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Jam Production from Muscat Ottonel and Muscat of Hamburg Grapes: A Sustainable Approach for Valorizing Aromatic Varieties through Sugar-Free and Sugar-Added Formulations

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Abstract: *This study aims to explore the potential of two aromatic grape varieties, Muscat Ottonel and Muscat of Hamburg, for the production of jam, prepared in two formulations (with sugar and without sugar). Results showed that sugar-added samples had significantly higher soluble solids and reducing sugar content, while sugar-free samples exhibited higher acidity and slightly lower pH. Muscat of Hamburg jams demonstrated greater dry matter, attributed to the thicker pulp consistency of the variety. Sensory evaluation revealed favorable acceptance across all samples, with sugar-free variants scoring particularly well in terms of taste and overall acceptability. The results highlight the feasibility of valorizing unsellable or surplus grapes through sustainable jam processing, offering a simple and efficient method for reducing post-harvest losses and enhancing the economic value of grape production. These findings support the development of new horticultural products based on underutilized grape resources, with promising implications for local food processing and fruit diversification.*

• Introduction

Fruits and fruit-derived products have always played a central role in human nutrition, both for their sensory appeal and their nutritional value. Among these, jams and marmalades represent a traditional and widely accepted method of fruit preservation, allowing for the consumption of seasonal fruits throughout the year. These products are typically made by cooking fruit pulp or juice with sugar, pectin, and food-grade acids until a gel-like consistency is achieved. They are appreciated not only for their taste and aroma but also for their convenience, shelf stability, and role in reducing food waste. According to international regulations, such as the Codex Alimentarius, standard jam must contain at least 65% total soluble solids, and some formulations recommend up to 68%, with a minimum of 45% fruit pulp. The functional roles of ingredients in jam production are well established: sugar acts as a preservative and texture enhancer, pectin contributes to gelling, and acids like citric acid help to set the pectin network and maintain microbial stability. However, growing interest in healthier diets and clean-label products has encouraged the exploration of lower-sugar or sugar-free alternatives. This trend calls for the reconsideration of traditional formulations and the adaptation of techniques to modern consumer demands. Despite the broad variety of fruits used in jam production, ranging from plums and cherries to citrus and tropical fruits grapes remain relatively underutilized in this context. Grapes are typically consumed as table fruit or processed into wine, juice, raisins, and jelly, yet they hold significant untapped potential for jam production due to their natural sweetness, acidity, and rich content of polyphenolic compounds with antioxidant properties (Pop et al., 2015). In particular, aromatic grape varieties such as Muscat Ottonel and Muscat of Hamburg are recognized for their intense flavor, high sugar content, and desirable texture, which make them promising candidates for artisanal and industrial jam production. Moreover, the valorization of grape surpluses, especially fruit that does not meet the commercial standards for fresh markets or winemaking, has become increasingly important in the context of food waste reduction and sustainable agriculture. Converting these grapes into value-added products, such as jam, provides not only an ecological solution but also an economic opportunity for small and medium-sized producers. In addition to physicochemical quality, consumer acceptance of fruit products relies heavily on sensory properties. Sensory evaluation, involving the systematic assessment of attributes such as color, texture, aroma, and taste, is essential in product development. It enables producers to tailor formulations to consumer expectations, identify potential improvements, and enhance product appeal.

Therefore, the main objective of this study is to evaluate the technological and sensory potential of two aromatic grape varieties, Muscat Ottonel and Muscat of Hamburg for jam production. The re-search compares two formulation approaches: one using added sugar and one sugar-free, focusing on parameters such as pH, total soluble solids, acidity, texture, color, and organoleptic qualities. The results aim to provide practical insights into the development of grape-based jams that meet modern quality standards while promoting sustainability and grape valorization in the agri-food sec-tor.

• Material and method

Fruits used for jam. Two aromatic grape cultivars were selected for jam production: Muscat of Hamburg (a red table grape) and Muscat Ottonel (a white wine grape). The fruits were harvested at full technological maturity from the ampelographic collection of the Faculty of Horticulture and Business in Rural Development, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Romania (Figure 1). Although the vineyard is not located in one of the country's primary viticultural zones, both varieties reached optimal ripeness. Grapes were manually harvested and analyzed for key quality parameters prior to processing, including 100-berry weight, total soluble solids (°Brix), titratable acidity, and pH.

Figure 1. Grape varieties used for processing as jam

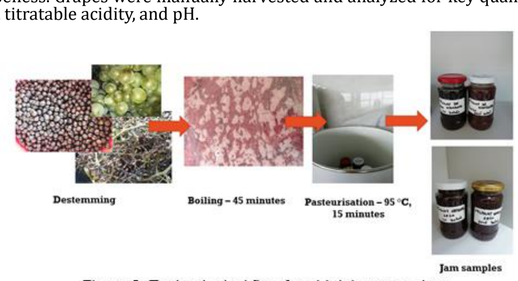

Figure 2. Technological flow for obtaining grape jam

Preparation of fruit jam. Grape jam was prepared at laboratory scale using destemmed and thoroughly washed grape berries. Two experimental variants were tested: one with added sugar and one without added sugar, as outlined in Table 1. The jam was obtained through thermal processing, following a standard boiling procedure to concentrate the fruit mixture and achieve the desired consistency. For the sugar-containing variants (MO S and MH S), grape berries (3 kg) were mixed with sugar (1 kg) in stainless-steel pans. The sugar-free variants (MO WS and MH WS) were prepared in the same manner (3 kg), but without any sugar addition. All mixtures were heated and gently stirred over low heat using a gas stove until the desired consistency was reached. No chemical preservatives were used during processing. The hot jam was immediately transferred into sterilized glass jars with a capacity of 100 mL. Subsequently, the sealed containers were pasteurized at 95°C for 15 minutes to ensure product safety and shelf stability (Figure 2).

Proximate composition analysis of jam samples. Jam samples were stored in 100 mL glass containers at ambient temperature (25 °C), and their physicochemical properties were analyzed after six months of storage. The parameters evaluated included total soluble solids, titratable acidity, pH, and reducing sugar content. All analyses were per-formed in triplicate, and results are reported as mean values ± standard deviation.

Organoleptic test. The sensory attributes of the jam samples, including color, flavor, taste, and overall acceptability, were assessed through a 9-point hedonic scale. The evaluation was conducted by a trained panel of 10 university students (5 female, 5 male, aged 22–24).

• Results and discussions

In the present study, Muscat of Hamburg recorded the highest average 100-berry mass, reaching 276.0 g, while Muscat Ottonel showed a lower value of 199.0 g. Total acidity is another fundamental parameter in assessing grape quality, especially when the fruit is destined for processing. It represents the cumulative effect of free and partially bound organic acids (such as tartaric, malic, and citric acids), which play a significant role in flavor balance, microbial stability, and pectin gelation during jam preparation. Acidity was expressed in g/L of tartaric acid equivalents and measured by titration with a standardized sodium hydroxide solution until a pH of 7.0 was reached. Among the two varieties, Muscat Ottonel exhibited the lowest total acidity, at 3.9 g/L.

The sugar content, expressed in grams of sugars per liter of grape juice (g/L), is a critical factor in both fermentation and jam production, as it influences not only sweetness but also viscosity, color development, and microbial preservation. Before processing, Muscat Ottonel recorded a higher sugar content (191 g/L), compared to Muscat of Hamburg (146 g/L).

The main physical traits of the grape varieties under study at harvest

Grape Variety	Sugar content g/l	Titrable acidity g/l tartaric acid	100 berries weight g	Bunch weight g	pH
Muscat Ottonel	191	3.9	199	101	3.34
Muscat of Hamburg	146	4.2	276	386	3.53

The total soluble solids (TSS), expressed in degrees Brix, were evaluated after six months of storage at ambient temperature (25 °C) in glass containers. As expected, the sugar-added variants exhibited higher Brix values compared to the sugar-free formulations. Specifically, the *Muscat Ottonel* sample with added sugar (MO S) reached a TSS value of 68.36%, exceeding the minimum threshold of 67% recommended by international food preservation standards, which ensures microbiological stability and shelf-life. In contrast, the sugar-free variants fell below this threshold, which may influence their long-term stability.

The main physical traits of the grape jam variants

Grape jam variants	Total soluble sugar Brix	Acidity %	Reducing sugar (g/100g)	pH
MO S	68.36±9.5 a	0.74±0.03 c	25.23±1.5 a	3.26±0.7 b
MO WS	63.33±8.6 b	0.79±0.2 b	18.05±2.2 b	3.14±0.2 c
MH S	66.35±10.5 ab	0.78±0.05 b	20.52±3.8 b	3.32±0.5 a
MHWS	61.45±8.4 c	0.85±0.09 a	16.13±1.9 c	3.17±0.9 c

Values are expressed as mean±standard deviation of three replicates.
Values with the same superscript within a column indicate no significant difference (p>0.05).

Figure 3. Gape jam variants – Muscat de Hamburg (left) and Muscat Ottonel (right)

Sensorial evaluation of the grape jam

Sensorial	MO S	MO WS	MH S	MH WS
Color	6.1±0.5c	6.3±0.4b	6.5±0.3a	6.4±0.3ab
Taste	7.2±0.7c	7.4±0.2c	7.9±0.2b	8.2±0.5a
Texture	7.3±0.4c	7.1±0.5c	8.2±0.6a	7.9±0.2ab
Flavour	8.1±0.6ab	8.3±0.3a	7.5±0.4c	7.8±0.5b
Overall acceptability	7.6±0.3c	7.8±0.6ab	7.7±0.6bc	7.9±0.7a

Values are expressed as mean ± standard deviation of three replicates.
Values with the same superscript within a row indicate no significant difference (p>0.05).

Sensory attributes such as color, flavor, texture, taste, and overall acceptability were assessed using a 9-point hedonic scale (1 = dislike extremely, 9 = like extremely) by a trained panel of 10 students (balanced for gender, aged 22–24). Statistically significant differences were observed between the different jam variants, with clear patterns emerging based on grape variety and the presence or absence of added sugar In terms of color, sample MH S recorded the highest score (6.5 ± 0.3), likely due to the deep pigmentation of Muscat of Hamburg, which contributes to a more visually appealing product. However, overall color scores were generally lower than other parameters, possibly due to oxidation during storage, especially in sugar-free variants, where antioxidant protection is lower. For texture, MH S also received the highest rating (8.2 ± 0.6), benefiting from both the varietal structure of the pulp and the gelling capacity of sugar-pectin interaction. Flavor ratings were highest for Muscat Ottonel samples—8.1 ± 0.6 for MO S and 8.3 ± 0.3 for MO WS—indicating a strong aromatic profile characteristic of the variety, which remains stable even without added sugar (Table 3).

•Conclusions

This study demonstrated that grape jam prepared from Muscat Ottonel and Muscat of Hamburg varieties, with and without added sugar, achieved good sensory acceptability. Notably, the sugar-free variants were more appreciated in terms of taste and overall acceptability, reflecting a growing consumer interest in low-sugar and naturally sweetened products. Among the samples, only the variant Muscat Ottonel with added sugar (MO S) exceeded the 67% threshold of total soluble solids required by international standards for product stability, reaching 68.36%, which confirms its suitability for long-term storage.

Sensory quality attributes including aroma, color, texture, and taste had a strong influence on consumer preference, with aromatic characteristics and balanced acidity playing key roles in acceptability. While acidity levels were slightly higher in sugar-free samples, they remained within acceptable limits and were inversely correlated with pH, as expected.

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