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Optimization of the Effect of Grape Syrup on the Fruit Filling in Comparison with Fructose Syrup and Sorbitol Syrup, and Evaluation of Their Physicochemical Properties

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ABSTRACT

Grape syrup is the primary product of grape processing industries which has been evaluated in this study as a natural substitute with antioxidant activity. This study investigates the effect of grape syrup in preventing further hardness in fruit fillings and the loss of spreadability due to sugar crystallization, compared to fructose and sorbitol syrups. In this context, the optimal formulation of fruit filling using a simplex lattice design was tested with various percentages of grape syrup, fructose syrup, and sorbitol syrup (at levels of 0, 6.37%, 12.73%, 19.1%, 25.47%, and 38.2%) based on texture analysis. Penetration testing was conducted using a texture analyzer, and the optimal treatments were evaluated on days 0 and 30 after production using various tests. The results on day 0 indicated that grape syrup significantly ($p < 0.05$) softens the texture of the fruit filling. Thirty days after production, the optimized formulation exhibited favorable performance, with a moisture content of 13.42%, water activity of 0.38, and °Brix of 31.80. The findings suggest that 38.2% grape syrup, due to its phenolic compounds (62.75 mg gallic acid per gram) and antioxidant free radical scavenging activity (22.54%), is suitable for producing fruit fillings.

1- INTRODUCTION

grape (*Wine grapevine* L.) is considered one of the most important horticultural crops in the world, which is of great importance in the agricultural economy [1] and Because of the beneficial effects on human health It is widely cultivated and consumed around the world.[4]. Among the products obtained from grapes are raisins, grape juice, grape seed oil, grape seed extract, vinegar, grape juice and grape juice. In Turkey, about 30% of grapes are used in the production of juice [1]. In Iran, according to reports from the Ministry of Agricultural Jihad, about 25%. Grapes produced in traditional processing are used to make juice, which indicates a potential in the food and traditional products industry [1]. Grape juice is a traditional product that is widely produced from fruits containing high amounts of sugar, such as grapes, dates, berries, figs, plums, apricots, and sugar beets [2, 3]. This processed product from grapes It has characteristics such as dark color, high sweetness, and sticky texture, which is traditionally produced through boiling and concentration. Grape juice can be used for various applications due to its Brix of around 69 [4]. For example, grape juice can be used as a sugar substitute in the production of products such as bread, pastries, and other bakery products.. It is also used as a flavoring agent or to increase nutritional value (as an alternative source of iron for people with anemia) [4, 5]. Considering the nutritional value and traditional uses of grape juice, it is of particular importance to investigate its use in the formulation of new food products. It can also be used as an anti-crystallization agent due to the presence of different types of sugars. Bakery and confectionery products containing natural fruit fillers are a popular food worldwide and are well accepted by consumers of all ages. Fruit fillers are usually composed of sugar, humectants, stabilizers and fats. Depending on the final application of the fruit filler, the ratio of ingredients and their type can vary significantly. Stabilizers and humectants are two essential ingredients that determine the structure and water activity of fillers [6]. Previous studies have investigated the effect of highly esterified pectin and modified tapioca, potato and waxy maize starches on fruit cores. Their results showed that pectin has a higher ability than all types of starch

to prevent gel syneresis [7]. Goodlow et al. (2014) showed that the use of a mixture of tapioca starch and low-methoxyl pectin increases temperature and frost resistance in fruit cores [8]. In 2022, Kurt et al. investigated the characteristics of candies produced using grape, blackberry and carob juices, and according to the physical and sensory tests performed, it was determined that the best textural and sensory properties were obtained using grape juice. Textural parameters are influenced by the amount and quality of some of the ingredients present in the fruit filling system. Hardness is directly related to the percentage of hydrocolloids and soluble solids, while cohesion and chewiness are more related to the molecular weight of complex carbohydrates. In this regard, the use of grape juice as a natural sweetener in fruit fillings can be a healthier alternative to common syrups and play an important role in improving nutritional quality. Therefore, given the importance of fruit fillings on the characteristics of the final product The aim of this research is to optimize the amount of grape juice used and compare it with fructose and sorbitol syrups in jam fillings from the perspective of physicochemical and thermodynamic properties.

2-Materials and methods

1-2-Materials

High methoxyl pectin (2.65 = degree of methoxylation) was purchased from Degussa France, fructose 55% with Brix 77 was purchased from Zarnam Company (Hashtgerd, Alborz, Iran). Other raw materials including sugar (Debal Khazaei, Khuzestan, Iran), sorbitol syrup 70% (Gujarat Ambuja, India), glycerin (Timor, Selangor, Malaysia), fig puree (Dehlar, Urmia, Iran), palm oil (Behshahr, Tehran, Iran), orange fiber (Cargill, USA), citric acid (Cisaron Chemicals, Khorasan, Iran), grapes (Bidane Sefid variety, Malayer, Iran) and certified white soil (Malayer, Iran) were purchased from their suppliers.

2-2-Methods

1-2-2- Grape pomace production process

White grapes (Bidaneh) *Vitis vinifera* L.) were collected directly from Malayer city, Hamedan province (Iran) in the summer of 2019. The grapes were washed and separated from the pulp and seeds using an industrial press to extract the grape juice. Then, the juicy pulp was dried in an oven at 60°C for 4 hours (Sweden, Sveba Dahlen, Fristad, D-2). Finally, the grape pomace particles were ground using a grinder (Iran, Hard stone,

GCS2700) were crushed so that 80% of the particles passed through a 200 mesh.

2-2-2- Grape juice production process

The resulting grape juice was mixed with white soil in a ratio of 1:10 and stirred until the foams disappeared. Then it was left for 6 hours to allow the soil to settle. In the next step, the soil was separated from the grape juice using a multi-layered cloth. Finally, the grape juice was filtered and heated to obtain grape juice with a Brix of 70.

3-2-2-The brain production process

Initially, pectin (1 g) was mixed in the entire amount of sugar (19.41) and poured into the thermomixer in which the fructose syrup had previously been heated to 60 °C and mixed at a speed of 300 rpm. The final temperature of the thermomixer was set to 90 °C. After the pectin was completely mixed, other powdered

ingredients including citric acid (0.35 g), orange fiber (0.04 g) and fig puree (22 g) were added and mixed until completely homogenized. After this step, glycerin (15 g) was added along with other liquid ingredients and homogenized at a speed of 200 rpm. Then palm oil (4 g) was added and after mixing for one minute, the kernel was discharged [9]. Optimal formulation of jam kernel using the simplex lattice design¹ and different percentages of grape juice, fructose syrup and sorbitol syrup (at levels of 0, 6.37, 12.73, 19.1, 25.47 and 38.2%) and the most desirable tissue response was selected. Table 1 shows the different treatments of this stage. The experimental design included 14 treatments with three replications for each treatment, which was implemented based on a simplex grid design and was obtained based on preliminary laboratory tests.

Table 1. Produced jam fillings with different ratios of grape syrup, fructose, and sorbitol syrup (%)

Sorbitol syrup	Fructose syrup	Grape syrup	Code of samples
38.2	0	0	A ₁
0	0	38.2	A ₂
0	38.2	0	A ₃
19.1	0	19.1	A ₄
19.1	19.1	0	A ₅
0	19.1	19.1	A ₆
25.47	6.37	6.37	A ₇
6.37	6.37	25.47	A ₈
6.37	25.47	6.37	A ₉
12.73	12.73	12.73	A ₁₀
38.2	0	0	A ₁₁
0	0	38.2	A ₁₂
0	38.2	0	A ₁₃
19.1	0	19.1	A ₁₄

4-2-2-Texture measurement

In order to find the optimal response, a penetration texture test was performed using a texture tester (TA.XT Plus, Stable micro systems UK,) equipped with a probe with a diameter of 0.25 was performed on the introduced treatments. The test conditions included pre-test speed, post-test speed, and interval (time interval between two sample compression cycles) of five, five, and three millimeters per second, respectively. The penetration test was performed

on days zero and 30 after production [10]. After determining the optimal amounts of grape juice, fructose syrup, and sorbitol syrup in the jam core, it was compared with the control treatment that contained only fructose syrup.

5-2-2-Humidity and water activity

The moisture content and water activity of the jam kernel samples were measured before and after cooking. For this purpose, 3 grams of the sample were placed in a Fandar oven at 120°C for 60 minutes. Then, the samples were

¹-Simplex lattice

transferred to a desiccator and cooled to ambient temperature. Finally, the samples were weighed. The moisture content was calculated by comparing the weight of the sample before and after heating with equation 1 [11]:

$$\text{Relationship (1)} \quad 100 \times \frac{\text{Initial weight} - \text{final weight}}{\text{Initial weight}} \times \text{Humidity (percentage)}$$

To measure water activity, an automatic water activity measuring device (Labmaster, Novasina, Switzerland) was used.

6-2-2-Brakes

Brix level using a refractometer (PTRP100, METTLER TOLEDO, Switzerland) Done.

7-2-2-Phenolic compounds

To determine the amount of total phenolic compounds² (TPC) from Folin's method–Cicaltio³ Microtubes containing 40 µL of sample, 960 µL of distilled water, 100 µL of 50% Folin-Cicalteo reagent and 300 µL of 10% disodium carbonate solution were combined and placed in the dark for two hours. Then the absorbance at 765 nm was determined. The concentration of each extract was determined using a gallic acid standard curve.⁴ (TO(Calculated in the range of zero to 500 ppm and results expressed as milligrams of gallic acid per gram of sample)mg GAE/g) was shown [12].

8-2-2-Antioxidant properties

2,2-Diphenyl, 1-picrylhydrazyl solution⁵ (DPPH) (60 µmol) was prepared in methanol. Three milliliters of solution DPPH It was mixed with 100 µL of sample solution. The solutions were kept in a water bath at 35°C for 15 minutes. The absorbance of the solutions was recorded at a wavelength of 515 nm and the amount of radical inhibition was determined. DPPH It was calculated using the following equation [13].

$$\text{radical inhibition(\%)} = \frac{\text{DPPHFree} \times \frac{A_1 - A_2}{A_1} \times 100}{100} \quad (2)$$

8-2-2-Thermal properties

Thermal analyses of jam brains using a differential scanning calorimeter (DSC)USA, Wellesley, PerkinElmer, Pyris 6) was performed. For each measurement, 45-50 mg of sample was sealed in an aluminum plate. Before starting the scan, a hole was made in each sample plate to allow water evaporation. An empty plate served as a reference. The samples were heated from -70 to 400 °C at a rate of 10 °C/min to analyze all the thermal transformations that occur in the jam core over a wide range of temperatures.

9-2-2-Temperature stability test

Thermal stability test of fruit kernels as a practical test⁶ and loop test⁷ was carried out. In the practical test, the physical state of the kernels was examined after baking for 10 minutes at 200 degrees Celsius. If the kernels spilled out from the edge of the product, it was concluded that the kernels were not heat-resistant, otherwise they were heat-resistant. In the ring test, a small circle of kernels was placed in the center of a larger circle, and the distance between the circumference of the small circle and the circumference of the larger circle was measured, and it was exposed to 200 degrees Celsius for 10 minutes. Then the same distance was measured again. If there was no change, it indicates that the kernels are heat-resistant. In this way, the baking index was corrected⁸ It is also called and is calculated based on equation 3 [9].

$$\text{Relationship (3)} \quad \text{Percentage based on cooking index} = 100 - \frac{D_2 - D_1}{D_2} \times 100 \quad \text{Cooking index in percentage}$$

In this regard:

D1 Indicates the average diameter of the sample before baking in millimeters.

D2 Indicates the average diameter of the sample after baking in millimeters.

2-3-Statistical analysis

To obtain the relationship between fructose syrup, grape juice, and sorbitol syrup as crystallization inhibitors, a test was also

2- Total phenolic content

3- Folin-Ciocalteu

4- Gallic acid

5- 2,2-diphenyl-1-picrylhydrazyl

6- Application test

7- Ring test

8- Bakery index

conducted using Design Expert software.⁹ Using the planSimplex lattice The tests were conducted in a completely randomized design. One-way analysis of variance (ANOVA) was used.¹⁰ (ANOVA) using statistical software SPSS Version 20 was performed at a 95% probability level. Duncan's test was used to examine the significance of the difference in means. In order to reduce error, all measurements of these sections were performed in triplicate.

3-Results and Discussion

3-1-Nutritional properties of jam with grape juice

At this stage, the optimal treatment was selected based on the best texture (softness) using the penetration test. By examining the results obtained from the test to evaluate the resistance to penetration of jam kernels on day zero (Figure 1a), it was determined that the kernels produced with sorbitol syrup on the first day of production were the softest samples, followed by the treatments prepared with grape syrup and fructose syrup, respectively. However, the difference between the treatments prepared with sorbitol syrup and grape syrup was not statistically significant ($0.05 > p$), but the difference between the two was significant with the treatment containing fructose syrup ($0.05 < p$). The reason for this may be attributed to

the difference in the amount of water in these syrups and, as a result, the higher fluidity of the nuts prepared with them compared to those produced with fructose syrup [14].

The results obtained from the test on the jam treatments on day 30 after production (Figure 2b) indicate that although fructose syrup performed slightly better than grape juice in terms of preventing crystallization and hardening of the jam jam, there was a significant difference ($p < 0.05$). p do not have each other. Meanwhile, the use of sorbitol syrup alone was significantly ($0.05 < p$) caused the jam core to become firmer after one month of storage, which could be due to the lower diversity of sugars in sorbitol syrup and as a result, fewer impurities entering the food matrix, which led to a higher crystallization ratio of sugars in the jam core tissue and a firmer texture of this core, which is clear in the figure [15]. However, as is also clear from this figure, the optimum softness level is achieved when 37.6% of sorbitol is also used in combination with fructose syrup or grape juice or a combination of the two, which actually covers the deep blue areas. The results obtained for the hardness of jam cores are consistent with the quadratic model and with the amount of R^2 . The obtained value of 0.97 confirms the accuracy of the model and the obtained results.

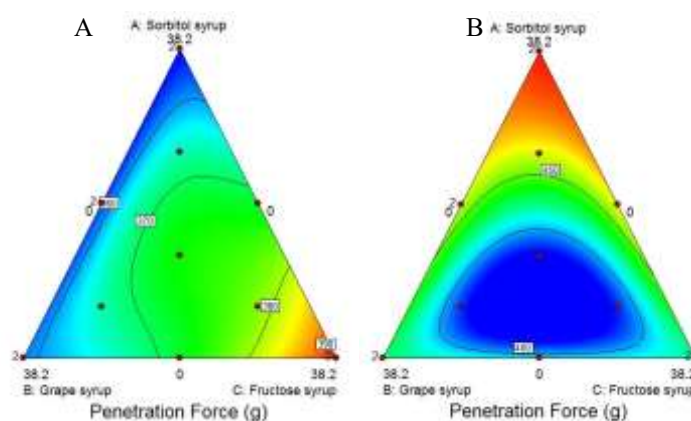


Fig. 1. Results of the penetration force test in the treatments at day 0 (A) and day 30 (B) after production

According to the results obtained, optimizing the ratio of grape juice use by considering the parameters of the amount of sorbitol syrup and fructose syrup used in the range of 0 to 38.2 percent, statistical prediction is shown in Figure

2 and the predicted values for sorbitol syrup, grape juice, fructose syrup and penetration force were 5.994 percent, 20.785 percent, 11.421 percent and 362.261 grams respectively. By producing the optimal treatment and maintaining

9 -Design Expert

10- Analysis of variance

it for 30 days and then measuring the value of the penetration force parameter, the number 374.87 grams was obtained, which was not statistically significantly different from the predicted result

(0.05).>p) and considering the insignificant fitting number, therefore, the model and the obtained result are validated.

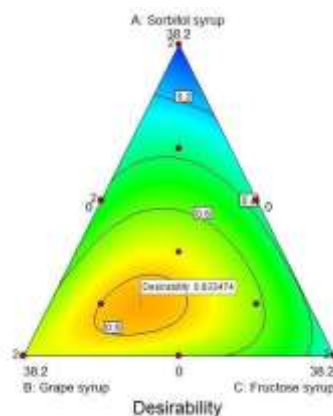


Fig. 2. The desirability region of softness using grape syrup, fructose syrup, and sorbitol syrup in fruit filling.

3.2-Moisture, water activity and Brix

The results of moisture content, water activity and Brix of different jam core samples are shown in Table 2. The moisture content in the optimal jam core containing different percentages of grape juice, sorbitol syrup and fructose syrup decreased insignificantly, which could be due to

the lower moisture content (20.6) in date juice compared to fructose syrup (22.9%). The optimal core moisture content on day 0 was 13.48 (grams per 100 grams of sample), which decreased by 0.06%. The water activity value of the jam core sample did not change over time. In the optimal jam core, the Brix decreased from 34.80 to 31.80, which was not statistically significant.

Table 2. Moisture content, water activity, Brix, total phenolic compounds, and DPPH free radical scavenging activity of the produced fruit filling

Day	Moisture content (%)	Water activity	°Brix	TPC (mg GAE/g)	DPPH (%)
0	13.48±0.83 ^a	0.38±0.01 ^a	80.34±1.09 ^a	107.23±1.45 ^a	39.45±1.03 ^a
30	13.42±0.49 ^a	0.38±0.02 ^a	80.31±1.01 ^a	62.75±1.97 ^b	22.54±0.22 ^b

Different letters indicate statistically significant difference between days of storage at $p < 0.05$.

3-3-Polyphenolic compounds and antioxidant properties

Phenolic compounds in foods can enhance the body's cellular defenses and protect against oxidative damage [16]. Phenolic compounds, which also have antioxidant properties, are also important for increasing the shelf life of foods [17]. The study of antioxidant properties has been carried out by various methods, because

antioxidant properties occur through multiple pathways [17, 18].

The amount of phenolic compounds and also the antioxidant properties of the optimal jam are shown in Table 2. On day zero and after 30 days of storage, there was a statistically significant difference (0.05).>p(No significant difference was observed in the amount of phenolic compounds and antioxidant properties. As can be

seen in Table 2, the amount of phenolic compounds after adding grape juice to the jam kernel in the optimal treatment increased to 107.23 (mg GAE/g) has been reached. Also, regarding the antioxidant properties, the inhibition rate DPPH In the optimal treatment, which contains high amounts of grape juice, it reached 39.45%. The increase in the amount of phenolic compounds and DPPH In the optimal treatment, it is due to the presence of various phenolic compounds in grape juice [19]. Studies have shown that grape polyphenols are mainly flavonoids (anthocyanins and flavonols), phenolic acids (gallic acid, syringic acid) and stilbenes (trans-resveratrol, ϵ -viniferine) [20]. The high content of phenolic compounds and antioxidant properties can help protect the jam kernel against oxidation and spoilage [21]. Various laboratory studies have been conducted to evaluate the relationship between polyphenols and the viability of probiotic bacteria. Reports have shown that polyphenols have shown antimicrobial effects against pathogens but growth-promoting effects on probiotics [22].

3-4-Thermal properties of jam kernels

As can be seen in Figure 3, the curves DSC Fruit kernels exhibit the following thermal properties: Glass transition temperature (T_g), boiling point (T_b), caramelization temperature (T_c) and thermal degradation temperature (T_d). The thermal properties of fruit nuts mainly depend on the gel

strength and polysaccharide network formation in their composition, which are significantly affected by the moisture content and the type of sweetener used in the fruit nut composition [23]. Considering the lack of effect of calcium ions and the minor effect of pH Based on the thermal properties of the final product reported in previous studies [9], it can be said that the thermal behavior of jam kernels is mainly influenced by the amount and composition of their soluble solids. As can be seen, in the optimal jam kernel, due to the Brix above 70, there is no ice melting peak, and the caramelization peak is well expressed and high values of thermal degradation temperature are also observed, which indicates that the kernel can be placed in the group of heat-resistant kernels, which is also consistent with the results of Kropotova et al. [9]. The reason why these jam kernel samples, with a high soluble solids content (70° Brix), do not have an ice melting peak in the diagrams DSC was that all the water in them was probably bound for freezing by carbohydrates [24]. Hydrocolloids and high levels of sugars strongly bind water molecules from the liquid phase of the product, making them less dynamically mobile and less likely to cluster together to form ice crystals [25]. The water bound by polysaccharides in high-soluble solids cores is thermodynamically “unfrozen,” as can be seen from the thermogram where no peaks are detected.

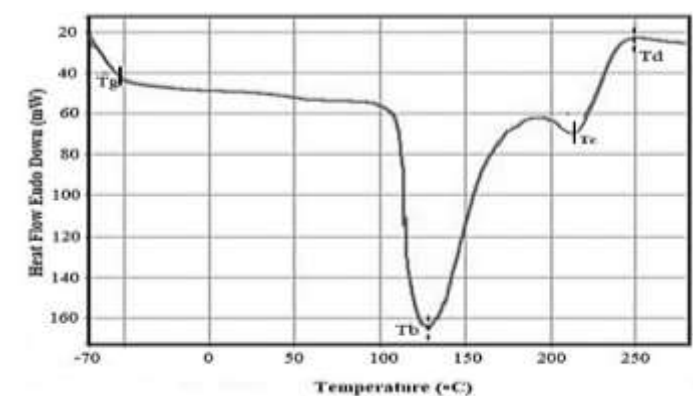


Fig. 3. DSC curve of the optimized fruit filling containing grape syrup.

The experimental results of thermal analysis of the optimal fruit pulp containing grape juice are shown in Table 3. As can be seen from Figure 3 and Table 3, T_g The optimal treatment containing grape juice was negative, indicating that grape juice had a significant effect on preventing jam

kernel crystallization. The moisture content of fruit kernels strongly affects their glass transition temperature [26]. Therefore, kernels with high moisture content (Brix 50 and below) had lower amounts of T_g . They have lower moisture content than nuts (Brix level above 70), because the water from their ingredients acts as a strong

plasticizer and T_g The higher the water content, the greater the degree of water plasticization of biopolymers within a fruit core matrix at the molecular level, leading to a decrease in dynamic viscosity and a decrease in T_g. As a result, by reducing the amount of T_g, the rate of crystallization increases. In fact, T_g of the fruit core decreases with increasing water content in its formulation, which is consistent with the results obtained from moisture content [9].

A large peak corresponding to the boiling point resulting from the evaporation of water under applied heat in the curves DSC. Both types of fruit kernels are observed. The shape of this peak appears to be the same in both samples. The thermal decomposition of fruit kernels begins with the removal of water and melting of the sugars, which occurs between 125.43 and 133.1°C, and ends with strong chemical

transformations that occur in the amorphous state of the sugars at temperatures above their melting point. Further thermal destruction of the jam kernel matrix, which is shown in the curve DSC. It has been shown to result from the thermal degradation of polysaccharides, which have much higher molecular weights than simple sugars. Therefore, thermal degradation of brains results in an exothermic peak in the curve DSC and then converts to a normal weight loss due to changes in the mass of the brain sample [26]. In addition, a small endothermic peak is observed in the curves DSC. The fruit kernel is observed before the main peak of exothermic thermal degradation. Considering the fact that this peak occurs directly after the boiling point and is therefore clearly visible in the curves DSC, it may be traced to the caramelization temperature of sugars (T_c), which is done after melting them in a sugar-rich environment [9].

Table. 3. Experimental results of thermal analysis of fruit filling

Temperature °C/W	T _d (peak) °C	ΔH _b J/g	T _b (peak) °C	C _p (J/g·°C)	T _g (peak) °C
1274.13±0.93	250.53±1.65	328.56±1.93	132.14±1.52	1.43±0.09	-61.73±0.41

Mean values and standard deviation (n=3) of thermal properties of fruit filling. T_g: glass transition temperature, C_p: specific heat capacity, T_b: boiling point, ΔH_b: water vaporization enthalpy, T_d: thermal degradation temperature, Θ: thermal stability.

3.5- Temperature stability test

Designing stabilizing systems containing different polysaccharides that add value to the final product is a major goal for food manufacturers who produce heat-stable jams, jellies, and jam fillings for various applications. Jam fillings require thermal stability against heat exposure during cooking [23]. Therefore, the optimal jam fillings for cooking stability were analyzed to evaluate whether they can maintain their original shape during cooking. Standard jam filling WITH A It was equal to 100%, which indicates good stability of the jam produced.

4- Conclusion

According to the results obtained, it can be concluded that grape juice can act like fructose syrup in terms of technological properties. It was also observed that in terms of this property, grape juice had a better effect than sorbitol

syrup. Although grape juice can act as well as fructose syrup, it was observed that these three compounds together and in certain amounts can have a greater effect in preventing the formation of sugar crystals and, as a result, firmness of the texture; because increasing the amount of impurities always acts in the direction of increasing entropy and reduces the possibility of sugar molecules joining together. The use of grape juice also increases the antioxidant properties of jam kernels by increasing the amount of phenolic compounds. The results of this study evaluate the use of grape juice at a rate of 38.2% in jam kernel formulations positively.

Conflict of interest

There are no items to declare.

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Authors' Contributions

All authors contributed to the design, writing, and approval of the final version.

Artificial Intelligence Statement

Artificial intelligence was not used in the preparation and writing of this study.

5-Resources

- [1] Akan, L. S. (2018). Original paper production and characteristics of a traditional food: Molasses (Pekmez). *Food Science and Nutrition*, 2(2), 25-32.
- [2] Güçlü, H. I., Yücel, P., & Ocak, S. B. (2023). Optimization of an Adulteration Detection Technique in Grape, Carob, Fig, and Mulberry Molasses (Pekmez) Based on Physicochemical Properties. *ACS Food Science & Technology*, 3(10), 1768-1776.
- [3] Başaran, B., Kanbur, E., Birinci, C., & Aydın, F. (2021). Determination of acrylamide and 5-hydroxymethyl-2-furfural (HMF) levels and related parameters in Turkish pekmez (a traditional fruit product). *Journal of food quality and hazards control*.
- [4] Helvacıoğlu, S., Charehsaz, M., Erdem, O., & Aydın, A. (2021). Assessment of toxic element content of some grape molasses produced by conventional and industrial techniques: insights into human safety. *Toxin Reviews*, 40(4), 1198-1205.
- [5] Bilgicli, N., & Akbulut, M. (2009). Effects of different pekmez (fruit molasses) types on chemical, nutritional content and storage stability of cake. *Journal of Food Quality*, 32(1), 96-107.
- [6] Saberi, F., Karami, M., Shiri, A., Rasouli, M., Karimi, R., & Kieliszek, M. (2024). Using grape pomace powder as a pectin replacer to prepare low water activity bake-stable fruit filling. *Journal of Food Measurement and Characterization*, 1-9.
- [7] Janna, C., & Svetlana, P. (2013). Influence of different hydrocolloids on physicochemical and heat-stable properties of fruit fillings. *The Annals of the University Dunarea de Jos of Galati. Fascicle VI-Food Technology*, 37(2), 59-67.
- [8] Agudelo, A., Varela, P., Sanz, T., & Fiszman, S. (2014). Formulating fruit fillings. Freezing and baking stability of a tapioca starch-pectin mixture model. *Food Hydrocolloids*, 40, 203-213.
- [9] Cropotova, J., Tylewicz, U., Rocculi, P., Popel, S., & Dalla Rosa, M. (2017). Thermal properties of fruit fillings as a function of different formulations. *Food Structure*, 14, 85-94.
- [10] Momchilova, M., Zsivanovits, G., Milkova-Tomova, I., Buhalova, D., & Dojkova, P. (2016). Sensory and texture characterisation of plum (*Prunus domestica*) fruit leather. *Bulgarian Chemical Communications*, 48, 428-434.
- [11] Sinha, A., & Bhargav, A. (2020). Effect of state transition, drying kinetics and moisture content on Young's modulus variation during thermal drying of hygroscopic food materials. *Journal of Food Engineering*, 279, 109957.
- [12] Rosales-Chimal, S., Navarro-Cortez, R. O., Bello-Perez, L. A., Vargas-Torres, A., & Palma-Rodríguez, H. M. (2023). Optimal conditions for anthocyanin extract microencapsulation in taro starch: Physicochemical characterization and bioaccessibility in gastrointestinal conditions. *International Journal of Biological Macromolecules*, 227, 83-92.
- [13] Ma, Y.-L., Wang, Y., Wu, Z.-F., Mei, J., Zhang, W.-Q., Shang, Y.-F., . . . Wei, Z.-J. (2023). Exploring the effect of in vitro digestion on the phenolics and antioxidant activity of *Lycium barbarum* fruit extract. *Food Bioscience*, 51, 102255.
- [14] Pradhan, R. C., Naik, S. N., Bhatnagar, N., & Vijay, V. K. (2009). Moisture-dependent physical properties of jatropha fruit. *Industrial Crops and Products*, 29(2), 341-347.
- [15] Awulachew, M. (2021). Fruit jam production. *International Journal of Food Science, Nutrition and Dietetics*, 10(4), 532-537.
- [16] Tatasciore, S., Santarelli, V., Neri, L., González Ortega, R., Faieta, M., Di Mattia, C. D., . . . Pittia, P. (2023). Freeze-Drying Microencapsulation of Hop Extract: Effect of Carrier Composition on Physical, Techno-Functional, and Stability Properties. *Antioxidants*, 12(2), 442.
- [17] Escher, G. B., Marques, M. B., do Carmo, M. A. V., Azevedo, L., Furtado, M. M., Sant'Ana, A. S., . . . Granato, D. (2020). *Clitoria ternatea* L. petal bioactive compounds display antioxidant, antihemolytic and antihypertensive effects, inhibit α -amylase and α -glucosidase activities and reduce human LDL cholesterol and DNA induced oxidation. *Food Research International*, 128, 108763.

- [18] Dudonne, S., Vitrac, X., Coutiere, P., Woillez, M., & Mérillon, J.-M. (2009). Comparative study of antioxidant properties and total phenolic content of 30 plant extracts of industrial interest using DPPH, ABTS, FRAP, SOD, and ORAC assays. *Journal of agricultural & food chemistry*, 57(5), 1768-1774.
- [19] Caponio, G. R., Noviello, M., Calabrese, F. M., Gambacorta, G., Giannelli, G., & De Angelis, M. (2022). Effects of grape pomace polyphenols and in vitro gastrointestinal digestion on antimicrobial activity: Recovery of bioactive compounds. *Antioxidants*, 11(3), 567.
- [20] Caponio, G. R., Minervini, F., Tamma, G., Gambacorta, G., & De Angelis, M. (2023). Promising application of grape pomace and its agri-food valorization: source of bioactive molecules with beneficial effects. *Sustainability*, 15(11), 9075.
- [21] Leyva-Porras, C., Román-Aguirre, M., Cruz-Alcantar, P., Pérez-Urizar, J. T., & Saavedra-Leos, M. Z. (2021). Application of antioxidants as an alternative improving of shelf life in foods. *Polysaccharides*, 2(3), 594-607.
- [22] Banerjee, A., & Dhar, P. (2019). Amalgamation of polyphenols and probiotics induce health promotion. *Critical reviews in food science and nutrition*, 59(18), 2903-2926.
- [23] Cropotova, J., Tylewicz, U., Dellarosa, N., Laghi, L., Romani, S., & Dalla Rosa, M. (2016). Effect of freezing on microstructure and degree of syneresis in differently formulated fruit fillings. *Food Chemistry*, 195, 71-78.
- [24] Kumar, S., Konwar, J., Purkayastha, M. D., Kalita, S., Mukherjee, A., & Dutta, J. (2023). Current progress in valorization of food processing waste and by-products for pectin extraction. *International Journal of Biological Macromolecules*, 239, 124332.
- [25] Carcelli, A., Albertini, A., Vittadini, E., & Carini, E. (2022). A fibre syrup for the sugar reduction in fruit filling for bakery application. *International Journal of Gastronomy and Food Science*, 28, 100545.
- [26] Ubbink, J., & Dupas-Langlet, M. (2020). Rheology of carbohydrate blends close to the glass transition: Temperature and water content dependence of the viscosity in relation to fragility and strength. *Food Research International*, 138, 109801.
- [27] Ahmed, J., Ramaswamy, H. S., & Pandey, P. K. (2006). Dynamic rheological and thermal characteristics of caramels. *LWT - Food Science and Technology*, 39(3), 216-224.



بهینه سازی تاثیر استفاده از شیر انگور در مقایسه با شربت فروکتوز و سوربیتول در مغزی مربایی و

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کلمات کلیدی:

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شیره انگور محصول اصلی صنایع فرآوری انگور است که در این تحقیق به عنوان جایگزین طبیعی با عملکرد آنتی اکسیدانی مورد ارزیابی قرار گرفته است. در این پژوهش به بررسی عملکرد شیره انگور در جلوگیری از ایجاد سختی بیشتر در مغزی های مربایی و از دست دادن خاصیت مالش پذیری؛ در ناشی از کریستالیزاسیون قندها؛ در مقایسه با شربت های فروکتوز و سوربیتول پرداخته شد. در این راستا، فرمولاسیون بهینه مغزی مربایی با استفاده از طرح سیمپلکس شبکه ای و درصدهای مختلف شیره انگور، شربت فروکتوز و شربت سوربیتول (در سطوح صفر، ۶/۳۷، ۱۲/۷۳، ۱۹/۱، ۲۵/۴۷ و ۳۸/۲ درصد) بر اساس سنجش بافت انجام شد. آزمون نفوذ با استفاده از دستگاه بافت سنج انجام پذیرفت و تیمار بهینه در روزهای صفر و ۳۰ روز پس از تولید با آزمون های مختلف مورد بررسی قرار گرفتند. نتایج بررسی نشان داد در روز صفر نشان داد که شیره انگور بطور معنی داری ($p < 0.05$) باعث نرمی بافت مغزی می شود و ۳۰ روز پس از تولید، تیمار بهینه عملکرد مناسبی از خود نشان داد، به طوری که دارای رطوبت ۱۳/۴۲٪، فعالیت آبی ۳۸/۰ و بریکس ۸۰/۳۱ بود. نتایج این تحقیق استفاده از ۳۸/۲٪ شیره انگور را به سبب دارا بودن ترکیبات فنولی (۶۲/۷۵ میلی گرم اسید گالیک بر گرم) و خاصیت آنتی اکسیدانی مهار رادیکال آزاد (۲۲/۵۴٪) جهت تولید مغزی مربایی مناسب ارزیابی می نماید.

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