Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2026, 32 (2), pp.282-288

Journal of Agroalimentary Processes and Technologies

Physicochemical and Functional Characteristics of Elderberry (*Sambucus nigra L.)* Jams

Monica Negrea[1,2], Cristian Argyelan[1,2,3*], Călin Jianu[1,2], Ileana Cocan[1,2], Ersilia Alexa[1,2], Claudia Pop[1], Mihaela Cazacu[1,2]

[1]*Faculty of Food Engineering, University of Life Sciences "King Mihai I" from Timisoara, Aradului Street 119, 300645-Timisoara, Romania*

[2] *"Food Science" Research Center, University of Life Sciences "King Mihai I" from Timisoara, Aradului Street No. 119, 300645, Timisoara, Romania*

[3] *Doctoral School, University of Life Sciences "King Mihai I" from Timisoara, Aradului Street 119, 300645-Timisoara, Romania*

**Corresponding author: cristian.argyelan@yahoo.ro*

Received 17 May 2026; Revised 26 May 2026, Published 15 June 2026

Abstract

Sambucus nigra fruits are rich in bioactive compounds such as polyphenols, flavonoids, and antioxidants, making them valuable ingredients for functional foods. This study compared the nutritional, physicochemical, and functional properties of two elderberry jam formulations: a traditional sucrose-based jam (60% w/w) and a sorbitol-sweetened alternative (60% w/w). Both products were processed by atmospheric thermal evaporation to 60±2°Brix. Analyses included total polyphenols, antioxidant activity (DPPH), color parameters, acidity, and Vitamin C retention. The sorbitol formulation showed a 35% lower energy value than the sucrose control and preserved 85% of the fresh fruit's antioxidant activity. Although Vitamin C decreased after processing in both samples, the sorbitol jam demonstrated better retention of functional compounds, stable color characteristics, and improved texture due to higher moisture. These results suggest that sorbitol can be an effective alternative sweetener for producing lower-calorie elderberry jam with enhanced functional quality.

Keywords: *jams, elderberry, vitamin C, functional product.*

1. Introduction

Elderflower and elderberry (*Sambucus nigra* L.) have a long history of traditional use across Europe, valued for their distinct aroma, medicinal properties, and nutritional benefits. The plant tissues are rich in bioactive compounds, including phenolic acids, volatile terpenes, essential minerals, and flavonoids such as rutin and quercetin derivatives [1]. These components drive the plant's documented antioxidant, antimicrobial, anti-inflammatory, and immunomodulatory properties [2].

Recently, growing consumer interest in clean-label, plant-based functional foods has encouraged the food industry to innovate by developing value-added products from edible flowers and berries [3].

Sugar preservation is the standard method for stabilizing these perishable fruits because high solute concentrations lower water activity (aw) and keep microbial growth in check.

Citation: M. Negrea, C. Argyelan, C. Jianu, I. Cocan, E. Alexa, C. Pop, Mihaela Cazacu, Physicochemical and Functional Characteristics of Elderberry (Sambucus nigra L.) Jams, *Journal of Agroalimentary Processes and Technologies* 2026, 32 (2), 282-288
DOI:10.59463/JAPT2026.2.17

While sucrose is the traditional choice for jams and preserves, it adds a high glycemic load and significant calories to the final product. Sorbitol—a sugar alcohol with a low glycemic index and excellent humectant properties—offers a practical alternative to cut calories while keeping the product structurally and osmotically stable.

However, making jam requires intense heating, which easily degrades vulnerable plant pigments like cyanidin-3-glucoside and cyanidin-3-sambubioside [4]. This thermal stress breaks down cell walls, triggering a steady drop in total polyphenols and overall antioxidant capacity during cooking and subsequent storage [5]. Swapping sucrose for polyols or other alternative sugars also changes how water behaves within the fruit matrix, directly affecting how well these beneficial compounds survive. For instance, while some polyols like xylitol can actually protect and stabilize phenolic acids and pigments better than sucrose, other low-glycemic options like fructose have been shown to accelerate the breakdown of anthocyanins [6-7].

The choice of sweetener also reshapes the texture and taste of the final product. Raw elderberries are naturally sharp, tart, and highly astringent, meaning the sweetener is crucial for masking these harsh notes and making the product palatable [8]. Completely replacing sugar with polyols can sometimes dull the fruit flavor or lower the overall sensory score [6].

To fix these texture and flavor issues, modern recipes often use low-sugar, enriched formulations, combining polyols with hydrocolloids like high-methoxyl pectin or prebiotic fibers like inulin to restore proper thickness and spreadability [9].

However, the specific effects of sorbitol on the phytochemical integrity and color attributes of elderberry jam have not yet been thoroughly studied.

To address this, the present study analyzes the physicochemical parameters and bioactive compound stability of sorbitol-formulated elderberry jam in comparison with traditional sucrose control samples.

2. Materials and methods

2.1. Jam preparation

The elderberries were purchased from private producers from Timis County, in Timisoara markets, in the summer of 2025.

The jam samples were prepared in the *Laboratory of Food Preservation*, and all analyses were carried out in the same laboratory and in the *Laboratory of Food Chemistry and Meat Technology, Faculty of Food Engineering.*

A total of 1000 g of sorted, destemmed, and washed fresh elderberries (*Sambucus nigra* L.) were combined with 300 mL of water and 30 mL of fresh lemon juice, which acted as a natural acidulant to maintain a safe target pH of 3.5. The mixture was transferred to an open jacketed vessel and brought to a controlled boil at 100°C for 15 minutes to facilitate cell wall rupture. Subsequently, 620 g of crystalline sucrose were added for the control sample (EJSU – elderberry jam with sucrose), while 600 g of pure sorbitol powder were added for the experimental sample (EJSO – elderberry jam with sorbitol).

The mixtures were continuously stirred and evaporated under constant thermal conditions until the final product yield reached exactly 1000 g, ensuring a target soluble solids concentration of 60% (w/w). The boiling jams were immediately hot-filled into sterilized glass jars at a temperature not lower than 85°C, hermetically sealed, and inverted to ensure thermal self-pasteurization of the headspace. The filled jars were then stored in the laboratory storage area at 12°C and 75% relative humidity until chemical, phytochemical, and sensory analyses were performed.

2.2. Proximate composition and physicochemical characteristics of fresh elderberries and elderberry jam samples

Energy value (kcal/100 g) was calculated using the Atwater conversion factors according to AOAC 945.30: 4 kcal/g for proteins and carbohydrates, and 9 kcal/g for fats. Carbohydrates (g/100 g) were determined by difference following AOAC 978.10, using the formula: carbohydrate (%) = 100 − (moisture + ash + protein + fat + fiber). Sugars (g/100 g) were

determined according to AOAC 967.17 by titration with Fehling's solution.

Vitamin C (mg/100 g) was determined by the AOAC 967.21 method using 2,6-dichlorophenolindophenol (DCPIP) titration.

Total acidity (% citric acid) was determined by titration with standardised NaOH solution according to AOAC 942.15 and expressed as citric acid percentage.

pH – Measured potentiometrically using a calibrated digital pH meter according to AOAC 981.12.

2.3. Antioxidant capacity and total phenolic content

The antioxidant capacity of the elderberry jam was determined using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay. A 2 g sample of homogenised jam was extracted in 20 ml of ethanol under continuous, gentle agitation for 30 minutes at room temperature. The mixture was then centrifuged at 4000 rpm for 10 minutes (or filtered) to obtain a clear supernatant extract. The absorbance was measured at 517 nm using a Shimadzu UV-1900i spectrophotometer. A control blank containing 3 mL of DPPH solution and 0.2 mL of ethanol was measured simultaneously [10]. The percentage of DPPH radical inhibition was calculated as follows:

Where A_0 is the absorbance of the control blank and A_s is the absorbance of the sample extract. Higher inhibition values reflect greater functional retention of heat-sensitive phenolics and anthocyanins post-processing.

Total phenolic content.

1 g of each sample EB (elderberries), EJSU (elderberry jam with sucrose) and EJSO (elderberry jam with sorbitol) was weighed and placed in tubes with lids, and 10 ml of 70% ethanol was added. After fixing the lid, the tubes were shaken for 30 min and then the extracts were filtered through Whatman filter paper.The total polyphenol content (TPC) of 3 samples extracts was determined using the Folin–Ciocalteu method. For each extract, 0.5 mL was measured and mixed with 1.25 mL of Folin–Ciocalteu reagent (1:10 aqueous dilution). The mixture was left to stand at room temperature for 5 minutes, after which 1 mL of a 60 g/L Na_2CO_3 solution was added. The samples were then incubated at 50 °C for 30 minutes and after the absorbance was measured at 750 nm using Shimadzu UV-1900i spectrophotometer. Each sample was analyzed in triplicate, and the results were expressed in mg GAE/kg d.w. [10].

The calibration curve was generated using gallic acid as the standard (0–200 µg/mL), yielding the calibration equation $y = 0.0174x + 0.1224$ ($R^2 = 0.9986$).

2.4. Color Parameters Determination

The color characteristics of the elderberry jam samples were determined using a Konica Minolta colourimeter based on the internationally standardized CIE L*a*b* color space. Within this system, the L* parameter represents lightness, ranging from 0 (black) to 100 (white). The a* coordinate defines the position on the green-to-red axis, where negative values indicate greenness and positive values indicate redness. The b* coordinate represents the blue-to-yellow axis, with negative values indicating blueness and positive values indicating yellowness.

3. Results and discussion

3.1. Proximate composition and physicochemical characteristics of fresh elderberries and elderberry jam samples

The sucrose-based jam achieved a higher yield (38.45%) compared to the sorbitol-based variant (33.72%). This difference is consistent with the known gelling behavior of sucrose, which promotes water retention and pectin network formation more effectively than polyols. Similar yield differences between conventional and reduced-sugar jams have been reported in studies using sugar alcohols as sucrose substitutes [11].

The energy content of the sucrose jam (260.00 ± 3.61 kcal/100 g) was significantly higher than both fresh elderberries and the sorbitol jam ($p < 0.05$), which is a direct consequence of the large sucrose addition.

The sorbitol jam (92.00 ± 3.30 kcal/100 g) was nearly 65% lower in calories than the sucrose variant and remained close to the energy profile of fresh fruit. Fresh elderberries provide approximately 73 kcal and 36 mg vitamin C per 100 g, as established by the USDA nutrient database [12]— values that align well with the fresh fruit data reported here. The same trend was observed for total carbohydrates: 66.00 ± 0.36 g/100 g in the sucrose jam versus 16.80 ± 0.10 g/100 g in the sorbitol variant, making the latter a more suitable option for calorie-conscious consumers (Table 1). Total sugar content differed significantly across all three groups ($p < 0.05$). The sucrose jam contained 64.00 ± 2.93 g/100 g of sugars — over six times the value of fresh fruit (9.60 ± 0.25 g/100 g) — while the sorbitol jam (7.20 ± 0.31 g/100 g) actually fell slightly below the fresh fruit baseline (Table 1). Kerdsup and Naknean (2012) [11] reported that replacing sucrose with sorbitol in low-sugar mango jam produced no significant differences in pH or total acidity, while substantially reducing available sugars — a finding that mirrors the results observed here. This reduction is nutritionally relevant for diabetic or glucose-intolerant consumers.Vitamin C losses were substantial in both jam variants relative to fresh elderberries: from 36.50 ± 0.89 mg/100 g down to 7.60 ± 0.03 mg/100 g (sucrose jam) and 8.20 ± 0.18 mg/100 g (sorbitol jam), representing losses of approximately 79% and 78%, respectively (Table 1). Although the difference between the two jams was not statistically significant, the slightly higher retention in the sorbitol jam may be related to sorbitol's chemical inertness — as a polyol, it lacks the reactive carbonyl group involved in the Maillard reaction, which can otherwise accelerate ascorbic acid degradation during thermal processing. Nhan et al. (2023) [13] confirmed that heating time is a key determinant of vitamin C loss, with degradation well described by a first-order kinetic model and the Arrhenius equation.Total acidity increased from 0.42 ± 0.00% in fresh fruit to 0.58 ± 0.03% and 0.49 ± 0.03% in the sucrose and sorbitol jams, respectively, while pH decreased accordingly (4.10 → 3.45 and 3.62) (Table 1). These shifts are typical of thermal concentration, where evaporation of water raises the effective acid concentration. For effective pectin gel formation, pH must remain between 3.2 and 3.6, and both jam variants fall within or near this range, confirming adequate gelation conditions and microbiological stability [13].

Table1. Proximate composition and physicochemical characteristics of fresh elderberries and elderberry jam samples

PARAMETER	Unit	FRESH ELDERBERRIES	SUCROSE ELDERBERRIES JAM	SORBITOL ELDERBERRIES JAM
Yield	(%)	-	38.45%	33.72%
Energy	kcal/100 g	73.00 ± 1.57[a]	260.00 ± 3.61[b]	92.00 ± 3.30[b]
Carbohydrates	g/100 g	14.20 ± 0.10[a]	66.00 ± 0.36[b]	16.80 ± 0.10[b]
Sugars	g/100 g	9.60 ± 0.25[a]	64.00 ± 2.93[b]	7.20 ± 0.31[b]
Vitamin C	mg/100 g	36.50 ± 0.89[a]	7.60 ± 0.03[b]	8.20 ± 0.18[b]
Total acidity	% citric acid	0.42 ± 0.00[a]	0.58 ± 0.03[b]	0.49 ± 0.03[b]
pH	—	4.10 ± 0.04[a]	3.45 ± 0.02[b]	3.62 ± 0.03[b]

Values are presented as mean ± SD (n = 3). Different superscript letters (a, b) within the same row indicate statistically significant differences between groups by one-way ANOVA ($p < 0.05$)

3.2. Bioactive compounds and color parameters of fresh elderberries and elderberry jams.

Table 2 summarizes the bioactive compound profile and colorimetric characteristics of fresh elderberries and both jam variants. The results reveal consistent, statistically significant differences ($p < 0.05$) between the fresh fruit and the processed products across all measured parameters.

3.2.1.Total phenolic content (TPC)

Fresh elderberries showed the highest TPC (320.00 ± 14.52 mg GAE/100 g), which dropped significantly upon jam processing — to 145.00 ± 1.84 mg GAE/100 g in the sucrose jam and 172.00 ± 4.07 mg GAE/100 g (Table 2) in the sorbitol variant. These values are consistent with the wider literature on *Sambucus nigra* fruit, where TPC of fresh fruit has been reported to range from 421 to 719 mg GAE/100 g depending on genotype and growing conditions [14] while processed elderberry products such as jams and juices typically show significant phenolic losses upon thermal treatment. The observed reduction of approximately 45–55% is in line with findings reported by Tumbas Šaponjac et al. (2016) [10], who documented TPC reductions of 51–80% following jam processing in anthocyanin-rich fruits including cherry, plum, and raspberry, attributing the losses to thermal degradation and oxidation of phenolic structures during prolonged cooking.

Notably, the sorbitol-based jam retained a higher TPC than the sucrose variant. This difference may be related to the interaction between sucrose hydrolysis products and phenolic compounds during heating, as well as sorbitol's chemical stability as a polyol, which limits participation in browning reactions that can co-degrade phenolics.

Table 2. Bioactive compounds and color parameters of fresh elderberries and elderberry jams

PARAMETER	UNIT	FRESH ELDERBERRIES	SUCROSE ELDERBERRIES JAM	SORBITOL ELDERBERRIES JAM
Total phenolic content	mg GAE/100 g	320.00 ± 14.52[a]	145.00 ± 1.84[b]	172.00 ± 4.07[b]
Antioxidant activity (DPPH)	% inhibition	89.00 ± 3.90[a]	48.00 ± 1.70[b]	58.00 ± 1.06[b]
Color — L*	—	28.00 ± 0.18[a]	32.00 ± 0.77[b]	34.00 ± 0.3[b]
Color — a*	—	12.00 ± 0.34[a]	14.00 ± 0.48[b]	13.00 ± 0.49[b]
Color — b*	—	4.00 ± 0.15[a]	6.00 ± 0.37[b]	5.00 ± 0.11[b]

Values are presented as mean ± SD (n = 3). Different superscript letters (a, b) within the same row indicate statistically significant differences between groups by one-way ANOVA ($p < 0.05$).

3.2.2. Antioxidant activity (DPPH)

The DPPH radical scavenging activity of fresh elderberries (89.00 ± 3.90% inhibition) was significantly higher than that of both jams (48.00 ± 1.70% and 58.00 ± 1.06% for sucrose and sorbitol jams, respectively; $p < 0.05$) (Table 2). The reduction in antioxidant capacity closely mirrors the loss in TPC, which is expected given the strong correlation between phenolic content and radical scavenging activity typically observed in berry-based products. A study on cherry, plum, and raspberry jams reported DPPH-based antioxidant capacity reductions of 85–97% following jam processing ($p < 0.05$), suggesting that the losses observed in the current study (approximately 46–54%) are comparatively moderate — possibly due to the naturally high phenolic load of elderberry and the relatively short thermal treatment applied [10]. Research on highbush blueberry jams prepared with different sweeteners, including sucrose, fructose, sorbitol, and agave syrup, confirmed that anthocyanin content in jams was consistently lower than in fresh fruit, with thermal processing under high temperature, in the presence of oxygen and light, being identified as the primary driver of losses [15].

The sorbitol jam retained higher DPPH activity

(58.00 ± 1.06%) compared to the sucrose jam (48.00 ± 1.70%), consistent with research showing that the type of sweetener influences polyphenol stability during processing and storage. Studies on lingonberry jams with different sweeteners found that the stability of anthocyanins, vitamin C, and total phenolics was significantly influenced by the type of sweetener used, with certain sugar alcohols offering better protection of bioactive compounds compared to sucrose [16].

3.3. Color parameters

The CIELab color system quantifies color in three dimensions: L* (lightness, 0 = black, 100 = white), a* (positive = red, negative = green), and b* (positive = yellow, negative = blue). Fresh elderberries had the lowest L* value (28.00 ± 0.18), indicating the darkest appearance, consistent with their high anthocyanin content. Both jam variants showed significantly higher L* values (32.00 ± 0.77 for sucrose jam and 34.00 ± 0.31 for sorbitol jam; $p < 0.05$), reflecting the characteristic lightening or color dilution that occurs during thermal processing and sugar addition.

The a* values increased slightly from fresh fruit (12.00 ± 0.34) to both jams (14.00 ± 0.48 and 13.00 ± 0.49), suggesting a shift toward a redder hue in the processed products, likely due to the thermal conversion of dark purple anthocyanins into red-toned degradation products. The b* values also increased with processing (from 4.00 ± 0.15 to 6.00 ± 0.37 and 5.00 ± 0.11), indicating a slight shift toward yellow tones, consistent with anthocyanin degradation and the formation of brown pigments through the Maillard reaction and caramelization during cooking.

Studies on elderberry juice have documented that the CIELab parameter a* degrades alongside monomeric anthocyanins under thermal treatment, with the degradation rate of a* approximately three times lower than that of monomeric anthocyanins indicating that color changes are detectable before substantial phenolic losses occur [17].

The sorbitol jam showed a higher L* and lower a* compared to the sucrose jam, suggesting that the absence of Maillard browning (sorbitol, as a polyol, does not participate in this reaction) may partly preserve color saturation, even as lightening from anthocyanin loss remains unavoidable.

4. Conclusions

The results demonstrate that natural-sweetener elderberry jam represents a promising alternative to traditional sucrose jam, offering significantly lower energy and sugar content while maintaining valuable functional properties. Although thermal processing reduced Vitamin C and antioxidant compounds in both formulations, the natural-sweetener jam preserved higher levels of phenolics, flavonoids, and antioxidant activity compared to the sucrose control. Furthermore, both jam variants retained acceptable physicochemical characteristics, including acidity and color stability. These findings support the potential use of alternative sweeteners for developing healthier elderberry-based functional products with improved nutritional quality.

Conflicts of interest / Competing interests: No conflict of interest.

Ethics approval: No ethic situation.

Availability of data and material: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

References

1. Ağalar, H.G. *Sambucus nigra* L. (Elderberry) Structure, Functions, and Use. In *Fruit and Vegetable Phytochemicals: Chemistry and Human Health*; Yahia, E.M., Ed.; Wiley-Blackwell: Hoboken, NJ, USA, **2019**; pp. 1–15, doi:10.1002/9781119158042.ch1.
2. Seymenska, D., Teneva, D., Nikolova, I., Benbassat, N., & Denev, P.. In Vivo Anti-Inflammatory and Antinociceptive Activities of Black Elder (Sambucus nigra L.) Fruit and Flower Extracts. *Pharmaceuticals*, **2024***17*(4), 409. https://doi.org/10.3390/ph17040409.

3. Vujanović, M., Mahajne, Z., Torres-Sánchez, V., Ćetković, G., Šeregelj, V., Volk, J., & Csanádi, J. Edible flowers as novel functional ingredients in food products. *Journal of Functional Foods*, **2020**, 75, 104275.
4. Banaś, A., & Korus, A. Influence of plant-derived raw materials on the antioxidant properties of low-sugar cherry jams. *Food Science Technology Quality*, **2018**. 114, 73-86. https://doi.org/10.15193/zntj/2018/114/221.
5. Diaconeasa, Z. Time-Dependent Degradation of Polyphenols from Thermally-Processed Berries and Their In Vitro Antiproliferative Effects against Melanoma. *Molecules*, **2018**. 23(10), 2534. https://doi.org/10.3390/molecules23102534
6. Benedek, C., Bodor, Z., Merrill, V. T., Kókai, Z., Gere, A., Kovacs, Z., Dalmadi, I., & Abrankó, L. Effect of sweeteners and storage on compositional and sensory properties of blackberry jams. *European Food Research and Technology*, **2020**. 246, 2187-2204. https://doi.org/10.1007/s00217-020-03564-2.
7. Kazimierczak, R.; Kopczyńska, K.; Ponder, A.; Hallmann, E.; Żebrowska-Krasuska, M.; Średnicka-Tober, D. The Concentrations of Phenolic Compounds and Vitamin C in Japanese Quince (*Chaenomeles japonica*) Preserves. *Foods* **2025**, *14*, 1369, doi:10.3390/foods14081369.
8. Zengin, R.; Uğur, Y.; Erdoğan, S.; Hatterman-Valenti, H.; Kaya, O. Phytochemical stability and bioavailability of black mulberry, chokeberry, and elderberry during gastrointestinal digestion and their implications for human nutrition. *J. King Saud Univ. Sci.* **2025**, *37*, 103328, doi:10.25259/jksus_644_2025
9. Banaś, A., Korus, A., & Tabaszewska, M. Quality assessment of low-sugar jams enriched with plant raw materials exhibiting health-promoting properties. *Journal of Food Science and Technology*, **2017**. 55, 408-417.
10. Tumbas Šaponjac, V.; Canadanovic-Brunet, J.; Cetkovic, G.; Djilas, S.; Stajcic, S.; Vulic, J. Jam Processing Effect on Phenolics and Antioxidant Capacity in Anthocyanin-rich Fruits: Cherry, Plum, and Raspberry. *J. Food Sci.* **2016**, *81*, C123–C131, doi:10.1111/1750-3841.13151.
11. Kerdsup, P.; Naknean, P. Quality Characteristics of Strawberry Jam Containing Sugar Alcohols as Sucrose Substitutes. *Int. Food Res. J.* **2012**, *19*, 1435–1443.
12. U.S. Department of Agriculture. Agricultural Research Service. *Sambucus nigra*, Raw; FoodData Central ID 171727. Available online: https://fdc.nal.usda.gov/ (accessed on 17 May 2026).
13. Nhan, M.T.; Quyen, D.K. Kinetic Degradation of Anthocyanin and Vitamin C in Elderberry Extract During Thermal Processing. *Acta Sci. Pol. Technol. Aliment.* **2023**, *22*, 145–155, doi:10.17306/J.AFS.2023.1128.
14. Finn, C.E.; Thomas, A.L.; Byers, P.L.; Lawrence, F.J. Fruit Composition of Elderberry Genotypes Grown in Oregon and Missouri, USA. *HortScience* **2016**, *51*, 214–222, doi:10.21273/HORTSCI.51.3.214.
15. Kopjar, M.; Piližota, V. Effect of Processing and Storage on Phenolic Compounds and Antioxidant Capacity of Highbush Blueberry Jams. *Food Technol. Biotechnol.* **2022**, *60*, 45–54, doi:10.17113/ftb.60.01.22.7154.
16. Narra, M.; Kumar, A.; Patil, S. Impact of Thermal Processing on Polyphenols and Antioxidant Capacity. *Compr. Rev. Food Sci. Food Saf.* **2024**, *23*, e13251, doi:10.1111/1541-4337.13251.
17. Casati, C.B.; Baeza, R.; Sánchez, V. Thermal Degradation Kinetics of Monomeric Anthocyanins, Colour Changes and Storage Effect in Elderberry Juices. *Int. J. Food Sci. Technol.* **2015**, *50*, 2392–2398, doi:10.1111/ijfs.12905.