

Formulation and optimization of Chia-Based Strawberry Jam: A Functional Food Innovation

Abstract

The growing demand from consumers for nutrient-dense and health-promoting choices has drawn significant attention to the creation of value-added food items. In this study, we concentrated on the formulation and organoleptic assessment of strawberry jam with chia seeds added for value. In response to increasing consumer demand for nutritious and value-added food products, incorporating chia seeds into traditional jam formulations presents an opportunity to enhance nutritional content while maintaining sensory appeal. The research involves the formulation of strawberry jam recipes with varying concentrations of chia seeds to optimize both nutritional benefits and sensory attributes. Strawberries are rich in vitamin C and other antioxidants, which helps to reduce the risk of serious health conditions like cancer, diabetes, stroke, and heart disease. Chia seeds are well known for having a lot of nutrients, including fibre, antioxidants, and omega-3 fatty acids. The objective of the study includes the

development of strawberry jam treated with chia seeds as an innovative functional food product and checking the consumer acceptability of the developed product. This study was aimed to develop strawberry jam by incorporating chia seed (1 & 3%). The control and the treated jam samples were also evaluated sensorily on a composite scale. The method of the study involves preparation of the strawberry chia seed jam and standardisation of the ingredients accordingly. Thus two treatments were developed with T1 (1%) and T2(3%) of chia seeds. The next technique of the study after preparation was focused on sensory evaluation of the developed product evaluated by semitrained panellists by composite scale. Outcome of the study were strawberry chia seed jam were successfully prepared in two ratios of T1 (3%) and T2 (3%), consumer acceptability was also conducted. A concentration of 1% and 3%

chia seeds appears to be optimal, providing a balance between nutritional enhancement and sensory appeal. Arithmetic mean of the score of semitrained pannelists were taken and plotted a graph based on the attributes taken in consideration. Treatment T2 (3%) of chia seed obtained highest scores in all attributes including colour (19 of 20), consistency (18.45 of 20), flavour (38.15 of 40), absence of defects (18.5 of 20), total scores (93.1 of 100) compared to treatment T1 (1%). The jam with 3% of chia seed concentration was found to be more liked by the panellists.

Keywords: Strawberry jam, chia seeds, value-added product, health benefits, sensory evaluation

1. Introduction

Fruit and vegetable preservation is becoming a more and more popular processing technique these days. Strawberry is a commercial fruit that has a lot of processing possibilities. It is used a lot to make purees, squash, juice, candies, preserves, jams, and blended beverages. The process of making jam involves adding enough sugar to the fruit pulp until it becomes quite thick. This ensures that the fruit tissues are held firmly in place. The fruit pulp's high sugar content made it possible to benefit from the preservation action of the fruit. The addition of sugar to jam contributed in its sweetening, gel formation, and colour retention (Rahman *et al.*, 2018). Jams are mostly manufactured using fruits and various kinds of sugars that are significantly enhanced by heating (Sawant *et al.*, 2013). Fruit or vegetable pulp, pectin, acid, and sugar are cooked together to a manageable consistency to create jam, a semi-solid culinary product. Jam needs to have at least 45% pulp and 65% or greater TSS. Sugar in jam inhibits the growth of microbes and keeps it from spoiling. Sugar has the ability to retain water, which extends product shelf life. Pectin is used to increase the textural, stabilising, and thickening properties of a variety of foods, including drinks, confections, jams, and jelly. For precise balancing, which is necessary while making jam, citric acid is necessary.

The best preservation technique is to make jam. The definition of jam is the pulp or juice of fruits or vegetables mixed with sugar, pectin, and citric acid. Typically, the blend is heated to a suitable temperature (spreadable). For jam to be produced, it is necessary to have access to raw materials and affordable sources of additional components such sugar, citric acid, pectin, and jam jars. Preserving fruits and vegetables may be achieved with greater effectiveness by using jam. Comparing it to other preservation techniques like freezing and drying, it takes less time. The definition of jam in the US is a semi-solid food that comprises at least 45 parts fruit by weight to every 55 parts sugar by weight. To get the required quality, this mixture is

concentrated to 68 percent total soluble solids. It's possible to add colour and flavouring ingredients (Awulachew 2021).

In modern times, individuals eat more fruits because of their nutritional content and medicinal properties. One of them that deserves special attention is the strawberry, which is becoming more widely available for "organic" consumption and whose agro-industrial products are enjoyed globally because of its delicious flavour and high nutritional content.

Strawberry jam has been a beloved staple in households for generations, cherished for its sweet, fruity flavour and versatility. However, as consumer preferences shift towards healthier options, there's a growing demand for value-added products that not only taste great but also offer nutritional benefits. In response to this trend, the incorporation of chia seeds into strawberry jam presents an innovative approach to enhance its nutritional profile and appeal to health-conscious consumers.

The strawberry (*Fragaria Ananassa Duch*) is a fruit that attracts attention because of its unique qualities, which include its vivid red colour, odour, soft texture, and flavour that is somewhat acidified. The presence of bioactive compounds with anti-carcinogenic qualities, such as flavonoids and anthocyanins, is what gives this coloration. It is widely consumed worldwide and is high in vitamins, fibre, folic acid, and minerals. It is used to reduce weight since it is low in carbohydrates and high in fruit and sugar. Because of its high vitamin C content and its citric and malic acid content, it helps the body absorb iron. It is also advertised as a treatment for a few illnesses and dysfunctions, such hypertension and constipation. It encourages intestinal emptying and urine removal and acts as a moderate laxative and diuretic. With a high natural sugar content, this fruit is a great source of energy for the liver. Additionally, its fragrant components stimulate the senses of taste and smell, which in turn increases hunger (Matos *et al.*, 2022).

Chia seeds (*Salvia hispanica L.*) are rich in medicinal and nutritional properties. About one metre tall, the chia plant has simple leaves with a sharp tip that are oval-elliptic in form, 4 to 8 cm long and 3 to 5 cm broad. The leaves are pubescent. A chia seed is roughly oval in shape, measuring between 0.8 and 1.3 mm in diameter, 0.8 and 1.4 mm in length, and 0.8 and 2 mm in breadth. It might be black, brown, grey, black speckled, or white, with a smooth and glossy peel. Given its potential to prevent chronic illnesses including obesity, heart disease, diabetes, and cancer, chia intake has been rising over time. The high quantities of proteins, dietary fibre, antioxidants, vitamins, minerals, carotenoids, and essential fatty acids in chia seeds are the primary cause of these health benefits (Grancieri *et al.*, 2019).

Health benefits of chia seeds:

Chia is a plant species that the Mayans and Aztecs have long utilised for food and medicine. It produces a dry, indehiscent fruit that is frequently referred to as a seed. The plant's seeds have gained popularity recently due to its culinary applications and potential health advantages. As a matter of fact, seeds are an abundant supply of nutrients, chief among which are the polyunsaturated omega-3 fatty acids, which have anti-inflammatory, cognitive-improving, and cholesterol-lowering properties. Additionally abundant in seeds are polyphenols, which are antioxidant substances that shield the body against ageing, cancer, and free radicals. Polyphenols are formed from caffeic acid. Furthermore, large concentrations of carbohydrate-based fibres have been linked to bowel regulation, cholesterol reduction, and inflammation reduction.

Chia seeds have the potential to be used as an ingredient in food industry applications because of their high nutritional fibre content. Dietary fibre is a group of substances that can include other substances (such as lignin, pectins, gums) and include both oligosaccharides and polysaccharides like cellulose, hemicellulose and additionally mucilage. The presence of carbohydrates with free polar groups that interact with hydrophilic links within the matrix to form a gel and subsequently increase peristalsis has made total dietary fibre (TDF) an important part of the diet, particularly for its physiological functionality based on the swelling property after water absorption. Numerous health advantages have been linked to TDF use, according to published investigations. Soluble dietary fibre (SDF) and insoluble dietary fibre (IDF) make up TDF, which are found in chia seeds. Specifically, when the seed comes into touch with water, the SDF are partly released from it as a mucilaginous gel and ferment in the colon (Lanzotti *et al.*, 2017).

The objective of this project was to create a value-added strawberry jam with chia seeds and offer a new product in order to improve its nutritional content and overall health advantages. Since the jam loses part of its nutritious content during processing or preparation. To determine if the produced product is acceptable for marketing, a sensory evaluation was carried out.

2. Materials and Methods

Materials

The present research was conducted at Babasaheb Bhimrao Ambedkar University, Lucknow 226025, Uttar Pradesh, at the Department of Food and Nutrition's School of Home Science. The study focused on standardizing value-added strawberry jam made using chia seeds. For this investigation, strawberries and chia seeds were bought from the local market of Lucknow

and in digital platform (blinkit).

To guarantee that the food would have enough nourishment without compromising flavour or texture, the proportions of each ingredient were carefully considered.

Preparation of Jam

Fresh, healthy, and ripe strawberries were brought from the local market of Lucknow. Sepals were removed from them. After being graded and sorted, they were extensively washed to get rid of dust, dirt, and other foreign materials from its surface. It was then cut into small pieces and was pulped with the help of a grinder. All the ingredients were weighed separately. After the pulp was achieved, it was cooked for a few minutes and sugar was added while stirring continuously. After a few minutes chia seeds were added followed by pectin. Until the cooking mass reached the appropriate consistency, the mixture was cooked gently and occasionally stirred. A spoon dipped into the mixture was allowed to drip the mixture from its edges once the mass had sufficiently thickened. When the product cooled down and slid off in a sheet rather than flowing easily in a single stream, it was considered that the product had reached its end point and was prepared for filling the container. Then citric acid was added and cooked until the TSS reached 65°-68° Brix. Hot jam was poured into the sterilised and clean airtight glass container, which was then stored in a cool place. Ingredients are shown in Table1.

Table 1. Ingredients in different treatments of strawberry jam

Sl.No.	Ingredients	Quantity		
		Control sample	T1	T2
1	Strawberry pulp (g)	36	42	41
2	Sugar (g)	64	57	56
3	Chia seeds (g)	—	1	3
4	Citric acid (g)	0.5	0.5	0.5
5	Pectin (g)	0.3	0.3	0.3

Fig. 1. Preparation of strawberry chia seed jam



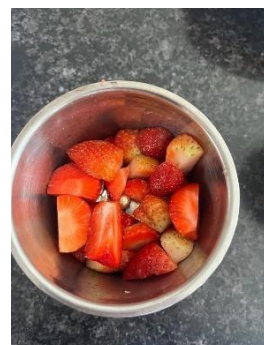
Fresh
strawberries



Removal of
sepals



Cutting into
small pieces



Blending



Addition of
chia seeds



Addition of sugar
and cooking in
low flame



pouring the pulp
to kadai



Strawberry
pulp



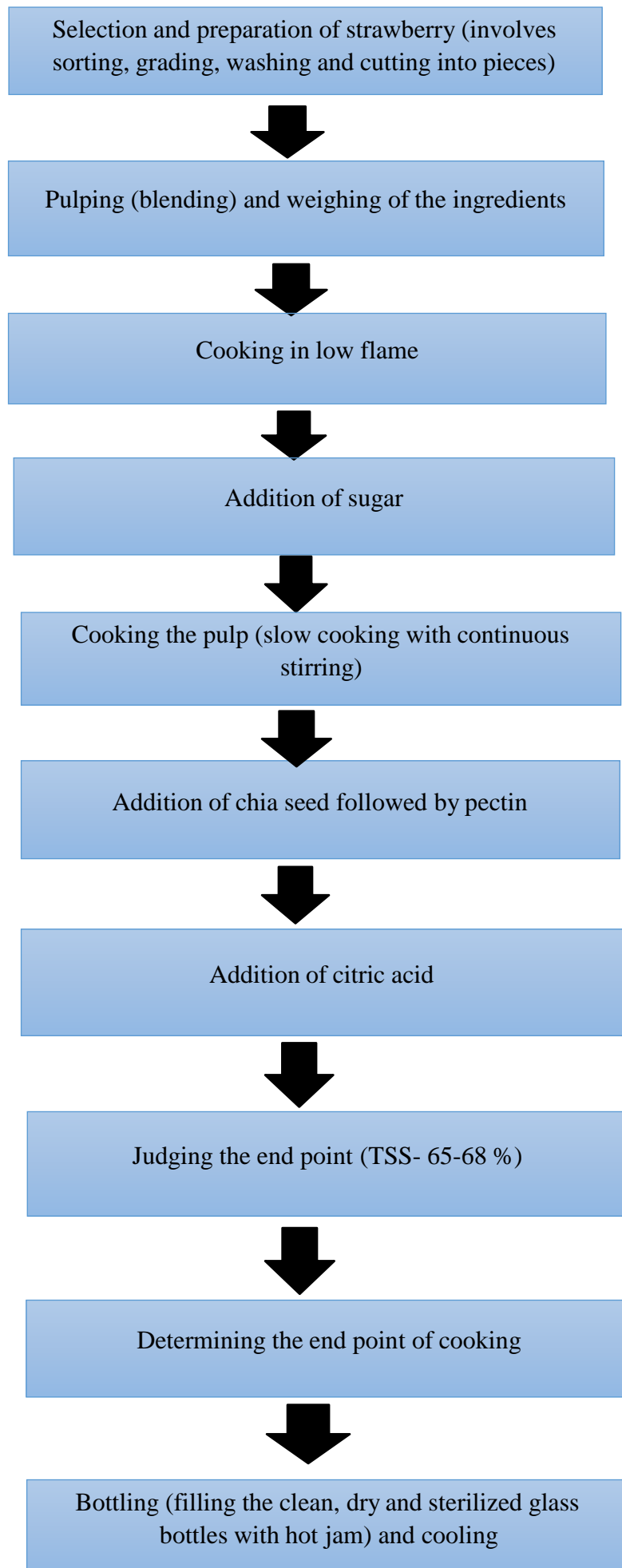
Addition of
pectin and citric



Determining
endpoint of jam



Bottled in glass
jar



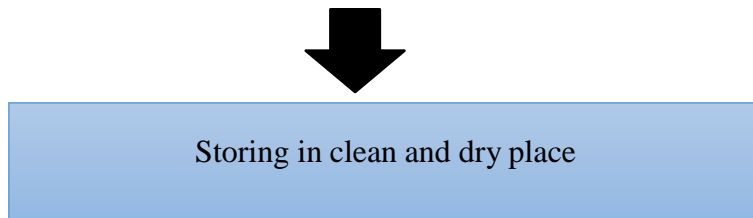


Fig. 2. Flow chart demonstrating the preparation of strawberry chia seed jam

Sensory Evaluation

The semi-trained panel, consisting of 40 members who were friends, staff, and students of Babasaheb Bhimrao Ambedkar University, evaluated the produced value-added jam based on its organoleptic attributes: appearance, taste, flavour, aroma, texture, and acceptability. Sensory Evaluation was carried using composite table sensory evaluation. In this Control sample, T1 and T2 evaluated their sensory score then calculated their mean score and compared.

Table 2. Composite scoring test for sensory evaluation

Composite Scoring Test				
Name :		Date:		
Product:				
		Sample scores		
Quality	Possible scores	Reference sample	Test sample 1	Test sample 2
Colour	20	_____	_____	_____
Consistency	20	_____	_____	_____
Flavour	40	_____	_____	_____
Absence of defects	20	_____	_____	_____
Total score	100			
Comments:				
Signature				



Fig. 3. Sensory evaluation

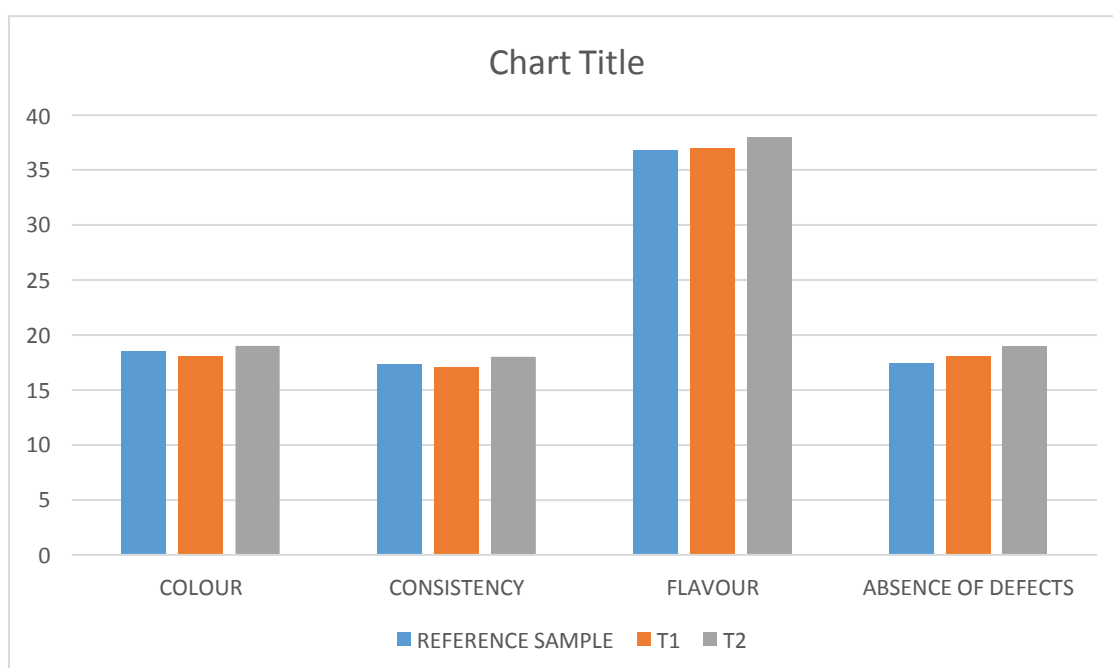
3. Results and Discussion

Based on the panellist's assessments, the data gathered from the sensory assessment of the strawberry chia seed jam samples were thoroughly evaluated. In addition to tasting the samples, the panel's attendees analysed them closely, evaluating their flavour, colour, consistency, texture, and lack of defects. The evaluation was effective and had real positive results.

The sensory evaluation suggests that fortifying strawberry jam with chia seeds is a viable option, enhancing its nutritional profile without sacrificing sensory quality. A concentration of 1% and 3% chia seeds appears to be optimal, providing a balance between nutritional enhancement and sensory appeal. The jam with 3% of chia seed concentration was found to be more liked by the panellists due to its colour, flavour and consistency. The development of value-added strawberry jam with chia seed presents a promising avenue for enhancing the nutritional profile and consumer appeal of traditional fruit preserves. In our study, we meticulously crafted a formulation integrating strawberries, a beloved fruit rich in antioxidants and vitamins, with chia seeds, renowned for their omega-3 fatty acids, fiber, and protein content. Results indicated a favourable reception towards the value-added jam, with its vibrant red hue, a well-balanced sweetness complemented by the subtle crunch of chia seeds. The texture was smooth and spreadable, enhancing the palatability of the product. The result of the evaluation is given below in a Table 3.

Table 3. Results of sensory evaluation in percentage

Quality	Possible score	Reference sample	T1	T2
Colour	20	18.5	18.2	19
Consistency	20	17.35	17.1	18.45
Flavour	40	36.8	37.05	38.15
Absence of defects	20	17.4	18	18.65
Total scores	100	86.5	91.2	93.1

**Fig. 4. Graphical representation of sensory evaluation**

4. Conclusion

The composite table, which was meant to evaluate consumer acceptance and satisfaction over different quality attributes, yielded a favourable result. Furthermore, the inclusion of chia seeds not only contributed to the nutritional enrichment of the jam but also imparted a unique textural element, enhancing its perceived value among consumers seeking health-conscious options. The incorporation of chia seeds did not compromise the sensory appeal of the jam but rather enhanced its desirability, suggesting its potential as a marketable product catering to health-conscious consumers

In conclusion, the development of value-added strawberry jam with chia seed presents an innovative approach to enhance the nutritional profile and consumer appeal of traditional fruit preserves, offering a delicious and nutritious option for consumers seeking both flavour and health benefits.

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References

- Rahman, M. M., & Moshiur, A. (2018). Preparation of strawberry jam and estimation of its nutritive value during storage. *Journal of Postharvest technology*, 6(1), 41-56.
- Sawant, A. A., & Patil, M. M. (2013). Preparation of guava jam blended with sapota. *Agricultural Engineering International: CIGR Journal*, 15(1), 167-172.
- Awulachew, M. (2021). Fruit jam production. *International Journal of Food Science, Nutrition and Dietetics*, 10(4), 532-537.
- Matos, R. L. Q., González, O. Q., Parra, R. C., Macías, M. A. C., & Josias, A. F. S. (2022). Processing of strawberry “Festival” to jam and determination of physical and physicochemical parameters. *Trends in Horticulture*, 6(1).
- Grancieri, M., Martino, H. S. D., & Gonzalez de Mejia, E. (2019). Chia seed (*Salviahispanica* L.) as a source of proteins and bioactive peptides with health benefits: A review. *Comprehensive Reviews in Food Science and Food Safety*, 18(2), 480-499.

- De Falco, B., Amato, M., & Lanzotti, V. (2017). Chia seeds products: an overview. *Phytochemistry Reviews*, 16, 745-760.
- Kulczyński, B., Kobus-Cisowska, J., Taczanowski, M., Kmiecik, D., & Gramza-Michałowska, A. (2019). The chemical composition and nutritional value of chia seeds—Current state of knowledge. *Nutrients*, 11(6), 1242.
- Taga, M. S., Miller, E. E., & Pratt, D. E. (1984). Chia seeds as a source of natural lipid antioxidants. *Journal of the American Oil Chemists' Society*, 61, 928-931.
- Knez Hrnčič, M., Ivanovski, M., Cör, D., & Knez, Ž. (2019). Chia Seeds (*Salvia hispanica* L.): An overview—Phytochemical profile, isolation methods, and application. *Molecules*, 25(1), 11.
- Marcinek, K., & Krejpcio, Z. (2017). Chia seeds (*Salvia hispanica*): health promoting properties and therapeutic applications-a review. *Roczniki Państwowego Zakładu Higieny*, 68(2).
- Saleem, M. F., Ahmed, S. A., Galali, Y., Sebo, N. H., Yildirim, A., & Najmdaddin, B. S. (2024). Physiochemical and Sensory Properties of Pumpkin and Strawberry Jams Fortified with Chia Seed (*Salvia hispanica* L.). *Cihan University-Erbil Scientific Journal*, 8(1), 29-35.
- Özbek, T., Şahin-Yeşilçubuk, N., & Demirel, B. (2019). Quality and nutritional value of functional strawberry marmalade enriched with chia seed (*Salvia hispanica* L.). *Journal of food quality*, 2019.
- Koppel, K., Timberg, L., Salumets, A., & Paalme, T. (2011). Possibility for a strawberry jam sensory standard. *Journal of Sensory Studies*, 26(1), 71-80.
- Da Silva Pinto, M., Lajolo, F. M., & Genovese, M. I. (2007). Bioactive compounds and antioxidant capacity of strawberry jams. *Plant foods for human nutrition*, 62, 127-131.
- Islam, M. Z., Monalisa, K., & Hoque, M. M. (2012). Effect of pectin on the processing and preservation of strawberry (*Fragaria ananassa*) jam and jelly.
- Levaj, B., Bursać Kovačević, D., Bituh, M., & Dragović-Uzelac, V. (2012). Influence of jam processing upon the contents of phenolics and antioxidant capacity in strawberry fruit (*Fragaria ananassa* × Duch.). *Hrvatski časopis za prehrambenu tehnologiju, biotehnologiju i nutricionizam*, 7(SPECIAL ISSUE-7th), 18-22.
- Giampieri, F., Tulipani, S., Alvarez-Suarez, J. M., Quiles, J. L., Mezzetti, B., & Battino, M. (2012). The strawberry: Composition, nutritional quality, and impact on human health. *Nutrition*, 28(1), 9-19.