

The Influence of Qvevri-aged Saperavi and Saperavi Elixir on the Organoleptic and Chemical Characteristics of Bread

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<https://doi.org/10.52340/idw.2025.07>

Abstract. *This study investigates the migration and concentration of phenolic compounds in bread enriched with Qvevri-aged Saperavi wine and Saperavi elixir. The analysis focused on total phenolic content, proanthocyanidins, tannins, anthocyanins, catechins, and antioxidant activity. Following the incorporation of 30 mL of Qvevri-aged Saperavi wine and 30 mL of Saperavi elixir into the bread formulation, the total phenolic content reached 1,483 mg/L and 2,100 mg/L, respectively. Anthocyanin concentrations were measured at 912.8 mg/L in the wine-enriched bread and 602 mg/L in the elixir-enriched bread; proanthocyanidins at 391.2 mg/L and 600 mg/L; and catechins at 889.8 mg/L and 901 mg/L, respectively. Antioxidant activity was determined to be 94.8% in the wine-enriched sample and 90.9% in the elixir-enriched sample. Both types of enriched bread exhibited significantly elevated phenolic content and strong antioxidant potential. In addition to the distinctive Saperavi aroma and balanced tannin profile, the successful transfer of phenolic and other bioactive compounds contributes to the bread's enhanced nutritional value and functional properties. These findings suggest the potential of such products to serve as functional foods with prophylactic and preventive health benefits.*

Keywords *Qvevri-aged Saperavi, Saperavi elixir, phenolic compounds, anthocyanins, antioxidant activity, functional bread.*

Bread, one of the oldest staple foods, has maintained its relevance through millennia and continues to be a key component of the modern human diet. Therefore, ensuring a balanced composition and enhancing its nutritional value remain highly relevant and significant issues in contemporary life [6].

Adding various natural ingredients to bread products allows for the extension of shelf life, texture improvement, development of dietary and therapeutic-functional products, and compensation for nutritional deficiencies in the human diet [2,13,8]. Bread typically exhibits a broad flavor spectrum, enabling a wide range of product variations and allowing the incorporation of various natural, health-promoting ingredients, thereby transforming bread into a functional food. Several researchers have investigated the content of phenolic compounds and antioxidant activity in breads enriched with fruits and vegetables. Their findings confirmed a significant increase in the total phenolic content and antioxidant activity in these types of breads [3,4]. Furthermore, the impact of winemaking byproducts, specifically dried grape pomace obtained after alcoholic fermentation, has been studied on bread's functional characteristics, such as texture, sensory attributes, and physicochemical properties. It was established that grape pomace serves as a valuable enriching ingredient in bread production, as its addition leads to an increase in antioxidant activity and phenolic

compound concentration in the final product [14]. According to scientific research, phenolic compounds possess strong antioxidant, antibacterial, and antiviral properties, as well as a wide spectrum of biological activities. Recent studies have demonstrated that phenolic compounds are effective as adjunctive therapeutic agents in the treatment of COVID-19, both during the acute phase and in the management of post-COVID syndrome [11].

Bioactive substances found in grape juice and the solid parts of grapes represent a rich raw material due to their high antioxidant capacity and other biological activities [15]. Notably, phenolic compounds, classified into flavonoid (including oligomeric and polymeric procyanidins, catechins, flavonols, and anthocyanins) and non-flavonoid groups (such as phenolic acids, stilbenoids, and others), are characterized by their high biological activity in various physiological pathways. The concentration of these compounds in wine and grape-derived products largely determines the functional role of such products, particularly concerning their therapeutic and preventive health benefits [5,9,10,16]. The positive effects and biological activities of polyphenols have been scientifically confirmed. These include antioxidant, antimicrobial, antihypertensive, anticarcinogenic, immunomodulatory, and antiviral properties, particularly important for human health [12].

The organoleptic quality of bread depends on its appearance, crumb structure, taste, and aroma, significantly contributing to its overall nutritional value. The concentration of flavor and aromatic compounds in bread is primarily determined by the type and quality of flour used, the formulation, the specific characteristics of dough preparation, the addition of various natural ingredients, and the duration of baking. Among the most popular biologically active natural additives are those that enhance the quality parameters of bread products and increase their nutritional value [3,4]. One such component that allows the enrichment of bread with biologically active compounds is *Qvevri-aged Saperavi*, a traditional red dry wine, and Saperavi elixir.

Based on the aforementioned, it can be concluded that the use of grape-derived components in bread production is both relevant and important. Accordingly, this study aimed to investigate the presence of certain phenolic compounds transferred into bread enriched with *Qvevri-aged Saperavi* wine and Saperavi elixir.

Research Objects and Methods. The objects of the research included the following:

Control	bread	sample	(I)
Bread enriched with	Qvevri-aged	Saperavi wine	(II)
Bread enriched with	Saperavi	elixir	(III)
Qvevri-aged	Saperavi	wine	(IV)
Saperavi elixir			(V)

The samples of bread enriched with *Qvevri-aged Saperavi* wine were prepared at the vocational college “*Prestige*”. The *Qvevri-aged Saperavi* wine used for enrichment was traditionally vinified in the family winery “*Itabani*” (located in the village of Kvemo Alvani, Akhmeta Municipality, Georgia) using the Kakhetian method of fermentation on grape pomace in a clay vessel (*Qvevri*) for two months. The bread samples enriched with Saperavi elixir were prepared at the pilot bakery of the Tashkent State Agrarian University. The Saperavi elixir was produced in the laboratory of the Department of Storage and Processing of Agricultural Products (Tashkent) using grapes harvested at their technological ripeness stage, including stems. The production process involved pre-freezing the grapes at –11 to –10°C for

4 hours, followed by mechanical crushing, low-temperature pasteurization (55°C for 12 hours), and thermal stabilization (60–65°C for 4 hours). The final product, rich in phenolic compounds, was obtained through filtration [9,10]. All samples, both control and experimental, were prepared following the technological sequence and process parameters required for the proper execution of operations.

Organoleptic parameters of the control and experimental bread samples were evaluated, including color, odor, taste and aroma, surface characteristics, crumb structure, and porosity. The results of the study are presented in Table 1. For accurate and structured evaluation, the data are presented in the form of a spider (radar) diagram, clearly illustrating the organoleptic advantages of each sample (Figure 1).

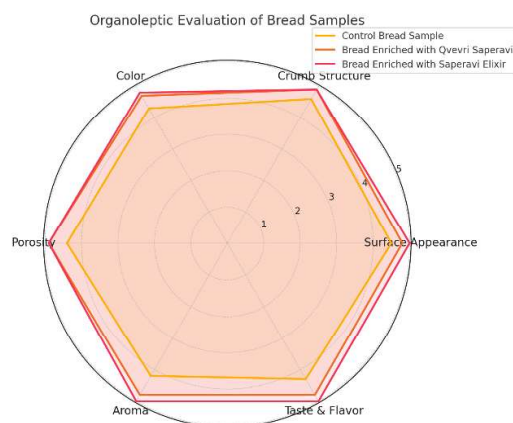


Figure 1. Comparison of the organoleptic properties (aroma, taste, color, texture, surface, porosity, grumb structure) of the control sample, bread enriched with Qvevri-aged Saperavi, and bread enriched with Saperavi elixir.

Total phenolics, anthocyanins, proanthocyanidins, catechins, and antioxidant activity of the Saperavi wine and Saperavi elixir used during the bread-baking process were determined by spectrophotometric methods. Total phenolics and anthocyanins in the crumb of the experimental samples were quantified according to the Gloria method [7], using a spectrophotometer (HACH/DR/3900) at wavelengths of 480 nm and 520 nm, respectively (Table 2). Antioxidant activity was measured by the DPPH assay (DPPH, 517 nm) [1]. Proanthocyanidins and catechins were determined at wavelengths of 500 nm and 280 nm, respectively.

Table 1. Organoleptic Characteristics of Control and Experimental Bread Samples

Quality Indicators	Research Results		
	Control Sample I	Test Sample	
		Bread Enriched with Qvevri-aged Saperavi Wine II	Bread Enriched with Saperavi Elixir III
Surface	With slight unevenness, no cracks or fissures, and a uniformly colored crust	Uniform, without cracks or fissures, with a uniformly colored crust.	Straight, uniform, without cracks or fissures, with a uniformly colored crust.
Crumb	Well-baked; no traces of under-kneaded	Well-baked; no signs of under-kneaded dough observed	Well-baked; no signs of under-kneaded dough

mb structure	dough detected in the cross-section; thin-walled with uniform porosity and free of hollow pockets.	in the cross-section; thin-walled, with uniform porosity and without hollow spaces.	observed in the cross-section; thin-walled, with porosity and without hollow spaces.
Color	Off-white to creamy coloration	With a pinkish-purple hue	With a light pinkish-purple hue
Porosity	Well-baked, with thin walls; the crumb is porous and elastic, regaining its original shape after light finger pressing. When touched, it does not leave a sticky or moist sensation.	With thin walls, the breadcrumb is porous and elastic, easily regaining its shape after compression. When touched, it does not leave a sticky or moist sensation.	With thin walls, the breadcrumb is porous and elastic, easily recovering its shape after compression. It does not leave a sticky sensation upon touch and is moderately moist.
Aroma	Pronounced bread aroma with a very light, harmonious sour note.	Very delicate aroma of Saperavi with a harmonious scent.	With a light, harmonious aroma of Saperavi.
Taste and aroma	Characteristic taste and aroma of wheat bread, with a mild acidic note.	With the characteristic taste of wheat bread, complemented by light, pleasant, and harmonious notes of Saperavi aroma.	The varietal aroma notes of Saperavi grape juice were evident, accompanied by a balanced, tannic, and harmonious taste characteristic of grape must.

Table 2. Total Phenolics, Proanthocyanidins, Anthocyanins, Catechins, and Antioxidant Activity Transferred into Bread Enriched with Qyevri-aged Saperavi Wine and Saperavi Elixir

Name	Total phenols (mg/L)	Anthocyanins (mg/L)	Proanthocyanidins (mg/L)	Catechins (mg/L)	Antioxidant Activity by DPPH at 517 nm (%)	Organoleptic Characteristics
Kyevri-aged Saperavi	1473	1027.6	440.4	883.8	75,5	
Saperavi Elixir	2190	670,8	590, 6	880.3	92,77	With a distinctive varietal aroma
100 g flour, yeast, salt, water (control sample)	-	-	-	-	-	Typical
100 g flour, yeast, salt, water (control sample)	-	-	-	-	-	Typical
100 g flour, yeast, salt, water, 30 mL Qyevri Saperavi.	1483	912.8	391.2	889.8	94.8	With harmonious aromatic tones of Saperavi and a light pinkish-purple coloration.
100 g flour, yeast, salt, water, Saperavi elixir (30 mL)	2100	602	600	901	90,9	Light Saperavi notes with a balanced, tannic, and harmonious flavor of grape pomace.

This study represents the first attempt in Georgia, specifically at Telavi State University named after Ivane Javakhishvili, and in Uzbekistan, at Tashkent State Agrarian University, to investigate the enrichment of bread with Qvevri-aged Saperavi wine and Saperavi elixir as functional, biologically active ingredients. The research focuses on evaluating their impact on the organoleptic properties and biochemical characteristics of bread, with particular emphasis on the preservation of phenolic compounds and antioxidant activity.

The results obtained demonstrated that the addition of small doses of Qvevri-aged Saperavi wine and Saperavi elixir during the bread-baking process improves the organoleptic parameters of the bread and significantly enriches its chemical composition. The addition of 30 mL of Qvevri-aged Saperavi imparted a distinctive varietal aroma of Saperavi to the finished bread, with the crumb characterized by a pinkish-purple hue typical of Saperavi, which enhanced the visual identity of the bread. The bread retained the neutral, mild flavor characteristic of wheat, enriched with aromatic, slightly tannic notes of Saperavi. A well-balanced sensory harmony among the components was observed. In the finished bread, the total phenolic content was 1483 mg/L; anthocyanins measured 912.8 mg/L; proanthocyanidins amounted to 391.2 mg/L; catechins were 889.8 mg/L; and the antioxidant activity reached 94.8%. The Saperavi wine itself was distinguished by a high concentration of phenolic compounds (1473 mg/L) and anthocyanins (1027 mg/L). A slight increase in total phenolics was recorded in the finished bread, which may be attributed to the concentration and stability effects within the dough matrix. Regarding the observed decrease in anthocyanins, it is presumed to be a result of thermal degradation during the baking process.

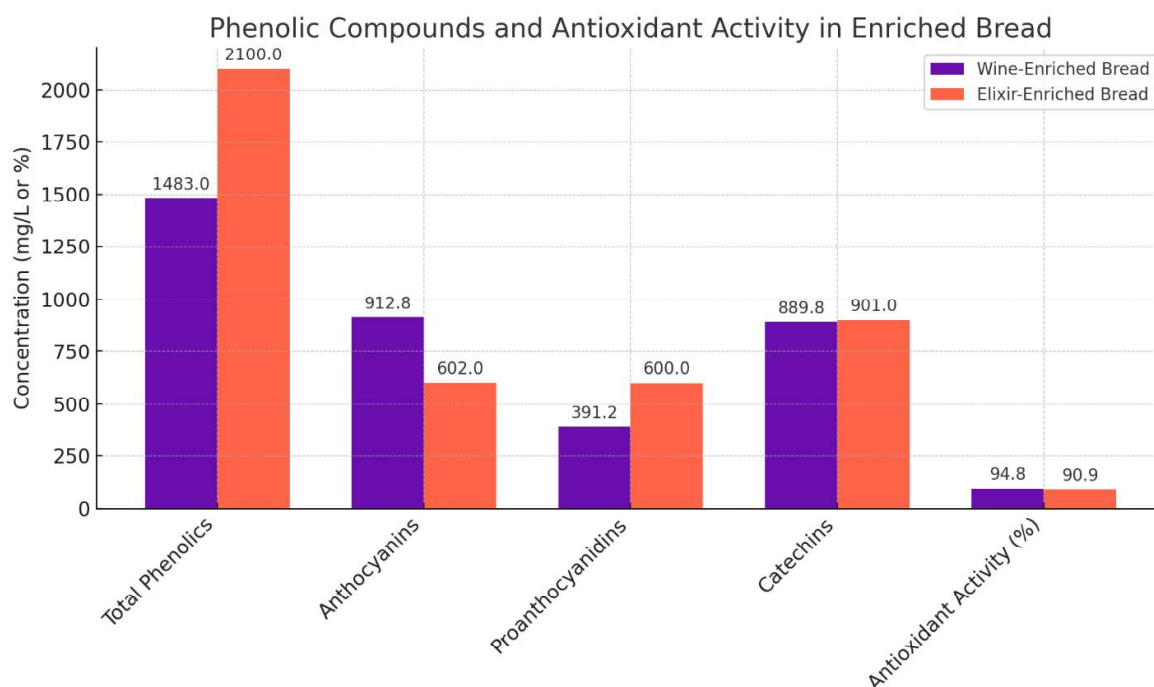


Figure 2. Comparative content of phenolic compounds and antioxidant activity in bread enriched with Qvevri Saperavi wine and Saperavi elixir.

During the bread-baking process, the addition of Saperavi elixir imparted varietal aroma notes of Saperavi grape juice, characterized by a balanced, tannic, and harmonious flavor reminiscent of grape must. The bread crumb exhibited a light pinkish-purple coloration, with a fine and uniform pore structure, soft consistency, and elasticity. The addition of the elixir enhanced not only the bread's aromatic profile, color, and structure but also significantly increased the content of biologically active compounds - total phenolics, anthocyanins, proanthocyanidins, and catechins. In bread enriched with Saperavi elixir, the total phenolic content reached 2100 mg/L; anthocyanins were 602 mg/L; proanthocyanidins amounted to 600 mg/L; catechins measured 901 mg/L; and antioxidant activity was 90.9%, indicating the high antioxidant potential of the elixir and confirming its functional role as a natural and bioactive source of polyphenols [Fig.2,3].

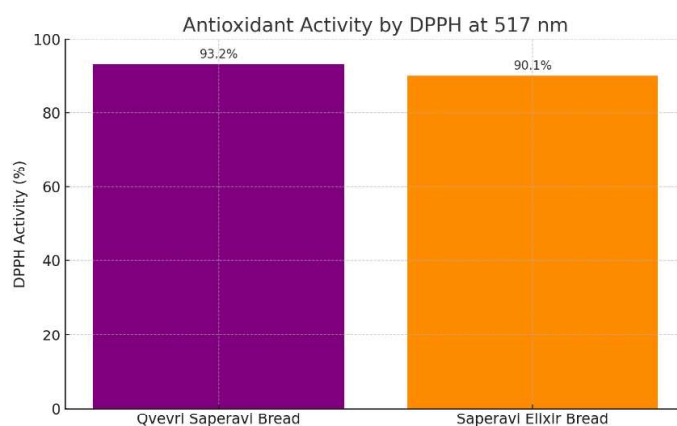


Figure 3. Antioxidant activity of bread enriched with Qjevri Saperavi wine and Saperavi elixir.

Despite equal addition volumes of 30 mL during baking, the initial phenolic concentration of the Saperavi elixir was approximately 48% higher than that of the Qjevri Saperavi wine. This difference should be carefully considered when comparing results to objectively assess the transfer efficiency of phenolic compounds.

Phenolic compounds from grape-derived products partially transfer into the bread; however, their retention quality significantly depends on the initial phenolic concentration, thermal stability, dough structure, and baking conditions. Bread enriched with Qjevri Saperavi wine and Saperavi elixir demonstrated superior results in terms of both total phenolic content and antioxidant activity.

Considering the above, it is advisable to conduct further in-depth studies on the impact of these additives on the shelf life and nutritional value of the bread, as well as to evaluate the potential beneficial effects on human health with regular consumption.

Based on the results of this study, we can conclude that enriching bread with Saperavi wine and Saperavi elixir represents an effective strategy to improve the sensory properties, enhance the nutritional value, and diversify the product assortment. The bread stands out not only with its characteristic Saperavi aromatic flavor and harmoniously tannic notes but also due to the phenolic compounds transferred into the bread. These compounds, together with other beneficial nutrients present in the product, contribute to its high nutritional value and consequently to its functional purpose from a prophylactic and preventive perspective.

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ქვევრის საფერავისა და საფერავის ელექსირის გავლენა პურის ორგანოლეპტიკურ და ქიმიურ მაჩვენებლებზე

ელანიძე ლალი

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აბსტრაქტი. ჩატარებულია საფერავის ღვინითა და საფერავის ელექსირით გამდიდრებულ პურში გადასული ფენოლური ნაერთების კვლევა, კერძოდ, საერთო ფენოლების, პროანტოციანიდინების, ტანინების, ანტოციანებისა და ასევე, ანტიოქსიდანტური აქტივობის განსაზღვრა. 30 მლ საფერავის ღვინის დამატებისას საერთო ფენოლების რაოდენობამ შეადგინა 1483 მგ/ლ, ხოლო 30 მლ საფერავის ელექსირის დამატებისას კი - 2100 მგ/ლ, ანტოციანების რაოდენობამ, შესაბამისად, შეადგინა 912.8 მგ/ლ და 602მგ/ლ, პროანტოციანიდინების - 391.2 მგ/ლ და 600 მგ/ლ, კატექინების რაოდენობამ კი - 889.8 მგ/ლ და 901მგ/ლ, ხოლო, ანტიოქსიდანტურმა აქტივობამ შეადგინა, შესაბამისად, 94.8 % და 90,9 %. საფერავის ღვინითა და საფერავის ელექსირით გამდიდრებულმა პურმა აჩვენა საუკეთესო შედეგი როგორც საერთო ფენოლების, ასევე ანტიოქსიდანტური აქტივობის თვალსაზრისით. პური გამოირჩევა არა მარტო საფერავის არომატული გემოთი და ჰარმონიულად ტანინიანი ტონებით, არამედ, პურში გადასული ფენოლური ნაერთები, პროდუქტში შემავალ სხვა სასარგებლო ნუტრიენტებთან ერთად განაპირობებენ პურის მაღალ კვებით ღირებულებასა და შესაბამისად ფუნქციურ დანიშნულებას, პროფილაქტიკური და პრევენციული თვალსაზრისით.

საკვანძო სიტყვები: ქვევრის საფერავი, საფერავის ელექსირი, ფენოლური ნაერთები, ანტიოქსიდანტური აქტივობა.