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Effect of Grape Juice on the Physiochemical and Sensory Properties of Yogurt

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Abstract: *Fruit yogurt was prepared with the addition of grape juice and its effect of on the physicochemical, functional and sensory properties of yogurt was investigated. Yogurts with grape juice at a ratio of 3%, 5% and 7% were prepared and the properties were analyzed along with the control. The pH, syneresis, viscosity and firmness of yogurt were measured and the considerable changes were observed. The adhesiveness, taste, mouthfeel, color, flavor, texture and overall acceptability of grape juice added yogurt were analyzed. The pH value of yogurt was changed dramatically due to the addition of grape juice and it was decreased steadily by the increasing percentage of grape juice. Syneresis was higher in 7% grape juice added yogurt compared to those of no addition of grape juice. The viscosity was decreased with the increased concentration of grape juice. The firmness was increased with the increasing percentage of grape juice on yogurt. The sensory analysis revealed that there was no significantly different ($p<0.05$) between yogurt with added grape juice and that with no addition of grape juice. The consumer acceptance of 3% and 5% grape juice concentrated yogurt were higher than those of 7% grape juice concentrated yogurt. The 3% and 5% grape juice concentrations could be recommended for the industrial scale production of fruit yogurt.*

Keywords: *Grape juice, Syneresis, Viscosity, Firmness, Sensory evaluation.*

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I. Introduction

Yogurt has been the part of the human diet for thousands of years, and during that time a number of health benefits have been associated with its consumption. The goal of the First Global Summit on the Health Effects of Yogurt was to review and evaluate the strength of current scientific knowledge with regard to the health benefits of yogurt and to identify areas where further research is needed (Donovan and Shamir, 2014). The evidence base for the benefits of yogurt in promoting bone health, maintaining health throughout the life cycle, improving diet quality, and reducing the incidence of chronic diseases, such as obesity, metabolic syndrome, and cardiovascular disease, was presented (Shiby et al. 2013).

Yogurt gels are produced by the fermentation of milk with thermophilic starter bacteria consisting of a combination of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* (Tamime and Robinson, 1999). Yoghurt products have gained significant economic importance worldwide because of their high dietary content that can be increased further by adding nutraceutical ingredients (Guggisberg et al. 2007). The use of different fruits and additives in fruit yogurt production has enhanced its nutritional and sensory properties (Cakmakci et al. 2012).

Grape can be eaten fresh as table grapes or they can be used for making wine, jam, juice, jelly, grape seed extract, reisins, vinegar, and grape seed oil. The nutrients in grapes may help to protect against cancer, eye problems, cardiovascular disease and other health conditions. Resveratol is a key nutrient in grapes that may offer health benefits. Grapes are an excellent source of fiber, potassium, vitamins and other minerals (Wightman et al. 2015). Additionally, grape is providing us with conventional antioxidant nutrient like vitamin C, manganese and also filled with antioxidant phyto nutrients that range from common carotenoids like beta-carotene to unusual stilbenes like resveratol. Grape is also enriched with different antioxidant nutrients (Anastasiadi et al. 2010).

Grape juice is prepared from grapes by crushing and blending the fruit into liquid. Regular consumption of grape juice may reduce the threat of coronary heart disease and severe platelet thrombus creation (Folts et al. 1997). Grape fruits or foods produced from the fruit, as well as wine and grape juice, contain high amounts of different phenolic compounds, such as stilbenes, anthocyanin, catechins, flavonols and proanthocyanidins (Renaud et al. 1992). Foods or beverages enriched with phenolic compounds are

advantageous to human health in that they prevent cardiovascular diseases and different kinds of cancer (Delmas et al. 2006).

The physical attributes of yoghurts, including the lack of visual whey separation and perceived viscosity, are crucial aspects of the quality and overall sensory consumer acceptance of yoghurts (Mahomud et al. 2017). An understanding of the mechanisms involved in the formation of the texture in yoghurts and the impact of processing condition on texture development may help to improve the quality of yogurt.

Fruit flavored yogurts are prepared by adding fruit concentrates or flavored syrups or juice to cultured milk before or after incubation (Keating and White, 1990). The production and consumption of fruit yogurt is low in Bangladesh compared to plain yogurt, but yogurt is widely made and consumed in homes. There is no commercial production of Grape Flavored Yogurt in Bangladesh. It will be a suitable use of grape which has a short shelf life. The goal of this research is to investigate a new type of functional yogurt by adding grape juice. The objectives of the research work are to study the feasibility of formulation of yogurt using grape for the best formulation of yogurt and to analyze the effects of adding grape juice on physicochemical and functional properties, sensory properties of grape juice added set yogurt.

II. Materials And Methods

2.1. **Materials**

Several major ingredients such as skimmed milk powder, starter culture (YC-X11, Chr Hansen, Denmark) and sugar were collected from markets which were used for the preparation of yogurt.

2.2. Preparation of reconstituted skim milk

Reconstituted skim milks were prepared by dispersing 12 g of skim milk powder in 100 g of distilled water. Then the dispersion was agitated using a magnetic stirrer for 1 hour. Skim milk was heated in a thermostatically controlled water bath at 85^{o}C for 20 minutes. Then it was cooled with the help of ice water to normalize the temperature.

2.3. Preparation of grape juice

Fresh green grapes were collected from local market. The grapes were washed with clean water to remove dirt and other undesirable materials before use. Then the grapes were blended with Blender machine without adding water. After that the grape juice was sieved by a sifter. The grape juice was collected in a glass jar and used for yogurt preparation.

2.4. Preparation of starter culture

A commercial yogurt culture which consisted of mainly *Streptococcus thermophilus* and *Lactobacillus bulgaricus* with a few other probiotic strains, was used to prepare yogurt. Stock culture was prepared by transferring 130 mg of freeze dried culture to 1000 g of reconstituted skim milk and was incubated 35^{o}C for 10 hours and then stored.

2.5. Preparation of yogurt incorporating grape juice

Skim milk powder was used to prepare reconstituted milk with 12% (w/v) total solids. Icing sugar was added at 5%. The reconstituted milk was heated at 85°C for 30 min and divided into twelve equal batches and then cooled to (42±1) °C. After cooling, milk was inoculated with 2% (2 gm/v) active commercial yogurt starter culture and incubated at (37±1) ^{o}C for 12 hours in a Incubator (VS-8480 SN, Vision Scientific Co., Ltd., Korea). After cooling at room temperature, one batch of yogurt was taken as control and grape juice was added to the other batches of milk at 0%, 3%, 5%, and 7% respectively (Table 1) and furthermore mixed properly. Both the control and grape juice flavored yogurts were stored at 4^{o}C for further analysis.

Table 1 Basic Formulation of Yogurt on 100 ml basis of Total Ingredients

	Samples			
Ingredients	S1	S2	S3	S4
Milk (ml)	100	100	100	100
Grape juice (%)	0	3	5	7
Sugar (%)	5	5	5	5
Active yogurt culture (%)	2	2	2	2

S1= Control Yogurt, S2= yogurt produced by adding 3% grape juice, S3= yogurt produced by adding 5% grape juice and S4= yogurt produced by adding 7% grape juice.

2.6. Physio-chemical and functional properties of yogurt
The prepared yogurt samples were analyzed for pH, syneresis, viscosity and firmness.

2.6.1. **Determination of pH**
The yogurt samples were analyzed for pH and acidity using standard Association of Analytical Chemist procedure (AOAC, 2000).The pH of yogurt samples was measured by using through electronic digital pH meter (HI 2211, Hanna Instruments, Romania). The electrode of the pH meter was directly dipped in the set yogurt samples and the pH was recorded immediately after taking out the samples from the incubator. The pH meter was calibrated routinely with fresh pH 4.0 and 7.0 standard buffers (Behrad et al. 2009).

2.6.2. Syneresis analysis
The determination of syneresis was carried out 24 h after the completed fermentation (Wu et al. 2001). 10 g of the yogurt was spread in a thin layer to cover the surface of the Whatman No.1 filter paper. The yogurt was filtered under vacuum for 10 min. The liquid that passed through the filter paper was collected and recorded. The percentage of syneresis was calculated as the weight of the liquid divided by the weight of the initial sample multiplied by 100.

2.6.3. Viscosity analysis
The viscosity determination was based on Rawson and Marshall (1997) method, with some modifications. The gel was broken by stirring with a glass rod (10 times clockwise; 10 times anticlockwise). Rotational viscosity measurements were made using a Viscometer (Viscotech Hispania S. L., 43700 E Vendrell, Spain). Each measurement was made at room temperature at 100 rpm for 1 min.

2.6.4. Firmness analysis
Firmness of the yoghurt samples was measured with an instrumental compression/penetration test (Carson et al. 2002), using a texturometer (GY-4, Yueqing Handpi Instruments Co., Ltd., China) equipped with high precision sensor. The pretest, test and post-test speed were 1.0 mm/s. The depth of the yoghurt was 12 mm. Firmness was expressed as the maximum force as the test cell penetrated to a depth of 10 mm into the sample, as described by Mohamed and Morris (1987). The mean of three determinations was calculated for each yoghurt sample.

2.7. Sensory analysis
Formulated yoghurt of various combinations was judged by a semi-trained sensory panel comprising of faculty members and students. Eight sensory characteristics of the product i.e. adhesiveness, taste, mouthfeel , color, flavor, texture and overall acceptability were evaluated using 1- 9-point hedonic scale (9= Like extremely; 1=dislike extremely) (Peryam et al. 1952). Each sample weighing 5g under chilled condition was presented to panelists in identical plastic cups labeled with random numbers and in random order. The panels recognized the yogurt only by codes. Sensory panelists were instructed to rinse their mouth by drinking plain water after assessment of each sample.

2.8. Statistical analysis
One way analysis of variance (ANOVA) was used to compare mean of three replications. Significant differences between means were determined by Duncan ($P < 0.05$). The software used was SPSS program (IBM, version 22).

III. Results and Discussions

3.1. Effect of grape juice on the pH of the yogurt

Grape is highly acidic fruit. Before incubation, the lowest pH (6.38) of S4 and highest pH (6.51) of control were recorded. With the increasing percentage of grape juice, the pH of the yogurt samples was decreased gradually. Table 2 showed that lowest pH (3.73) and highest pH (3.82) were observed belong to yogurt sample S4 and control respectively after incubation. S4 sample was found to be more acidic among these yogurts because of its lowest pH. Fruit juices were acidic so that they increased acidity in yogurts.

Table 2. Variation of pH with different concentration of grape juice of skim milk yogurt

Sample	pH (before incubation)	pH(after incubation)
S1	6.51 ± 0.48^a	3.82 ± 0.15^a
S2	6.45 ± 0.31^a	3.80 ± 0.11^a
S3	6.40 ± 0.21^a	3.78 ± 0.07^a
S4	6.38 ± 0.12^a	3.73 ± 0.04^a

Here, S_1= Control Yogurt, S_2= yogurt produced by adding 3% grape juice, S_3= yogurt produced by adding 5% grape juice and S_4= yogurt produced by adding 7% grape juice.

*Mean values ± standard deviation (SD)
*Means followed by different superscript letters within a column are significantly different at 5% level of significance

3.2. Effect of grape juice on the syneresis of the yogurt

Syneresis was expressed as the volume of separated whey per 100 ml of yogurt (Wacher et al. 1993). Syneresis is defined as the expulsion of whey from the network which then becomes visible as surface whey. Syneresis negatively affects consumer perception of yogurt as consumers think there is something microbiologically wrong with the product. Addition of fruit juice 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). Spontaneous syneresis, which is contraction of gel without the application of any external force (e.g., centrifugation), is the usual cause of whey separation (Lucey et al., 1998). Figure 1 revealed that syneresis was gradually increased with the increase of grape juice percentages. The syneresis of control was observed 4.67 % (wt/wt) and the highest syneresis was recorded 5.0 % (wt/wt) for Sample 4. The syneresis of the control was lower than the syneresis of grape juice yogurt. Lactic acid production was higher in control than grape juice yogurt and thus lowered the pH. Increase in syneresis is common for fruit yogurts (Akyüz et al., 1995).

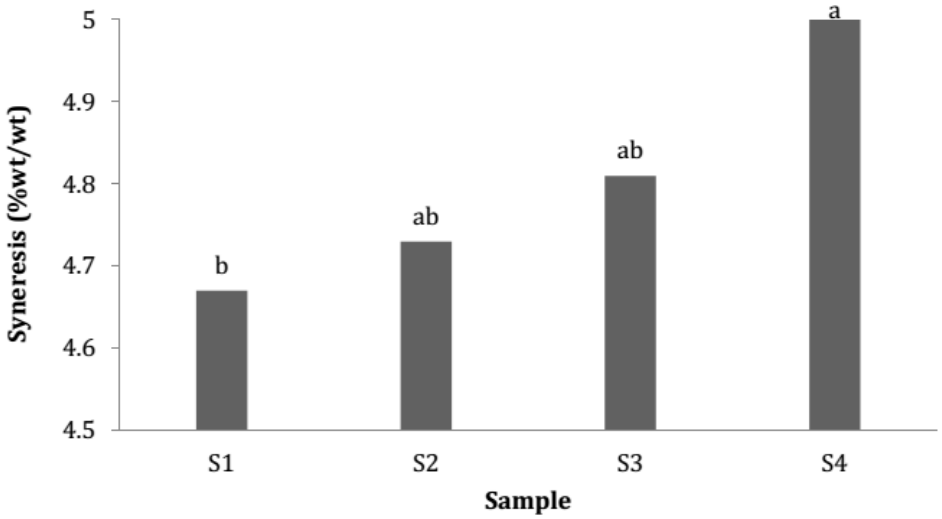

Figure 1. Effects of different concentration of grape juice on syneresis of the yogurt

3.3. Effect of grape juice on the viscosity of the yogurt

From Figure 2, it can be said that the viscosity of grape juice yogurt is lower than the viscosity of control. The water binding capacity of protein is decreased with addition of grape juice. Addition of grape juice reduced viscosity of yogurt in which 7% grape juice (w/w yogurt) sample had the lowest value of 143.33 mPas while it was 183.33 mPas in the control. This result was probably because stirring high concentration of grape juice in yogurt broke down the coagulated milk thus reducing the viscosity. Ramaswamy and Basak (1992) exclaimed that the addition of grape juice or fruit concentrate generally decreased the consistency of the products owning to reduce water binding capacity of the proteins. Almost every processing step in the manufacture of yogurt can affect the viscosity of the finished product (Keating and White, 1990). The increased viscosity could regard as recovery of structure or rebodying (Lee et al. 2010).

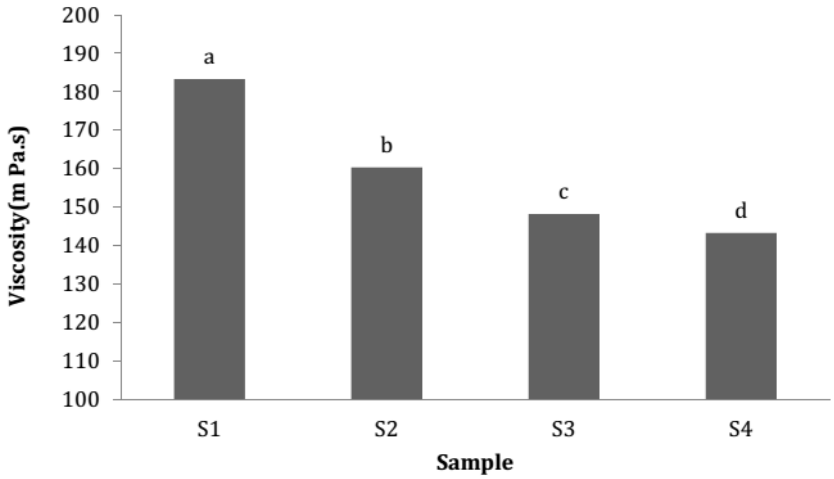

Figure 2. Variation of viscosity of skim milk yogurt with different concentration of grape juice

3.4. Effect of grape juice on the firmness of the yogurt

Firmness is a very important quality parameter in yoghurt. Measuring the firmness of the set-type yoghurt is very important, which represents its resistance to rupture, i.e., the yield point of the structure as determined by a compression-type test Marshall (1992). Gel firmness can be measured at a predefined time or at a predefined depth or until a point of gel breakage occurs i.e. yield point (Fiszman et al. 1999). From Figure 3 it was observed that the highest firmness of S4 was 5.57(N) and the lowest value of firmness of control was 4.83(N) was recorded. Due to the addition of the solids in the samples supplemented with a 7% (w/w) grape juice the firmness of the yogurt is increased than control yogurt sample. Higher firmness values resulting from an increase in total solids have been previously exclaimed by other authors (Mahdian and Tehrani, 2007). Yield stress would be more appropriate to explain the texture of yogurt in product development, since several methods that allow a quick and direct determination of yield stress are available (Ares et al. 2006). These phenomena could explain the lower texture values of the S1 sample. Other studies have exclaimed that fat globules coated with proteins have remarkable effect on yogurt texture (Lucey et al. 1998; Sandoval-Castilla et al. 2004).

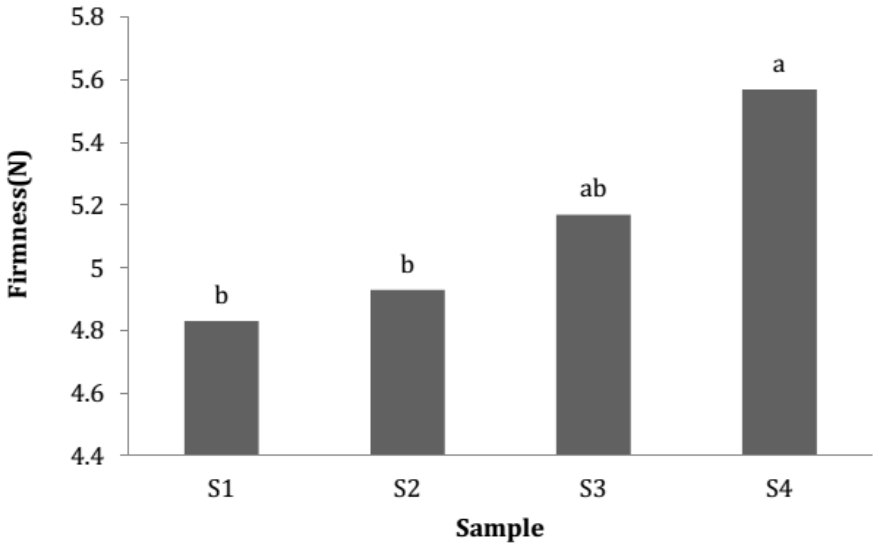

Figure 3. Variation of firmness of skim milk yogurt with different concentration of grape juice

3.5. Effect of grape juice on the sensory attribute of the yogurt

For evaluation of yogurt samples containing grape juice, color, flavor, texture, taste, mouthfeel and adhesiveness were used to assess the acceptability of yogurts containing 3%, 5% and 7% grape juice. The mean score with standard deviation for all parameters of the samples are given in Table 3. The results revealed that the samples are not significantly different at 5 % level of significance for all the parameters. A slight increase in the

colour scores of grape based yoghurt correlated with an increase in percentage of grape juice except sample 4. For flavour the samples got near about same score. Table 3 showed that with the increase of grape percentage there is an increase of score for texture and taste. For mouthfeel scores are decreasing with the increase of grape juice percentages. The sample S2 incorporated is obtained the highest score (7.17±1.11) and sample S3 is securing (6.9±0.90) is nearly acceptable as control yogurt. As shown in Table 3 sample S1 obtained highest score (7.25±1.05) and samples S2 and S3 secured same score (7.08±0.66) which is equally acceptable as control yogurt for overall acceptability. Finally, it is clear that all the samples are equally acceptable. So, grape juice can be incorporated in yogurt as considering the health beneficiary properties of grape. But, too much amount of grape juice (more than 5 %) can reduce the water holding capacity of grape.

Table 3: Effect of different concentration of grape juice on the sensory properties of yogurt

Yogurt Sample	Color	Flavor	Texture	Taste	Mouthfeel	Adhesiveness	Overall acceptability
S1	7.67±0.65[a]	7.17±0.83[a]	6.92±1.31[a]	6.83±1.19[a]	7.25±1.05[a]	7.00±1.04[a]	7.25±1.05[a]
S2	7.67±0.65[a]	7.33±0.77[a]	7.17±0.93[a]	6.92±0.79[a]	7.08±0.66[a]	7.17±1.11[a]	7.08±0.66[a]
S3	7.75±0.75[a]	7.17±1.11[a]	7.20±1.12[a]	7.00±0.85[a]	7.08±0.66[a]	6.90±0.90[a]	7.08±0.66[a]
S4	7.58±0.51[a]	7.17±1.19[a]	7.42±0.79[a]	7.08±1.24[a]	6.92±0.79[a]	7.08±1.24[a]	6.92±0.79[a]

*Mean values ± standard deviation (SD)

*Means followed by different superscript letters within a column are significantly different at 5% level of significance

IV. Conclusion

In the last decades, the market share of fruit-flavored yogurt has increased extensively. Aside from promoting human health grape juice plays important role as antioxidant and antimicrobial agent to extend the shelf life of yogurt. Considering these health benefits grape juice was used for making skim milk yogurt and find out the best formulation suitable for the production of yogurt. Yogurts were prepared using grape juice at 3%, 5% and 7% concentrations respectively and sensory analysis revealed that the samples are not notably different at 5 % level of significance. The yogurts were prepared using grape juice at 3% and 5% concentrations are equally acceptable to the consumers in lieu with the control. Sample 4 was also acceptable with the other samples but there is a risk of too much whey exudation. In this study a new type of fruit yogurt with grape juice was prepared and demonstrated that the addition of increasing levels of grape juice in the yogurts affected slightly to the quality attributes. Finally, the findings of the present study may help in developing commercial processing technology for effective utilization of grape juice for manufacturing of yogurts. By use of this fruit, commercial yogurt could be enriched. Further work is needed to improve the texture of grape juice yogurt possibly by using different stabilizers. At last, food and beverages can be enriched using grapes.

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