

Technology Development for Panna Cotta Enriched with Grape Skin Powder with Focus on Nutritional Value and Sustainability

Eugenia Covaliov*, Capcanari Tatiana, Ruseva Olga, Suhodol Natalia, Deseatnicova Olga, Resitca Vladislav, Chirsanova Aurica, Netreba Natalia

Department of Food and Nutrition, Faculty of Food Technology, Technical University of Moldova, Chisinau, Republic of Moldova

Email: *eugenia.covaliov@toap.utm.md

How to cite this paper: Covaliov, E., Tatiana, C., Olga, R., Natalia, S., Olga, D., Vladislav, R., Aurica, C. and Natalia, N. (2025) Technology Development for Panna Cotta Enriched with Grape Skin Powder with Focus on Nutritional Value and Sustainability. *Food and Nutrition Sciences*, **16**, 1472-1488.
<https://doi.org/10.4236/fns.2025.1610086>

Received: August 22, 2025

Accepted: October 11, 2025

Published: October 14, 2025

Copyright © 2025 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

This research investigates the integration of grape skins, a by-product of the winemaking industry, into Panna Cotta formulations to enhance nutritional value, bioactive compound content, and sustainability in food production. The study addresses the underutilization of grape skins, which are rich in polyphenols, dietary fibers, and antioxidants with proven health benefits. Four Panna Cotta variants were developed by incorporating grape skin powder at 1%, 2.5%, 5%, and 7.5% concentrations, alongside a control. Physico-chemical analyses included colorimetric parameters, texture profiling, total polyphenol content, and antioxidant activity. Sensory evaluation was conducted to determine consumer acceptance, and microbiological testing ensured product safety. The results demonstrated a significant increase in polyphenol content and antioxidant capacity with higher levels of grape skin powder, with the most balanced sensory acceptance observed for the 2.5% and 5% formulations. Textural analysis revealed a correlation between powder concentration and increased firmness and elasticity. Microbiological assessments confirmed the absence of pathogenic microorganisms in all samples. The findings have implications for the development of functional foods that combine indulgence with nutritional and environmental benefits.

Keywords

Grape Skin, Panna Cotta, Sustainability, Polyphenols, Antioxidants

1. Introduction

The global food sector is confronted with a persistent challenge: the generation of

large volumes of waste and by-products across all stages of the production chain. It is estimated that food processing alone accounts for nearly 38% of food waste worldwide [1]. Beyond the economic burden associated with disposal, the microbial degradation of these materials accelerates environmental pollution and poses risks to human health [2]. At the same time, these side streams are increasingly recognized as reservoirs of nutritionally and technologically valuable compounds—including polysaccharides, proteins, lipids, fibers, phytochemicals, and other bioactive molecules—that could be redirected into food systems [3].

This perspective aligns with the principles of the circular economy, which emphasize the valorization of industrial by-products as a strategy to reduce waste and create new economic opportunities [4]. By reintegrating these materials into the production cycle, industries can foster bioeconomic growth, design innovative food ingredients, and contribute to environmental sustainability. Consumer trends further reinforce this direction: the demand for natural, safe, and functional foods has increased considerably over the past decades, with the global functional food market already valued at approximately 100 billion USD in 2013 [5].

Among the most underutilized resources are lignocellulosic by-products generated by the oil, brewing, winemaking, sugarcane, coffee, fruit, and vegetable processing industries. Despite their high nutritional value, these materials—such as peels, seeds, stems, roots, and pulps—are frequently discarded and treated as pollutants [6]-[9]. In particular, viticulture and winemaking stand out as economically vital yet environmentally burdensome industries, producing large amounts of grape pomace. Inefficient management of grape residues, especially grape skins, exacerbates environmental concerns while neglecting their rich biochemical potential [10].

Grape skins are notable for their complex chemical profile, comprising polyphenols, anthocyanins, dietary fiber, vitamins, and minerals [11]. These compounds are increasingly studied for their health-promoting properties. Polyphenols, for example, exhibit dual functionality: they inhibit the growth of pathogenic microorganisms such as *Escherichia coli*, *Staphylococcus aureus*, and *Candida albicans*, while simultaneously stimulating beneficial species like *Lactobacillus* and *Bifidobacterium* [12] [13]. Additionally, polyphenols including resveratrol, catechins, and flavonoids act as powerful antioxidants, reducing oxidative stress and lowering the risk of chronic diseases such as cardiovascular disorders and cancer. Their anti-inflammatory properties further highlight the contribution of polyphenol-rich diets to long-term health maintenance [14].

Beyond polyphenols, the dietary fiber present in grape skins plays a crucial role in gut health, enhancing the production of short-chain fatty acids (SCFA) and supporting microbial balance. Such benefits are particularly relevant given current public health concerns related to excessive sugar consumption, obesity, diabetes, and cardiovascular diseases [15]. These challenges emphasize the urgent need for food innovations that integrate sustainable, nutrient-dense ingredients without

compromising sensory quality.

In light of these considerations, the present study investigates the incorporation of grape skins—an undervalued winemaking by-product—into the formulation of panna cotta, a traditional dairy dessert. The research aims to evaluate both the technological feasibility and the nutritional advantages of this approach, thereby contributing to sustainable waste valorization and the development of functional foods aligned with modern dietary needs.

2. Materials and Methods

2.1. Materials

The panna cotta formulations were prepared using cream with 35% fat content and pasteurized milk (3.5% fat), refined sugar, food-grade gelatin, and natural vanilla extract. The functional enrichment was ensured through the addition of grape skin powder obtained from two traditional Moldovan red grape varieties, *Fetească Neagră* and *Rară Neagră*, characterized by fine particle size and intense purple pigmentation.

2.2. Grape Skin Powder Sourcing & Characterization

The grape skin powders were produced from two Moldovan red cultivars, *Fetească Neagră* (FN) and *Rară Neagră* (RN). Skins were separated from fresh pomace, dried in a ventilated oven at 45°C - 50°C to constant mass, milled with a centrifugal mill, and sieved to obtain a median particle size of ~150 - 250 µm (D50). Moisture content was ≤8% (gravimetric). Powders were vacuum-packed and stored at 4°C in the dark until use.

2.3. Preparation of Panna Cotta

The preparation of panna cotta followed a standardized technological process. The cream and milk were first heated to 60°C, avoiding boiling, after which sugar was gradually added with continuous mixing to ensure complete dissolution. In parallel, gelatin was hydrated in cold water for 10 minutes and then gently heated until fully dissolved before incorporation into the mixture. Grape skin powder was subsequently added at predetermined levels (1%, 2.5%, 5%, and 7.5% of the total mass), followed by homogenization with a hand blender to achieve uniform distribution. Finally, the gelatin solution was incorporated, and the mixture was poured into molds and cooled at 4°C for 4 - 6 hours to ensure structural stabilization.

In total, nine experimental variants of panna cotta were obtained: one control sample without grape skin powder (P0%), and eight fortified formulations. These were prepared by incorporating either *Fetească Neagră* (FN) or *Rară Neagră* (RN) grape skin powder at four concentration levels each (1%, 2.5%, 5%, and 7.5%). The detailed formulations of these products, including the quantities of cream, milk, sugar, gelatin, and grape skin powder, are presented in **Table 1**.

Table 1. Functional panna cotta formulations.

Sample	Ingredients				
	Cream, %	Milk, %	Sugar, %	Gelatin, %	Grape skin, %
P0%	63	23	12	2	0
PFN1%	62	23	12	2	1
PFN2.5%	60.5	23	12	2	2.5
PFN5.0%	58	23	12	2	5
PFN7.5%	55.5	23	12	2	7.5
PRN1%	62	23	12	2	1
PRN2.5%	60.5	23	12	2	2.5
PRN5.0%	58	23	12	2	5
PRN7.5%	55.5	23	12	2	7.5

P0%—control sample, PFN1%—panna cotta with 1% addition of *Fetească Neagră* grape skin powder, PFN2.5%—panna cotta with 2.5% addition of *Fetească Neagră* grape skin powder, PFN5.0%—panna cotta with 5.0% addition of *Fetească Neagră* grape skin powder, PFN7.5%—panna cotta with 7.5% addition of *Fetească Neagră* grape skin powder, PRN1%—panna cotta with 1% addition of *Rară Neagră* grape skin powder, PRN2.5%—panna cotta with 2.5% addition of *Rară Neagră* grape skin powder, PRN5.0%—panna cotta with 5.0% addition of *Rară Neagră* grape skin powder, PRN7.5%—panna cotta with 7.5% addition of *Rară Neagră* grape skin powder.

2.4. Total Phenol Content and Antioxidant Activity

The total polyphenol content was determined according to the Folin-Ciocalteu spectrophotometric method described by Singleton and Rossi (1965) with slight modifications. Briefly, 1 mL of the extract was mixed with 5 mL of Folin-Ciocalteu reagent and 4 mL of 7% sodium carbonate solution. After 30 minutes of incubation in the dark, the absorbance was measured at 765 nm using a UV-Vis spectrophotometer. Results were expressed as mg gallic acid equivalents (GAE) per 100 g of sample [16].

The antioxidant activity was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay, following the method of Brand-Williams *et al.* (1995) with modifications. A solution of the extract was mixed with a 0.1 mM DPPH solution, and after 30 minutes of incubation in the dark, the absorbance was recorded at 517 nm. The radical scavenging activity was expressed as percentage inhibition of DPPH [17].

2.5. Colour Measurement

The color parameters were determined according to the CIE Lab* system using a Konica Minolta colorimeter CR-400 (Osaka, Japan). The instrument was calibrated with a standard white plate before each set of measurements. Color values were recorded as L* (lightness), a* (red-green), and b* (yellow-blue) coordinates.

2.6. Texture Profile Analysis

The textural properties were evaluated using a TA.HDplusC texture analyzer (Stable Micro Systems, Godalming, UK). A cylindrical probe (P/36R, 36 mm diameter) was employed to compress the samples in a double-cycle test. The test parameters were set as follows: pre-test speed 1.0 mm/s, test speed 1.0 mm/s, post-test speed 5.0 mm/s, compression distance 50% of the original sample height, and a trigger force of 5 g. A 5-second interval between the two compression cycles was applied to simulate mastication. From the force-time curves, the following parameters were calculated: firmness, adhesiveness, cohesiveness, gumminess, springiness, resilience and chewiness. These parameters were determined according to the procedure described by Khule *et al.* (2024) and further applied in food texture analysis [18].

2.7. Microbiological Analysis

Microbiological stability was assessed using two culture media: Sabouraud Dextrose Agar (SDA) for yeasts and molds, and HM Peptone B Agar for total aerobic mesophilic bacteria. Each sample (10 g) was homogenized in 0.85% sterile saline (1:10, w/v) using a sterile stomacher for 1 min. Appropriate decimal dilutions were plated by pour-plate or spread-plate methods. SDA plates were incubated at 25 °C for 3 - 5 days, while HM Peptone B plates were incubated at 37 °C for 24 - 48 h. Colony counts were expressed as CFU/g.

2.8. Sensorial Analysis

The sensory evaluation was carried out at the Department of Food and Nutrition of the Technical University of Moldova, following the recommendations of ISO 8589:2007 for sensory analysis in controlled environments [19]. A group of consumer-type assessors, aged between 21 and 74 years, participated in the evaluation under standardized conditions of neutral lighting and constant temperature. The panna cotta samples were presented in coded form and in randomized order to minimize bias, while panelists were instructed to rinse their mouths with water between tastings to ensure palate cleansing.

Each sample was judged for five key attributes: color (uniformity and visual appeal), appearance (smoothness, gloss, and absence of defects), consistency (creaminess, fineness, and compactness), taste (balance between sweetness and astringency, persistence of aftertaste), and aroma (intensity and dessert-specific character). For the evaluation, the classical 9-point hedonic scale was applied, originally proposed by Peryam and Girardot (1952) [20], where 1 corresponds to “dislike extremely” and 9 to “like extremely”. This approach allowed the collection of consumer preference data in a structured yet intuitive manner, providing insights into the acceptability of the formulations.

2.9. Statistical Analysis

All measurements were performed in triplicate and reported as mean \pm SD. One-

way ANOVA was applied to assess the effect of formulation (powder type and concentration), followed by Tukey's HSD post-hoc test. Differences were considered significant at $p < 0.05$. Different superscript letters within a row or column indicate significant differences. (XLStat)

3. Results and Discussions

3.1. Color Parameters

The assessment of color parameters is an important stage in the characterization of dairy desserts enriched with plant-based ingredients. In this study, the CIELAB system was applied in order to determine the influence of grape skin powder on the chromatic attributes of panna cotta. The evaluation included the coordinates L^* (lightness), a^* (red-green axis), and b^* (yellow-blue axis), as well as the overall color difference (ΔE) in relation to the control formulation. These indicators are widely recognized for their relevance in describing the visual appearance of food products and for establishing correlations with pigment composition, particularly anthocyanins and other phenolic compounds present in grape skins. The analysis was performed on samples fortified with different levels of *Fetească Neagră* and *Rară Neagră* grape skin powder (1.0%, 2.5%, 5.0%, and 7.5%), compared to the non-enriched control. The data (Table 2) provide insight into the extent to which the type of grape variety and the concentration of powder contribute to modifications in lightness, hue, and chromatic stability of the final product.

Table 2. Color parameters of panna cotta samples.

Sample	L^*	a^*	b^*	ΔE
P0%	71.48 ± 0.11 ^h	-3.23 ± 0.18 ^a	10.78 ± 0.12 ^f	
PFN1%	64.67 ± 0.14 ^f	-1.15 ± 0.22 ^c	4.24 ± 0.14 ^d	8.77 ± 0.14 ^b
PFN2.5%	45.91 ± 0.12 ^{cd}	0.02 ± 0.15 ^d	3.31 ± 0.16 ^e	27.86 ± 0.13 ^d
PFN5.0%	28.42 ± 0.09 ^{ab}	7.21 ± 0.11 ^f	1.55 ± 0.13 ^b	44.43 ± 0.11 ^f
PFN7.5%	27.35 ± 0.21 ^a	8.26 ± 0.17 ^g	-2.29 ± 0.15 ^a	46.32 ± 0.08 ^{fg}
PRN1%	68.62 ± 0.15 ^g	-2.11 ± 0.23 ^b	6.34 ± 0.11 ^d	4.90 ± 0.23 ^a
PRN2.5%	56.12 ± 0.12 ^e	-1.24 ± 0.12 ^c	6.28 ± 0.08 ^d	16.55 ± 0.15 ^c
PRN5.0%	44.32 ± 0.14 ^c	4.62 ± 0.08 ^e	4.55 ± 0.12 ^d	27.80 ± 0.14 ^d
PRN7.5%	33.58 ± 0.13 ^b	4.41 ± 0.13 ^e	7.81 ± 0.16 ^e	39.67 ± 0.08 ^e

Results indicate the mean value of three independent assays and are expressed as mean ± standard deviation (SD), in each row different letters a–h mean significant differences ($p < 0.05$). P0%—control sample, PFN1%—panna cotta with 1% addition of *Fetească Neagră* grape skin powder, PFN2.5%—panna cotta with 2.5% addition of *Fetească Neagră* grape skin powder, PFN5.0%—panna cotta with 5.0% addition of *Fetească Neagră* grape skin powder, PFN7.5%—panna cotta with 7.5% addition of *Fetească Neagră* grape skin powder, PRN1%—panna cotta with 1% addition of *Rară Neagră* grape skin powder, PRN2.5%—panna cotta with 2.5% addition of *Rară Neagră* grape skin powder, PRN5.0%—panna cotta with 5.0% addition of *Rară Neagră* grape skin powder, PRN7.5%—panna cotta with 7.5% addition of *Rară Neagră* grape skin powder.

Analysis of the experimental data revealed that the addition of grape skin powder led to marked alterations in the CIELAB color coordinates of panna cotta, with the magnitude of change depending on both the concentration and the grape variety used. The control sample displayed the highest lightness value ($L^* = 71.48$), corresponding to the characteristic cream-like color of the product. The addition of grape skin powder led to a progressive decrease in L^* , with the most notable reduction observed in samples fortified with *Fetească Neagră*, where the value dropped to 27.35 at the 7.5% level, corresponding to a 61.7% decline relative to the control. In contrast, *Rară Neagră* produced a somewhat less pronounced reduction in lightness, reaching 33.58 at 7.5%, equivalent to a 51.0% decrease. These observations confirm the strong pigmentation potential of anthocyanins, which accumulate in grape skins and directly affect the visual properties of food matrices.

The a^* parameter also shifted significantly with enrichment. The control sample had a negative value (-3.23), reflecting the absence of red hues. With increasing incorporation of grape skin powder, the a^* coordinate increased markedly, peaking at 8.26 for *Fetească Neagră* and 4.62 for *Rară Neagră*. This indicates the intensification of red tonalities, particularly in the *Fetească Neagră* formulations, where anthocyanins such as malvidin-3-glucoside predominate. The b^* values demonstrated a contrasting trend between the two varieties. In *Fetească Neagră*, the progressive reduction of b^* culminated in a negative value (-2.29) at 7.5%, which reflects a bluish shift and confirms the dominance of anthocyanin pigments with high antioxidant activity. Conversely, *Rară Neagră* samples maintained positive b^* values across all concentrations, with the highest level (7.81) recorded at 7.5%, indicating a persistent yellow component likely associated with flavonols and residual carotenoid pigments. The overall color difference (ΔE) confirmed perceptible modifications compared with the control, with values ranging from 8.77 to 46.32 for *Fetească Neagră* and from 4.90 to 39.67 for *Rară Neagră*. These data suggest that while both varieties significantly alter the chromatic attributes of panna cotta, *Fetească Neagră* exerts a more intense influence, leading to darker, red-blue hues, whereas *Rară Neagră* induces softer changes that retain yellowish undertones.

The physiological basis of these observations can be attributed to the presence of polyphenolic compounds, particularly anthocyanins, which are known for their dual role as natural colorants and antioxidants. As highlighted by Goff *et al.* (2025), colorants derived from natural pigments not only modify the visual appeal of foods but also contribute to their functional and nutritional profile, aligning with current trends in sustainable product development [21]. Comparable chromatic modifications were described by Covaliov *et al.* (2024), who reported that the enrichment of yogurt with grape skin powder from *Fetească Neagră* and *Rară Neagră* led to a significant decrease in L values and an increase in a^* , directly associated with the presence of anthocyanins such as malvidin-3-glucoside and delphinidin derivatives. The authors highlighted that the intensity of red-purple hues in the fortified samples was largely explained by the pH-dependent stability of

anthocyanins, confirming that these pigments are the primary drivers of visual transformations in dairy-based systems, a mechanism also reflected in the researched panna cotta formulations [11]. The parallel with the current study underscores that color intensification in enriched panna cotta is not merely an aesthetic modification but also reflects the accumulation of bioactive compounds with potential health benefits. Furthermore, Ekumah *et al.* (2023) demonstrated that structural modifications induced by ethanol exposure in kudzu starch gels altered their physicochemical appearance and digestibility [22], reinforcing the idea that chromatic shifts in food products often signal deeper changes in functionality and bioactive retention.

3.2. Texture Parameters

The instrumental assessment of texture provides valuable insight into the structural modifications induced by the incorporation of grape skin powder in panna cotta formulations. Parameters such as firmness, adhesiveness, springiness, resilience, cohesiveness, and chewiness were determined in order to describe the mechanical behavior of the product (Table 3). These indicators are essential for characterizing the consistency and mouthfeel of dairy desserts and for establishing the relationship between formulation, structural integrity, and consumer perception. The analysis was conducted on samples enriched with increasing levels of *Fetească Neagră* and *Rară Neagră* grape skin powder, with results compared against the control formulation.

Table 3. Texture parameters of panna cotta samples.

Sample	Firmness, g	Adhesiveness, g·s	Springiness, %	Resilience, %	Cohesiveness, %	Chewiness, g
P0%	25.01 ± 2.75 ^{ab}	27.27 ± 1.24 ^a	100.00 ± 1.75 ^e	0.98 ± 0.08 ^a	36.28 ± 2.65 ^d	907.86 ± 11.42 ^d
PFN1%	29.56 ± 1.89 ^{cd}	30.02 ± 2.64 ^{bc}	99.15 ± 1.19 ^d	0.69 ± 0.04 ^a	38.99 ± 1.42 ^{de}	1153.53 ± 15.87 ^e
PFN2.5%	29.93 ± 1.54 ^{cd}	31.63 ± 2.24 ^c	97.87 ± 2.24 ^c	4.37 ± 0.13 ^b	29.88 ± 1.75 ^c	894.61 ± 13.36 ^d
PFN5.0%	24.62 ± 2.11 ^a	28.62 ± 1.82 ^{ab}	96.26 ± 2.36 ^b	20.63 ± 0.19 ^e	12.12 ± 1.16 ^{ab}	297.32 ± 9.14 ^a
PFN7.5%	26.74 ± 2.57 ^b	29.05 ± 2.46 ^b	95.47 ± 1.45 ^a	25.16 ± 0.17 ^f	10.76 ± 2.35 ^a	287.9 ± 8.95 ^a
PRN1%	33.31 ± 3.41 ^d	31.94 ± 2.35 ^c	98.74 ± 2.86 ^d	0.36 ± 0.06 ^a	39.85 ± 3.92 ^e	1327.45 ± 12.45 ^f
PRN2.5%	33.56 ± 3.46 ^d	35.41 ± 3.15 ^d	96.75 ± 1.79 ^b	9.35 ± 0.15 ^c	22.09 ± 2.41 ^b	742.85 ± 7.68 ^c
PRN5.0%	28.07 ± 2.53 ^c	31.16 ± 2.24 ^c	95.67 ± 2.48 ^a	16.27 ± 0.12 ^d	13.64 ± 2.25 ^{ab}	383.08 ± 6.17 ^b
PRN7.5%	23.52 ± 1.74 ^a	28.08 ± 2.63 ^{ab}	94.54 ± 1.42 ^a	27.82 ± 0.14 ^g	10.4 ± 1.85 ^a	244.67 ± 7.26 ^a

Results indicate the mean value of three independent assays and are expressed as mean ± standard deviation (SD), in each row different letters a-g mean significant differences ($p < 0.05$). P0%—control sample, PFN1%—panna cotta with 1% addition of *Fetească Neagră* grape skin powder, PFN2.5%—panna cotta with 2.5% addition of *Fetească Neagră* grape skin powder, PFN5.0%—panna cotta with 5.0% addition of *Fetească Neagră* grape skin powder, PFN7.5%—panna cotta with 7.5% addition of *Fetească Neagră* grape skin powder, PRN1%—panna cotta with 1% addition of *Rară Neagră* grape skin powder, PRN2.5%—panna cotta with 2.5% addition of *Rară Neagră* grape skin powder, PRN5.0%—panna cotta with 5.0% addition of *Rară Neagră* grape skin powder, PRN7.5%—panna cotta with 7.5% addition of *Rară Neagră* grape skin powder.

The instrumental texture assessment demonstrated notable alterations in the structural behavior of panna cotta as a result of grape skin powder incorporation, with variations depending on both concentration and grape variety. Firmness values ranged from 25.01 g in the control to 29.93 g at 2.5% addition of *Fetească Neagră* and 33.56 g at 2.5% *Rară Neagră*, indicating that moderate enrichment increased gel strength by approximately 20% - 30%. However, at higher concentrations (5% - 7.5%), firmness declined, particularly in the *Rară Neagră* 7.5% sample (23.52 g), suggesting that excessive fiber incorporation may disrupt protein-gelatin interactions and reduce structural integrity.

Adhesiveness followed a similar pattern, with values rising from 27.27 g·s in the control to a maximum of 35.41 g·s in *Rară Neagră* at 2.5%, before decreasing at higher additions. This trend indicates that grape skin polysaccharides enhanced water-binding and matrix interaction at moderate levels, but oversaturation weakened gel cohesion. Springiness decreased slightly across all enriched samples, from 100% in the control to 94.54% at 7.5% *Rară Neagră*, reflecting reduced elasticity due to the interference of fibrous particles with the continuous gel network.

Resilience exhibited the strongest shifts, with control panna cotta showing minimal recovery (0.98%), while enriched samples, especially with *Fetească Neagră* at 7.5% (25.16%) and *Rară Neagră* at 7.5% (27.82%), displayed markedly higher resilience. This demonstrates the strengthening role of insoluble fibers, which contribute to energy absorption and recovery during deformation. Cohesiveness, however, decreased sharply from 36.28% in the control to 10% - 12% in high-fiber formulations, indicating reduced internal bonding within the gel structure. Chewiness followed the combined pattern of firmness and cohesiveness: the control exhibited 907.86 g, while *Rară Neagră* at 1% reached 1327.45 g (+46%), but higher concentrations caused a drastic decline, with *Fetească Neagră* at 7.5% measuring only 287.9 g (-68%).

These observations align with previous research on the fortification of dairy desserts with plant-derived ingredients. Sekhavatizadeh *et al.* (2022) reported that quinoa protein isolate increased firmness and chewiness in milk desserts at moderate levels, but excessive enrichment compromised texture due to protein-fiber competition [23]. Similarly, Şanlı (2023) showed that carob powder incorporation in whey-based desserts enhanced adhesiveness and resilience while reducing cohesiveness, a trend closely comparable to the present findings [24]. Kusio *et al.* (2022) demonstrated that dried vegetable powders in fat-free dairy desserts significantly modified springiness and firmness, supporting the view that fiber-rich additives act as both textural enhancers and disruptors, depending on concentration [25]. Salehi (2021) also emphasized that the integration of fruit and vegetable powders into dairy systems often results in a dual effect: improved mechanical strength at low doses and network destabilization at higher levels, consistent with the behavior observed in the current formulations [26].

Grape skin powder exerts a bidirectional impact on the textural attributes of panna cotta. At low to moderate levels (1% - 2.5%), both *Fetească Neagră* and *Rară*

Neagră improve firmness, adhesiveness, and chewiness, thus enhancing structural quality and mouthfeel. However, excessive incorporation (5% - 7.5%) reduces cohesiveness and chewiness, leading to a more fragile gel. The varietal effect was also evident: *Rară Neagră* contributed more strongly to firmness and chewiness, while *Fetească Neagră* showed higher resilience at elevated concentrations. These findings highlight the potential of grape skins not only as bioactive fortifiers but also as structural modulators in dairy desserts, with practical implications for optimizing formulations that balance nutritional functionality with consumer-acceptable texture.

3.3. Polyphenol Content and Antioxidant Activity of Panna Cotta Samples

The incorporation of grape skin powder into panna cotta formulations was investigated not only for its technological impact, but also for its contribution to the biological activity of the final product. Polyphenols are widely recognized as key bioactive compounds, being abundant in grape pomace and particularly concentrated in the skins of red grape varieties (*Vitis vinifera L.*). Their antioxidant potential derives from multiple mechanisms, including free radical scavenging, electron donation, and metal ion chelation [27] [28]. Beyond their chemical reactivity, polyphenols are associated with health-promoting effects such as the reduction of oxidative stress and the prevention of chronic diseases, which makes their inclusion in functional foods of particular interest [29]. Previous studies have already highlighted the value of grape pomace powders as fortifying agents in various matrices. Bender *et al.* (2017) [30] demonstrated that the enrichment of muffins with grape skins improved technological performance while enhancing bioactive content, while Walker *et al.* (2014) [31] reported similar benefits in baked goods without compromising sensory quality. Likewise, Marchiani *et al.* (2016) showed that grape pomace fortification in semi-hard cheeses increased phenolic content and antioxidant capacity without adversely affecting physicochemical stability [32].

In the present study, the effect of grape skin powders on total polyphenol content and antioxidant activity of panna cotta dessert was evaluated. The results, illustrated in **Figure 1**, confirm a strong enrichment effect, demonstrating the potential of these by-products as natural sources of phenolic compounds for improving both the nutritional profile and the functional value of dairy-based desserts.

The evaluation of bioactive potential was first conducted on the grape skin powders themselves, which revealed strikingly high values of total polyphenol content and antioxidant activity. The powder obtained from *Fetească Neagră* contained 638.31 mg GAE/100 g, while that from *Rară Neagră* contained 340.04 mg GAE/100 g. Antioxidant capacity, measured by DPPH inhibition, reached 98.12% for *Fetească Neagră* and 94.27% for *Rară Neagră*. These findings confirm that grape skins are highly concentrated sources of phenolic compounds, with varietal differences most likely explained by higher anthocyanin and flavonoid content in *Fetească Neagră*. Such varietal variation is consistent with the observations of

Kupe *et al.* (2021), who demonstrated significant differences in phenolic profiles and antioxidant activity among different clones of the Turkish grape cultivar “Karaerik” [33].

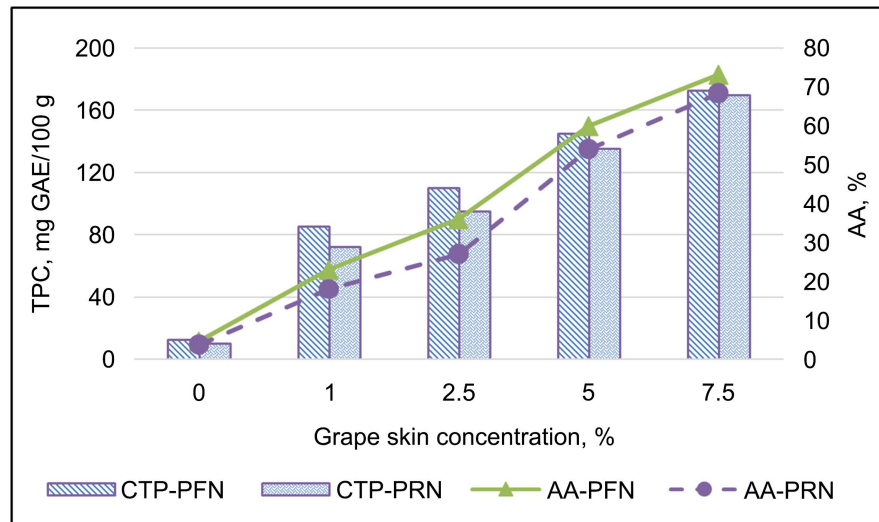


Figure 1. Total polyphenol content (TPC) and antioxidant Activity (AA) of panna cotta samples.

When incorporated into panna cotta, the powders produced a concentration-dependent increase in bioactive parameters. Control samples displayed only minimal phenolic content (12.44 mg GAE/100 g for *Fetească Neagră* and 10.13 mg GAE/100 g for *Rară Neagră*) and negligible antioxidant capacity (4.56% and 3.66%, respectively). With enrichment, however, polyphenol levels rose progressively to 172.34 mg GAE/100 g and 169.55 mg GAE/100 g at 7.5% addition, representing a more than fourteen-fold increase compared with the control. Antioxidant activity followed the same trend, reaching 73.23% for *Fetească Neagră* and 68.43% for *Rară Neagră* at the highest supplementation level. These results demonstrate that the bioactive potential of the powders is effectively transferred to the panna cotta matrix, enhancing both its nutritional and functional quality.

The physiological explanation for these findings lies in the structural diversity of grape polyphenols, particularly anthocyanins, catechins, and phenolic acids, which exhibit strong radical scavenging and metal-chelating properties. The slightly higher values observed in *Fetească Neagră* samples can be attributed to the greater abundance of anthocyanins, which are known for their potent antioxidant effects. Comparable effects of grape by-products in dairy systems have been reported by Navaz and Yam (2021), who showed that the incorporation of red grape pomace powder into probiotic yoghurt significantly increased total phenolic content and antioxidant activity while maintaining acceptable sensory properties [34]. Our findings also align with results obtained in cereal- and bakery-based matrices. Antonic *et al.* (2021) demonstrated that grape seed flour markedly improved the antioxidant profile of waffles [35], while Antonioli *et al.* (2024) con-

firmed that the inclusion of grape pomace in bakery products enhanced phenolic content and sensory perception [36]. Such parallels reinforce the idea that the beneficial effects observed in panna cotta are part of a broader trend: the incorporation of grape by-products consistently enhances both nutritional and functional properties across diverse food categories. Taken together, these results provide compelling evidence that grape skin powders from *Fetească Neagră* and *Rară Neagră* act as powerful bioactive enhancers in panna cotta. The marked increases in polyphenolic concentration and antioxidant capacity not only demonstrate the functional value of these ingredients but also highlight their potential as sustainable fortifiers in the development of functional dairy desserts.

The progressive increase in TPC and DPPH inhibition across the fortified samples indicates a meaningful gain in antioxidant capacity at the point of consumption; in line with prior evidence on grape-derived polyphenols, such improvements are relevant to oxidative-stress modulation and may support dietary strategies targeting chronic disease risk reduction when products are consumed as part of balanced diets [28].

3.4. Microbiological Load

The microbiological assessment confirmed that all panna cotta samples, including the fortified formulations with grape skin powder, complied with safety standards. After 48 h of refrigerated storage, no growth of pathogenic microorganisms was detected on selective media. Total aerobic mesophilic counts remained below 1.0×10^2 CFU/g, while yeasts and molds were not observed in detectable levels on Sabouraud Dextrose Agar. These values fall well within the microbiological safety criteria generally applied to refrigerated dairy desserts, which typically set limits of 1.0×10^4 CFU/g for total aerobic bacteria and 1.0×10^2 CFU/g for yeasts and molds. The absence of microbial hazards across all enrichment levels indicates that the incorporation of grape skin powder did not compromise safety, supporting the technological feasibility of using this by-product as a functional ingredient.

3.5. Sensorial Characteristics

The addition of grape skin powder produced concentration-dependent changes in the sensory attributes of panna cotta (Table 4). The control formulation (P0%) was most appreciated, with high scores for appearance (8.60), color (8.80), taste (8.24), aroma (8.76), and consistency (8.31), corresponding to *like very much*. At a 1% supplementation level, both *Fetească Neagră* and *Rară Neagră* maintained good consumer perception, with general acceptance values of 7.82 and 7.56, respectively. These scores fall into the category *like it*, showing that small additions were well tolerated without compromising the overall product quality.

With increasing powder levels, the visual parameters were the first to be affected. In PFN2.5% and PRN2.5%, color scores decreased to 5.81 and 5.86, which corresponds to *neither like nor dislike*. This change reflects the impact of anthocyanins such as malvidin-3-glucoside and delphinidin derivatives, which pro-

duced darker shades that were less appreciated by consumers. Interestingly, appearance in PRN2.5% remained relatively high (8.22), indicating that surface uniformity was still acceptable despite the intensified pigmentation.

Table 4. Average results obtained in the sensory evaluation of seasoning powders.

Sample	Aspect	Colour	Taste	Aroma	Consistency	General acceptance
P0%	8.60 ± 0.35 ^c	8.80 ± 0.25 ^d	8.24 ± 0.46 ^a	8.76 ± 0.17 ^c	8.31 ± 0.22 ^d	8.5 ± 0.29 ^d
PFN1%	8.32 ± 0.23 ^c	7.62 ± 0.37 ^c	7.80 ± 0.16 ^b	7.68 ± 0.08 ^b	7.60 ± 0.12 ^c	7.82 ± 0.19 ^c
PFN2.5%	6.92 ± 0.15 ^b	5.81 ± 0.21 ^a	6.72 ± 0.28 ^a	7.42 ± 0.24 ^b	7.78 ± 0.35 ^c	6.93 ± 0.25 ^b
PFN5.0%	5.81 ± 0.18 ^a	6.20 ± 0.13 ^b	6.58 ± 0.21 ^a	7.80 ± 0.20 ^b	7.36 ± 0.16 ^c	6.75 ± 0.18 ^b
PFN7.5%	5.82 ± 0.09 ^a	6.18 ± 0.32 ^b	6.24 ± 0.46 ^a	6.86 ± 0.34 ^a	5.10 ± 0.28 ^a	6.04 ± 0.30 ^a
PRN1%	8.44 ± 0.13 ^c	7.36 ± 0.27 ^c	7.28 ± 0.33 ^b	7.45 ± 0.14 ^b	7.38 ± 0.12 ^c	7.56 ± 0.26 ^{bc}
PRN2.5%	8.22 ± 0.42 ^c	5.86 ± 0.17 ^a	7.32 ± 0.20 ^b	7.28 ± 0.23 ^b	7.36 ± 0.27 ^c	7.21 ± 0.26 ^b
PRN5.0%	6.23 ± 0.18 ^b	5.74 ± 0.32 ^a	6.54 ± 0.24 ^a	7.14 ± 0.09 ^b	6.65 ± 0.18 ^b	6.46 ± 0.20 ^{ab}
PRN7.5%	5.58 ± 0.14 ^a	5.88 ± 0.24 ^a	6.28 ± 0.12 ^a	7.28 ± 0.16 ^b	4.92 ± 0.14 ^a	5.99 ± 0.16 ^a

Taste perception also declined gradually with higher enrichment. While FN1% and RN1% were well accepted (7.80 and 7.28, respectively), higher concentrations produced a more astringent flavor profile, leading to lower scores in FN2.5% (6.72) and RN5% (6.54). These results are consistent with earlier studies, where excessive incorporation of grape pomace or seed-derived ingredients imparted bitterness and reduced liking in dairy and bakery products [34] [36]. Aroma was less influenced overall, with scores remaining between 6.86 and 7.80 for most fortified samples, suggesting that volatile compounds from grape skins did not strongly interfere with the characteristic creamy aroma of panna cotta.

Consistency was the most sensitive parameter at high concentrations. While intermediate formulations (PFN2.5% - PFN5.0% and PRN2.5% - PRN5.0%) retained acceptable values (6.65 - 7.78), the highest level of supplementation (7.5%) markedly reduced scores to 5.10 for FN and 4.92 for RN, which corresponds to *dislike slightly*. This can be attributed to the high water-binding capacity of grape skin fibers, which disrupted gel formation and led to a denser, less elastic texture. Comparable outcomes have been reported by Antonioli *et al.* (2024) in bakery systems enriched with grape pomace, where excessive fiber incorporation altered crumb structure and reduced sensory appreciation [36]. The pattern observed across all attributes indicates that panna cotta fortified with small amounts of grape skin powder can be perceived positively by consumers, while higher concentrations progressively reduce acceptance due to intensified pigmentation, increased astringency, and loss of creaminess.

Beyond compositional and sensory outcomes, the use of grape skins directly advances circular-economy objectives by diverting a high-volume winery by-product into a value-added food ingredient. The observed feasibility at 1% - 5% inclusion demonstrates a practical route to reduce waste streams while enhancing the functional profile of a familiar dairy dessert—an approach consistent with bioresource valorization strategies highlighted in the introduction and recent literature.

4. Conclusions

The incorporation of grape skin powder from *Fetească Neagră* and *Rară Neagră* into panna cotta formulations produced consistent modifications in physico-chemical, functional, and sensory attributes. Lightness decreased from 71.48 in the control to 27.35 in PFN7.5%, while redness increased from -3.23 to 8.26, reflecting the contribution of anthocyanins such as malvidin-3-glucoside and delphinidin derivatives. Total polyphenol content rose markedly, from 12.44 mg GAE/100 g in the control to 172.34 mg GAE/100 g at 7.5% FN, accompanied by an increase in antioxidant activity from 4.56% to 73.23% inhibition of DPPH radicals. Textural evaluation showed that firmness and chewiness improved by up to 30% at low levels of enrichment (1% - 2.5%), whereas higher additions reduced cohesiveness and creaminess. Sensory acceptance remained high at 1% supplementation (7.56 - 7.82, corresponding to *like it*), but decreased to around 6.0 at 7.5% fortification, where darker pigmentation, increased astringency, and denser consistency were less appreciated. By combining nutritional enhancement with a sustainable approach to winemaking by-product utilization, grape skin powder provides a promising ingredient for the development of functional dairy-based desserts. From an industrial perspective, formulations with 1% - 2.5% grape skin powder balance functional gains with consumer acceptance and processability, offering an immediately transferable option for pilot-scale trials, while higher inclusions may require particle-size control or polyphenol-rich extracts to mitigate color and texture penalties during scale-up.

Acknowledgements

We gratefully thank Agence Universitaire de la Francophonie that supports the International Project “Valorisation intelligente des résidus viti-vinicoles dans le contexte de l'économie circulaire”, running at Technical University of Moldova and to the World Federation of Scientists National Scholarship.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Rao, M., Bast, A. and de Boer, A. (2021) Valorized Food Processing By-Products in the EU: Finding the Balance between Safety, Nutrition, and Sustainability. *Sustainability*, **13**, Article 4428. <https://doi.org/10.3390/su13084428>

- [2] Choudhary, M., Singh, D., Parihar, M., Choudhary, K.B., Nogia, M., Samal, S.K., *et al.* (2024) Impact of Municipal Solid Waste on the Environment, Soil, and Human Health. In: Meena, V.S., Rakshit, A., Meena, M.D., Baslam, M., Fattah, I.R., Lam, S.S. and Kaba, J.S., Eds., *Waste Management for Sustainable and Restored Agricultural Soil*, Academic Press, 33-58. <https://doi.org/10.1016/b978-0-443-18486-4.00011-7>
- [3] Kokkinomagoulos, E. and Kandylis, P. (2023) Grape Pomace, an Undervalued By-Product: Industrial Reutilization within a Circular Economy Vision. *Reviews in Environmental Science and Biol Technology*, **22**, 739-773. <https://doi.org/10.1007/s11157-023-09665-0>
- [4] Capanoglu, E., Nemli, E. and Tomas-Barberan, F. (2022) Novel Approaches in the Valorization of Agricultural Wastes and Their Applications. *Journal of Agricultural and Food Chemistry*, **70**, 6787-6804. <https://doi.org/10.1021/acs.jafc.1c07104>
- [5] Mallek-Ayadi, S., Bahloul, N. and Kechaou, N. (2018) Chemical Composition and Bioactive Compounds of Cucumis Melo L. Seeds: Potential Source for New Trends of Plant Oils. *Process Safety and Environmental Protection*, **113**, 68-77. <https://doi.org/10.1016/j.psep.2017.09.016>
- [6] Usman, I., Sana, S., Afzaal, M., Imran, A., Jaffar, H.M., Sukhera, S., *et al.* (2025) Phytochemicals in Plant Food Waste: Innovative Insight and Implications. *Journal of Agriculture and Food Research*, **20**, Article 101779. <https://doi.org/10.1016/j.jafr.2025.101779>
- [7] Okuthe, G. (2024) Valorizing Fruit and Vegetable Waste: The Untapped Potential for Entrepreneurship in Sub-Saharan Africa—A Systematic Review. *Recycling*, **9**, Article 40. <https://doi.org/10.3390/recycling9030040>
- [8] Capcanari, T.N., Covaliov, E.F. and Negoita, C.L. (2024) Hemp (*Cannabis sativa* L.) Seeds Nutritional Aspects and Food Production Perspectives: A Review. *Food systems*, **7**, 52-58. <https://doi.org/10.21323/2618-9771-2024-7-1-52-58>
- [9] Eugenia, C., Tatiana, C., Oxana, R. and Alina, B. (2024) Oil Seed Meals and Pasta: A New Dimension in By-Product Valorization. *The Annals of the University Dunarea de Jos of Galati. Fascicle VI-Food Technology*, **48**, 9-26. <https://doi.org/10.35219/foodtechnology.2024.2.01>
- [10] Covaliov, E., Ruseva, O., Resitca, V., Deseatnicova, O., Capcanari, T. and Suhodol, N. (2024) Harnessing Grape Pomace: Nutritional Aspects, Recovery and Extraction Techniques for Health Benefits. *Journal of Engineering Science*, **31**, 112-125. [https://doi.org/10.52326/jes.utm.2024.31\(1\).09](https://doi.org/10.52326/jes.utm.2024.31(1).09)
- [11] Covaliov, E., Capcanari, T., Reșitca, V., Chirsanova, A., Boiștean, A., Sturza, R., *et al.* (2024) Exploring the Biological Value of Red Grape Skin: Its Incorporation and Impact on Yogurt Quality. *Foods*, **13**, Article 3254. <https://doi.org/10.3390/foods13203254>
- [12] Pereira, A.P., Ferreira, I.C., Marcelino, F., Valentão, P., Andrade, P.B., Seabra, R., *et al.* (2007) Phenolic Compounds and Antimicrobial Activity of Olive (*Olea Europaea* L. Cv. Cobrançosa) Leaves. *Molecules*, **12**, 1153-1162. <https://doi.org/10.3390/12051153>
- [13] Kawabata, K., Yoshioka, Y. and Terao, J. (2019) Role of Intestinal Microbiota in the Bioavailability and Physiological Functions of Dietary Polyphenols. *Molecules*, **24**, Article 370.
- [14] Indra Arulselvi, P., Kavaya, K.R. and Kesavapriya, M. (2024) Dietary Polyphenols: Recent Trends in Its Biological Significance Science and Engineering of Polyphenols. John Wiley & Sons, Ltd, 489-507.

- [15] Taladrid, D., Rebollo-Hernanz, M., Martin-Cabrejas, M.A., Moreno-Arribas, M.V. and Bartolomé, B. (2023) Grape Pomace as a Cardiometabolic Health-Promoting Ingredient: Activity in the Intestinal Environment. *Antioxidants*, **12**, Article 979. <https://doi.org/10.3390/antiox12040979>
- [16] Singleton, V.L. and Rossi, J.A. (1965) Colorimetry of Total Phenolics with Phosphomolybdic-Phosphotungstic Acid Reagents. *American Journal of Enology and Viticulture*, **16**, 144-158. <https://doi.org/10.5344/ajev.1965.16.3.144>
- [17] Brand-Williams, W., Cuvelier, M.E. and Berset, C. (1995) Use of a Free Radical Method to Evaluate Antioxidant Activity. *LWT-Food Science and Technology*, **28**, 25-30. [https://doi.org/10.1016/s0023-6438\(95\)80008-5](https://doi.org/10.1016/s0023-6438(95)80008-5)
- [18] Khule, G.D., Ranvare, A.R., Singh, A. and C, S.B. (2024) Texture Profile Analysis: A Comprehensive Insight into Food Texture Evaluation. *Journal of Dynamics and Control*, **8**, 30-45. <https://doi.org/10.71058/jodac.v8i9003>
- [19] ISO 8589:2007 Sensory Analysis-General Guidance for the Design of Test Rooms. International Organization for Standardization.
- [20] Peryam, D. and Girardot, N. (1952) Advanced Taste-Test Method. *Food Engineering*, **24**, 58-61.
- [21] Goff, H.D., Hartel, R.W. and Rankin, S.A. (2025) Flavoring and Coloring Materials. In: *Ice Cream*, Springer, 93-126. https://doi.org/10.1007/978-3-031-77872-8_4
- [22] Ekumah, J., Han, X., Liang, Q., Kang, L., Wei, B., Rashid, A., *et al.* (2023) Production of Kudzu Starch Gels with Superior Mechanical and Rheological Properties through Submerged Ethanol Exposure and Implications for *in Vitro* Digestion. *Foods*, **12**, Article 3992. <https://doi.org/10.3390/foods12213992>
- [23] Sekhavatizadeh, S.S., Karimi, A., Hosseinzadeh, S., Shaviklo, A.R., Abedi, M., Mahmoodianfard, H., *et al.* (2023) Nutritional and Sensory Properties of Low-Fat Milk Dessert Enriched with Quinoa (*Chenopodium quinoa* Willd) Titicaca Protein Isolate. *Food Science & Nutrition*, **11**, 516-526. <https://doi.org/10.1002/fsn3.3082>
- [24] Şanlı, T. (2023) Investigation of Utilizing Whey in Dairy-Based Dessert Formulations with Carob Powder. *Gıda*, **48**, 670-681. <https://doi.org/10.15237/gida.gd23015>
- [25] Kusio, K., Szafrńska, J.O., Radzki, W. and Sołowiej, B.G. (2022) Effect of Different Dried Vegetable Powders on Physicochemical, Organoleptic, and Antioxidative Properties of Fat-Free Dairy Desserts. *Applied Sciences*, **12**, Article 11503. <https://doi.org/10.3390/app122211503>
- [26] Salehi, F. (2021) Quality, Physicochemical, and Textural Properties of Dairy Products Containing Fruits and Vegetables: A Review. *Food Science & Nutrition*, **9**, 4666-4686. <https://doi.org/10.1002/fsn3.2430>
- [27] Kammerer, D., Claus, A., Carle, R. and Schieber, A. (2004) Polyphenol Screening of Pomace from Red and White Grape Varieties (*Vitis vinifera* L.) by HPLC-DAD-MS/MS. *Journal of Agricultural and Food Chemistry*, **52**, 4360-4367. <https://doi.org/10.1021/jf049613b>
- [28] Averilla, J.N., Oh, J., Kim, H.J., Kim, J.S. and Kim, J. (2019) Potential Health Benefits of Phenolic Compounds in Grape Processing By-Products. *Food Science and Biotechnology*, **28**, 1607-1615. <https://doi.org/10.1007/s10068-019-00628-2>
- [29] Tseng, A. and Zhao, Y. (2013) Wine Grape Pomace as Antioxidant Dietary Fibre for Enhancing Nutritional Value and Improving Storability of Yogurt and Salad Dressing. *Food Chemistry*, **138**, 356-365. <https://doi.org/10.1016/j.foodchem.2012.09.148>
- [30] Bender, A.B.B., Speroni, C.S., Salvador, P.R., Loureiro, B.B., Lovatto, N.M., Goulart, F.R., *et al.* (2017) Grape Pomace Skins and the Effects of Its Inclusion in the Techno-

- logical Properties of Muffins. *Journal of Culinary Science & Technology*, **15**, 143-157. <https://doi.org/10.1080/15428052.2016.1225535>
- [31] Walker, R., Tseng, A., Cavender, G., Ross, A. and Zhao, Y. (2014) Physicochemical, Nutritional, and Sensory Qualities of Wine Grape Pomace Fortified Baked Goods. *Journal of Food Science*, **79**, S1811-S1822. <https://doi.org/10.1111/1750-3841.12554>
- [32] Marchiani, R., Bertolino, M., Ghirardello, D., McSweeney, P.L.H. and Zeppa, G. (2016) Physicochemical and Nutritional Qualities of Grape Pomace Powder-Fortified Semi-Hard Cheeses. *Journal of Food Science and Technology*, **53**, 1585-1596. <https://doi.org/10.1007/s13197-015-2105-8>
- [33] Kupe, M., Karatas, N., Unal, M.S., Ercisli, S., Baron, M. and Sochor, J. (2021) Phenolic Composition and Antioxidant Activity of Peel, Pulp and Seed Extracts of Different Clones of the Turkish Grape Cultivar 'Karaerik'. *Plants*, **10**, Article 2154. <https://doi.org/10.3390/plants10102154>
- [34] Navaz, S.H. and Zarei Yam, B.A. (2021) Influence of Red Grape Pomace Powder on Physicochemical, Antioxidant, Nutritional, Microbial, and Sensory Properties of Probiotic Yoghurt. *Indian Journal of Dairy Science*, **74**, 224-231. <https://doi.org/10.33785/ijds.2021.v74i03.005>
- [35] Antonic, B., Dordevic, D., Jancikova, S., Holeckova, D., Tremlova, B. and Kulawik, P. (2021) Effect of Grape Seed Flour on the Antioxidant Profile, Textural and Sensory Properties of Waffles. *Processes*, **9**, Article 131. <https://doi.org/10.3390/pr9010131>
- [36] Antoniolli, A., Becerra, L., Piccoli, P. and Fontana, A. (2024) Phenolic, Nutritional and Sensory Characteristics of Bakery Foods Formulated with Grape Pomace. *Plants*, **13**, Article 590. <https://doi.org/10.3390/plants13050590>