm0.03)^{aB}$	$(6.81\pm0.02)^{aAB}$	$(6.73\pm0.01)^{aA}$
	1	$(8.20\pm0.01)^{bC}$	$(8.12\pm0.08)^{bBC}$	$(8.04\pm0.02)^{bAB}$	$(7.94\pm0.04)^{bA}$	$(8.18\pm0.08)^{cC}$	$(8.07\pm0.07)^{bABC}$	$(8.01\pm0.04)^{bAB}$
Lactococci	7	$(8.22\pm0.03)^{bD}$	$(8.03\pm0.02)^{abB}$	$(8.00\pm0.01)^{bB}$	$(7.86\pm0.02)^{abA}$	$(8.14\pm0.04)^{bcC}$	$(8.02\pm0.01)^{bB}$	$(8.03\pm0.03)^{bB}$
	14	$(8.21\pm0.04)^{bD}$	$(8.02\pm0.02)^{abBC}$	$(7.96\pm0.06)^{bAB}$	$(7.87\pm0.04)^{bA}$	$(8.07\pm0.02)^{abC}$	$(7.99\pm0.02)^{bBC}$	$(7.92\pm0.02)^{bAB}$
	21	$(8.05\pm0.05)^{aD}$	$(7.93\pm0.02)^{aBC}$	$(7.85\pm0.04)^{aAB}$	$(7.76\pm0.02)^{aA}$	$(7.97\pm0.02)^{aCD}$	$(7.84\pm0.04)^{aAB}$	$(7.75\pm0.04)^{aA}$
	1	<2	<2	<2	<2	<2	<2	<2
Yeast and mold	7	<2	<2	<2	<2	<2	<2	<2
	14	<2	<2	<2	<2	<2	<2	<2
	21	<2	$(2.38\pm0.12)^{aA}$	$(2.76\pm0.10)^{aB}$	$(2.97\pm0.09)^{aBC}$	$(2.53\pm0.09)^{aA}$	$(2.86\pm0.12)^{aB}$	$(3.09\pm0.02)^{bC}$
	1	-	-	-	-	-	-	-
Coliform	7	-	-	-	-	-	-	-
	14	-	-	-	-	-	-	-
	21	-	-	-	-	-	-	-

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Table 7. Sensory properties of yogurt samples

Property	*t*/day	Y	6 % FG	8 % FG	10 % FG	6 % DG	8 % DG	10 % DG
Color	1	(8.37±0.23)^{cD}	(8.00±0.26)^{bBC}	(7.81±0.25)^{cAB}	(7.68±0.25)^{bA}	(8.12±0.35)^{bCD}	(8.18±0.25)^{cCD}	(8.25±0.26)^{cCD}
	7	(8.25±0.26)^{bcC}	(7.81±0.25)^{abAB}	(7.68±0.25)^{bcAB}	(7.56±0.17)^{bA}	(7.93±0.41)^{abBC}	(7.93±0.32)^{bcBC}	(8.00±0.37)^{bcBC}
	14	(8.06±0.32)^{abC}	(7.68±0.25)^{abABC}	(7.43± 0.32)^{abAB}	(7.31±0.25)^{aA}	(7.75±0.46)^{abBC}	(7.68±0.45)^{abABC}	(7.75±0.26)^{abBC}
	21	(7.87±0.23)^{aC}	(7.50±0.37)^{aABC}	(7.25±0.37)^{aAB}	(7.12±0.23)^{aA}	(7.62±0.51)^{aBC}	(7.50±0.37)^{aABC}	(7.56±0.41)^{aBC}
Odor	1	(8.43±0.17)^{cB}	(8.25±0.26)^{bAB}	(8.25±0.26)^{cAB}	(8.12±0.23)^{cA}	(8.37±0.23)^{bAB}	(8.25±0.26)^{bAB}	(8.37±0.23)^{bAB}
	7	(8.25±0.26)^{bcB}	(8.12±0.23)^{bAB}	(8.06±0.32)^{bcAB}	(7.87±0.35)^{bcA}	(8.18±0.25)^{bB}	(8.12±0.23)^{abAB}	(8.12±0.23)^{bAB}
	14	(8.12±0.23)^{abB}	(7.87±0.35)^{abAB}	(7.87±0.35)^{bAB}	(7.56±0.32)^{bA}	(7.87±0.23)^{aAB}	(7.93±0.32)^{abB}	(7.81±0.25)^{aAB}
	21	(8.00±0.00)^{aD}	(7.56±0.56)^{aBC}	(7.31±0.37)^{aAB}	(7.18±0.37)^{aA}	(7.68±0.25)^{aABC}	(7.81±0.37)^{aCD}	(7.68±0.25)^{aBCD}
Taste	1	(8.31±0.25)^{bD}	(7.81±0.25)^{cC}	(7.37±0.35)^{bB}	(6.93±0.32)^{cA}	(8.25±0.26)^{cD}	(8.25±0.26)^{bD}	(8.31±0.25)^{bD}
	7	(8.18±0.25)^{abD}	(7.62±0.35)^{bcC}	(7.18±0.37)^{bB}	(6.81±0.37)^{bcA}	(8.06±0.32)^{bcD}	(8.12±0.23)^{bD}	(8.18±0.25)^{bD}
	14	(8.06±0.17)^{aD}	(7.37±0.44)^{abC}	(7.00±0.53)^{abB}	(6.50±0.37)^{abA}	(7.87±0.23)^{abD}	(8.00±0.26)^{abD}	(8.00±0.37)^{abD}
	21	(8.00±0.00)^{aD}	(7.12±0.44)^{aC}	(6.68± 0.53)^{aB}	(6.25±0.37)^{aA}	(7.75±0.26)^{aD}	(7.81±0.25)^{aD}	(7.75±0.37)^{aD}
Appearance	1	(8.43±0.17)^{cD}	(8.12±0.23)^{bBC}	(7.87±0.23)^{cAB}	(7.68±0.37)^{bA}	(8.12±0.23)^{bBC}	(8.25±0.26)^{cCD}	(8.25±0.26)^{bCD}
	7	(8.25±0.26)^{bcC}	(7.93±0.32)^{abBC}	(7.75±0.26)^{bcAB}	(7.43±0.41)^{abA}	(8.00±0.37)^{abBC}	(7.93±0.32)^{bcBC}	(8.06±0.32)^{abBC}
	14	(8.12±0.35)^{abC}	(7.75±0.46)^{abBC}	(7.43±0.41)^{abAB}	(7.18±0.45)^{aA}	(7.87±0.35)^{abC}	(7.81±0.25)^{abBC}	(7.93±0.17)^{abC}
	21	(7.93±0.32)^{aC}	(7.56±0.56)^{aBC}	(7.31±0.37)^{aAB}	(7.06±0.49)^{aA}	(7.62±0.51)^{aBC}	(7.56±0.41)^{aBC}	(7.75±0.37)^{aBC}
Texture	1	(8.50±0.37)^{aE}	(8.12±0.23)^{bBC}	(7.81±0.37)^{bB}	(7.43±0.41)^{bA}	(8.31±0.25)^{bDE}	(8.18±0.25)^{bCD}	(7.87±0.23)^{bBC}
	7	(8.37±0.35)^{aE}	(8.00±0.37)^{abCD}	(7.62±0.35)^{bAB}	(7.31±0.37)^{abA}	(8.18±0.25)^{bDE}	(8.00±0.37)^{abCD}	(7.75±0.26)^{bBC}
	14	(8.25±0.26)^{aD}	(7.87±0.23)^{abBCD}	(7.43±0.41)^{abAB}	(7.18±0.37)^{abA}	(7.93±0.49)^{abCD}	(7.81±0.53)^{abBCD}	(7.62±0.44)^{abBC}
	21	(8.12±0.35)^{aC}	(7.75±0.26)^{aBC}	(7.06±0.41)^{aA}	(6.87±0.64)^{aA}	(7.75±0.46)^{aBC}	(7.56±0.41)^{aB}	(7.31±0.37)^{aAB}
Acceptability	1	(8.62±0.35)^{bD}	(7.93±0.32)^{bAB}	(7.93±0.32)^{bAB}	(7.75±0.26)^{cA}	(8.31±0.25)^{cCD}	(8.56±0.32)^{cD}	(8.18±0.25)^{bBC}
	7	(8.50±0.37)^{bD}	(7.81±0.25)^{bAB}	(7.75±0.46)^{bAB}	(7.50±0.37)^{bcA}	(8.12±0.35)^{bcBC}	(8.43±0.32)^{bcCD}	(8.00±0.26)^{bB}
	14	(8.25±0.26)^{abC}	(7.31±0.53)^{aA}	(7.31±0.37)^{aA}	(7.18±0.25)^{abA}	(7.87±0.25)^{abBC}	(8.18±0.25)^{abBC}	(7.81±0.45)^{bB}
	21	(8.00±0.46)^{aC}	(7.12±0.44)^{aA}	(7.00±0.37)^{aA}	(7.00±0.37)^{aA}	(7.68±0.37)^{aBC}	(8.06±0.41)^{aC}	(7.43±0.41)^{aAB}

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