Production and Evaluation of Yogurt with Concentrated Grape Juice

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ABSTRACT
Fruit yogurt was prepared by adding concentrated grape juice (pekmez) CGJ, to milk. Optimum CGJ concentration and its influence on quality and fermentation process of yogurt were evaluated. The pH, titratable acidity, protein content, viscosity, whey syneresis, starter bacteria, mold and yeast counts were determined weekly at 4°C for 1 month. Addition of 10% CGJ provided desired sweetness. After 4h incubation of 5-10% CGJ-added yogurts the pH was 4.44, 4.98 and 5.90, respectively, and the control was pH 4.26. CGJ addition increased fermentation time and decreased viscosity. During storage, acidity of 10% CGJ-added yogurt remained lower (P<0.05) than controls. CGJ did not affect (P>0.05) protein content and molds or yeasts were not detected.

Key Words: pekmez, yogurt, storage stability, grape juice concentrate

INTRODUCTION
CONCENTRATED GRAPE JUICE (CGJ) IS ONE OF THE MOST COMMON grape products in eastern and central Turkey. From all grapes produced, 37% are processed into CGJ by traditional methods without technological or scientific considerations. It is obtained by boiling grape juice without fortification (Batu and Aktan, 1992) and is called “concentrated grape juice” or sometimes “grape juice molasses.” CGJ is sold in liquid or solid form, and the solid CGJ is obtained by crystallization of liquid CGJ (Güven, 1989).

CGJ has a high mineral content, especially calcium and iron. It is brown or dark yellow due to nonenzymatic browning reactions. The pH is 5.05 and solids of CGJ are around 82%. The protein content is 0.63% and sugar is 83% of the total solids (Özkök, 1989; Anon, 1989). The high sugar content provides the product with a long shelf-life (2 hr). Due to its lower protein CGJ can be used for treatment of protein metabolism disorders. Relatively high iron content (5-10 mg/100g CGJ) makes CGJ useful for patients that suffer from anemia (Birer, 1983; Ataç et al., 1988; Topcu and Besler, 1997).

CGJ is used for preparation of desserts such as Turkish asure and helva, or can be mixed with taha and consumed at breakfast. Also CGJ, either in solid or liquid form, may be mixed with yogurt and frequently consumed at home. This mixture is called “fakibeyni” in southern Turkey (Özkök, 1989).

Flavored yogurts are made by adding fruit concentrates or flavored syrups to cultured milk before or after incubation (Keating and White, 1981). The production and consumption of fruit yogurt is low in Turkey compared to plain yogurt, but fakibeyni is widely made and consumed in homes. There is no commercial production of either CGJ or CGJ yogurt in turkey or elsewhere.

The objective of our investigation was to develop a new type of fruit-flavored set-yogurt by adding CGJ with high iron content and good nutritional value and to study the effects of CGJ addition on overall product quality and effects on fermentation.

MATERIALS & METHODS
CGJ was supplied by Gaziantep University. The typical pH was 4.96 and solids content about 72%. The CGJ was stored at room temperature in the dark until used in production trials. Commercial freeze-dried yogurt culture, Jogurt series 500 (VISBYVAC Jogurt-V, Laboratorium Wiesby, Niebull, Germany) was provided by Wiesby Starter culture and media laboratory. This culture consisted of a 1:1 ratio of Lactobacillus bulgaricus and Streptococcus thermophilus.

Yogurt making
Nonfat dry milk (Pinar A., dairy company) was used to prepare reconstituted milk with 16% (w/v) total solids. Milk was sterilized at 121°C for 5 min and cooled to 42–45°C. After cooling, CGJ was added to the milk at 5, 10, and 15% (v/v). Milk was inoculated with 3% (v/v) active yogurt culture. Fermentation was conducted at 43°C for 4h. Both the control and CGJ-added yogurts were stored overnight at 4°C for further analysis.

Viscosity and whey syneresis measurement
Syneresis was determined as follows: 5 mL of yogurt were centrifuged in a Hettich ABA III model centrifuge (Germany) 5000 rpm for 20 min) and the whey that accumulated after 1 min was measured. Syneresis (%) was expressed as volume of drained whey per 100 mL yogurt (Rodarte et al., 1993). Apparent viscosity was determined by using a RV Brookfield viscometer (Stoughton, USA) on 100 mL yogurt samples at room temperature. Samples were stirred for 40 sec before measurement. Readings were converted to centipoise units. All viscosity values were measured at 10 rpm with spindle #5 (Gasssem and Frank, 1991).

Acidity development and protein determination
The pH was measured at weekly intervals using a Jenway 3010 model pH meter (Essex, UK). Titratable acidity was determined as % lactic acid by titrating with 0.1N NaOH; using phenolphthalein as an indicator (Karleskind et al., 1993; White, 1995). The protein content of samples was measured by a dye-binding method (Eagan et al., 1981).

Microbiological analysis
Microbiological analysis of yogurts included determination of the numbers of total starter culture, yeast and molds. Samples were homogenized by using an Uve model vortex (type NM 110, Ankara, Turkey) stirrer and diluted up to 1/106 with sterile peptonized water. Mann, Rogosa, Sharpe (MRS) agar (Oxoid Co.) was used for assaying total starter culture (Anon, 1993). Potato dextrose agar (PDA) (Acumedia Chemical Co.) was used for determining yeasts and molds (Sharf, 1966). Yogurt samples were analyzed at weekly intervals up to 1 month; experiments were conducted in duplicate.

Statistical analysis
To estimate the effect of CGJ addition on each product parameter, ANOVA was conducted at the P=0.05 level. When significance was observed, separation of means was undertaken by using the Duncan Multiple Range test. Experiments were replicated twice.
RESULTS & DISCUSSION

Effect of CGJ addition on fermentation process

In order to determine optimum CGJ concentration for yogurt production, preliminary trials were conducted. CGJ was mixed (5, 10, 15% v/v) with skim milk and inoculated with starter culture. The pH changes were measured during fermentation (Fig. 1). An increase in CGJ concentration extended fermentation time. The initial pH of the skim milk was 6.35; addition of 5, 10 and 15% CGJ reduced the initial pH of the milk to 6.32, 6.28 and 6.24, respectively, due to the lower pH value of CGJ (4.96). After 4h incubation, at 42–45°C, the pH of the control was 4.26 while the 5, 10 and 15% CGJ yogurts were pH 4.44, 4.98, 5.90, respectively. CGJ addition delayed acid development with pH reduction rate slowed. The 15% CGJ addition increased fermentation time compared to 5 and 10% CGJ. Note that a slow fermentation is not desirable for yogurt because of typical increases in syneresis (Tamime and Deeth, 1980) and a breakdown of symbiotic relationship between starter bacteria (Tamime and Robinson, 1980). However, preliminary sensory tests on sweetness indicated that 5% CGJ addition did not provide adequate sweetness for the yogurt. Sweetness of 5% CGJ yogurt was lower (P<0.05) than 10 or 15% CGJ yogurt. Hence further experiments were conducted with 10% CGJ addition.

pH and titratable acidity of CGJ yogurts

Titratable acidity of control and CGJ yogurts (Fig. 2), showed increases in titratable acidities of both CGJ flavored yogurt and control yogurts after 1 wk storage at 4°C. Following 4 wk storage, the titratable acidity continued to increase. Titratable acidity of CGJ yogurt remained nearly constant following the second and third weeks with a small increase noted during the last week. Parallel to the change in titratable acidity, pH of control and CGJ yogurt decreased during the first 2 wk of storage. During the rest of storage, pH of the CGJ yogurt remained constant while the control continued to decrease (Fig. 3).

Viscosity and syneresis of CGJ yogurt

Initial viscosity of CGJ yogurt and control was 3660 cp. During the first 2 wk of storage at 4°C, viscosity of the control increased. Although viscosity profile of CGJ yogurt was similar to controls, increase in viscosity for CGJ yogurt was lower than controls (Fig. 4). At the end of storage, controls had higher viscosity than CGJ yogurt and thus the addition of CGJ tended to yield a finished product with lower viscosity.

After 1 day storage 15 4 C, syneresis of the control (42%) was lower than the syneresis of CGJ yogurt (43%) (Fig. 5). Nevertheless, syneresis of CGJ yogurt increased up to 15 days storage at 4°C and stayed higher than control during the entire storage period. Lactic acid production was higher in control than CGJ yogurt and this lowered
the pH. The lower the pH of product, the more resistant the casein particles were to syneresis and thus when syneresis of controls decreased. Increase of acidity during fermentation and storage increased the curd stability because of the increase in water-binding capacity of proteins (Langton, 1991). CGJ addition increased (P < 0.05) the syneresis of yogurt, a detriment that would need to be overcome.

Reduction in viscosity or increase in syneresis is common for fruit yogurts (Akyüz and Coskun, 1995). Addition of fruit concentrate generally tends to decrease the consistency of products due to reduction in water-binding capacity of proteins. Such products are often stabilized with viscosity modifiers such as starches, gums, gelatins, pectins, etc. (Ramaswamy and Basak, 1992). Through further studies it may be possible to improve the texture of CGJ yogurt using stabilizers.

**Starter bacteria of CGJ yogurt**

Starter bacteria numbers in control yogurts were higher than that of CGJ yogurt following 1 day of storage and the influence of CGJ on starter bacteria was summarized (Fig. 6). Following 2 wk storage, the number of starter bacteria decreased (71%). Although CGJ can provide necessary sweetness, the hydroxymethyl furfural (HMF) content of CGJ may have inhibited growth of starter bacteria, Jay (1970) studied the composition of CGJ produced in Turkey and reported the HMF content was 100.8 mg/kg. Thus, the amount of CGJ used in yogurt may be critical to culture growth. Also, higher osmotic pressure and higher amounts of glucose in the medium (substrate inhibition) may cause loss of viability (Ramaswamy and Basak, 1992). No yeasts or molds were detected in any of the yogurt samples in these trials.

**CONCLUSION**

A NEW TYPE FRUIT YOGURT WITH A HIGH IRON CONTENT WAS PRODUCED. By use of this fruit, commercial yogurt could be enriched. Further work is needed to improve texture of CGJ yogurt possibly by using different stabilizers. The inhibitory effects of HMF on yogurt bacteria require additional investigation.

**REFERENCES**


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