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New Technology of Complex Processing of Red Grape

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Abstract

Increasing the profitability of wine production requires the rational use of raw materials. This study proposes, for the first time, a comprehensive and waste-free technology for processing red grape varieties, in which the target product—wine—is obtained exclusively from the free-run fraction of fermented must. The remaining wet pomace is distilled in a Charentais copper alembic still to produce wine distillate. After distillation, the residual non-alcoholic pomace contains grape water with functional properties, enriched with phenolic compounds, indicating its antioxidant potential. The distillation residue is further processed using a cavitation device, resulting in the production of grape paste—a natural additive for bread.

This technology ensures an improvement in the quality of both wine and wine distillate: wine is produced solely from the free-run fraction, and the distillate is obtained from unpressed wet pomace, which retains residual wine, thus ensuring the high quality of the distillate. Processing the distillation residue through a cavitation crusher yields a natural antioxidant additive suitable for bread.

The chemical composition and organoleptic characteristics of wines made from the Saperavi grape variety, fermented with both seeded and deseeded must, were investigated. Additionally, the chemical composition of the wine distillate obtained from the distillation of wet pomace was studied. A technological scheme for the complex and waste-free processing of the Saperavi grape variety has been developed.

Keywords: Wine; Must; Wine distillate; Natural additive of Bread

1. Introduction

In accordance with the Strategy for the Development of Education and Science, it is essential to integrate secondary raw materials into the circular economy of the food and processing industries. This approach enhances the profitability of target-product production, increases the number of products obtained from a unit of raw material, and expands the product range.

In the wine industry, secondary raw materials account for approximately 20–25% of processed grapes. A significant portion of this waste consists of grape pomace (Chacha pomace), which remains after juice extraction in the form of sweet or fermented pomace and is enriched with grape-derived phenolic compounds.

Phenolic compounds are natural antioxidants that protect food from oxidative rancidity. They exhibit diverse bioactivities beneficial to human health, including the reduction of the risk of cancer, cardiovascular disease, and diabetes, inhibition of platelet aggregation, and antibacterial, antiviral, anti-inflammatory, and anti-allergic effects [1–3]. As primary antioxidants, phenolic compounds inhibit free radical formation, suppress the initiation and propagation

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of lipid oxidation reactions, and thereby reduce the formation of volatile decomposition products such as aldehydes and ketones [4].

Bread consumption has declined significantly in many countries in recent years, largely due to the widespread use of artificial bread improvers, including gluten, which have contributed to the prevalence of celiac disease and other health concerns. Artificial bread improvers are typically added to improve the baking properties of low-quality flour.

Phenolic compounds are capable of forming stable complexes with proteins, including gluten, a major protein in bread flour. These complexes modify the structural properties of gluten, presumably reducing its harmful effects, while maintaining dough elasticity and the structure and strength of the resulting bread [5,6]. Moreover, phenolic compounds impart antioxidant properties and confer functional health benefits to bread and bakery products. Specifically, grape-derived phenolic compounds can neutralize free radicals responsible for various diseases, endowing food products with therapeutic and prophylactic properties against cardiovascular disorders, including heart attack, stroke, and thrombosis [7,8].

2. Object of Research and Methodology

The object of this study was the Georgian industrial red grape variety, **Saperavi**. Wine analyses were conducted in accordance with state standards recognized in Georgia.

3. Results and Discussion

The aim of this study was to develop a comprehensive and waste-free processing technology for the Saperavi grape variety, with the dual objectives of improving the quality of the main product—wine—and generating novel products from secondary raw materials.

To achieve this, a technological scheme for the integrated processing of red grapes was implemented. The fermentation vessel is filled with destemmed must, and alcoholic fermentation proceeds under a must-circulation system. During fermentation, the juice is periodically withdrawn from the lower part of the vessel and returned from the top. This approach ensures efficient extraction of water-soluble compounds from the solid components of the must, while simultaneously separating seeds from the fermenting juice and allowing them to sediment at the bottom of the vessel.

Table 1 Chemical composition of wines made based on the must with and without seeds of Saperavi grape variety

No.	Parameter	Seedless Fermentation Free-run Fraction	Seedless Fermentation Pressed Fraction	Seeded Fermentation Free-run Fraction	Seeded Fermentation Pressed Fraction
1	Ethyl alcohol by volume, %	12.08	12.09	12.08	12.00
2	Titratable acidity (as tartaric acid), g/dm^3	5.70	6.15	5.70	6.15
3	Volatile acidity (as acetic acid), g/dm^3	0.79	0.85	0.80	0.88
4	Tannins, g/dm^3	3.36	3.80	3.70	4.00
5	Anthocyanins, mg/dm^3	317	317	456	480
6	Leucoanthocyanins, g/dm^3	1.00	1.20	1.248	1.248
7	Sensory evaluation score	8.43	8.00	7.70	7.40

As juice flows out, seeds are partially removed from the fermentation zone, which limits the transfer of undesirable seed-derived phenolic compounds into the wine. At the same time, the wine is enriched with phenolic compounds from grape skins and pulp, imparting a velvety texture and smoothness to the final product. According to this technological scheme, the free-run fraction of the fermented wine is collected as the main target product, while the wet pomace

(Chacha) is distilled to produce wine distillate, which can be further processed into Chacha spirit. The non-alcoholic residue remaining after distillation is processed to obtain grape paste.

Table 1 presents the chemical composition of the free-run and press fractions of fermented Saperavi wine. The wines were produced by fermentation of both seeded and deseeded must.

Table 2 Organoleptic Evaluation of Saperavi Grape Variety wine samples produced from must with seed and without seed. (After 11 Months of Storage)

Wine Fraction Samples	**Organoleptic Characteristics of Wine**	**Sensory Evaluation Score (points)**
Wine fermented in must without seed	Red wine of intense color, moderate varietal aroma, medium body, moderate acidity, harmonious, good quality	8.4
Wine fermented on must with seed	Red wine of intense color, pronounced varietal aroma, full-bodied, bitter–astringent taste	6.7

Table 3 Chemical Indicators of the wet pomace

N	**Test Parameter and Units**	**Actual Value**	**Test Method**
1	Ethyl alcohol by volume, %	76.1	GOST 13191-73
2	Mass concentration of higher alcohols, mg/100 cm^3 of anhydrous alcohol, including:	231.3	EX-PR-11(01)-G-01 Validated method
	– n-Propanol mass concentration	35.1	
	– Isobutanol mass concentration	37.6	
	– Isoamyl alcohol mass concentration	158.6	
3	Mass concentration of aldehydes, mg/100 cm^3 of anhydrous alcohol, calculated as acetaldehyde	63.8	GOST 12280-75
4	Mass concentration of esters, mg/100 cm^3 of anhydrous alcohol, calculated as ethyl acetate	82.9	EX-PR-11(01)-G-01 Validated method
5	Mass concentration of methanol, g/dm^3, not more than	0.32	EX-PR-11(01)-G-01 Validated method

The presented data indicate that grape seeds do not significantly affect the chemical composition of either the free-run or press fractions. However, the wines differ markedly in their organoleptic properties. Wine fermented from deseeded must was characterized by a soft, velvety mouthfeel, whereas wine fermented from seeded must exhibited a coarser structure and, therefore, required additional aging to enhance its sensory attributes.

As shown in Table 1, phenolic compounds were present at higher concentrations in the press fractions, reflecting their greater antioxidant potential.

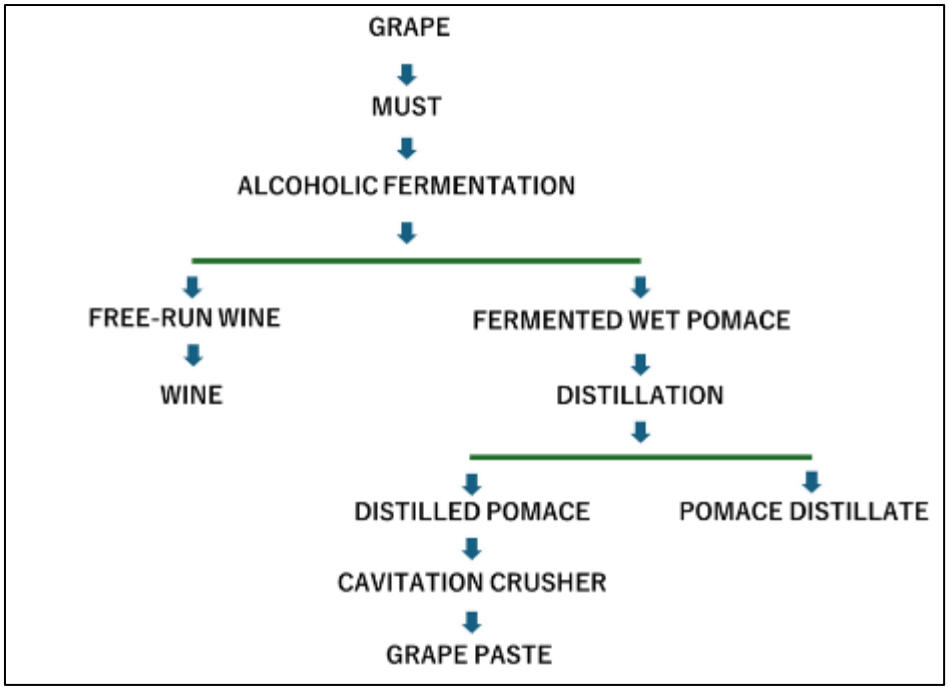

Figure 1 Technological Scheme of the Integrated Red Grape Processing Process

According to the technological scheme, the free-run fraction of the wine is used to produce the target product—wine. In contrast, the wet pomace is directed to the distillation unit, where raw alcohol is separated in an amount corresponding to approximately 35% of the initial wine. As a result, the phenolic compound content increases in the press fraction, which effectively represents a non-alcoholic wine enriched with phenolic compounds.

The data presented in Table 3 indicate that the distillate obtained from the distillation of wet pomace meets the requirements established for grape wine distillates.

The wine paste obtained from dealcoholized pomace can be used as a natural additive in bread production. Our studies have shown that grape paste imparts a violet coloration to bread and bakery products and enhances their antioxidant properties. Moreover, the incorporation of grape paste at a level of 15–20% significantly reduces the gluten content of bread and bakery products, resulting in low-gluten bread.

4. Conclusion

A technology for the complex processing of red grapes has been developed. The application of this new technology improves the quality of the target product—wine—since wine is produced exclusively from the free-run fraction. Wet pomace is utilized to produce high-quality wine distillate, while simultaneously yielding a novel co-product: an antioxidant grape paste enriched with phenolic compounds, intended for use as a natural bread additive.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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