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SENSORIAL EVALUATION OF ORGANIC STRAWBERRIES AND RASPBERRIES: EFFECTS OF COMPANION PLANTS

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Abstract

This study investigates the effect of companion planting on the sensory quality and consumer acceptance of strawberries (Amandine variety) and raspberries (Kwanza variety). Samples were evaluated based on attributes such as color intensity, aroma, taste, and re-consumption intention. The results showed that control groups of both fruits received higher sensory scores and re-consumption intention, with both strawberries and raspberries intercropped with Borago officinalis L. showing slight changes in taste profiles. Overall, the differences between the control and intercropped samples were minimal, indicating that companion planting had little impact on fruit quality. These findings suggest that while companion planting may not significantly alter sensory qualities, it offers a sustainable agricultural practice that supports biodiversity without compromising consumer preferences.

Key words*: berry crops; consumer acceptance; intercropping.*

INTRODUCTION

Berry production is influenced by a range of biotic and abiotic stressors, with pests and diseases being primary concerns for growers. Recent trends in agriculture have seen a shift towards more resilient cropping systems that align with consumer demands for high-quality berries, both in taste and nutritional content (Maitra & Gitari, 2020). As global consumer preferences lean towards food safety and natural products (Lelieveld, 2015), and the agricultural sector grapples with the challenges of climate change (Bucur & Dejeu, 2016; Pickering et al., 2014), organic farming practices are becoming increasingly popular. These practices not only help protect the environment but also offer sustainable solutions without compromising crop yields, particularly on soils with high fertility (Rusu et al., 2015). One such method gaining attention is the use of companion plants in berry crops, which can support biodiversity and enhance overall productivity by improving soil health and pest control.

Conservation biological control is a central aspect of this approach, aiming to increase biodiversity while providing sustainable pest management, especially in perennial crops (Landis et al., 2000). For example, in raspberry plantations lasting over 10-15 years, gradually increasing the presence of natural predators can lead to effective long-term pest control. Companion planting offers several benefits for berry crops, such as reducing pest populations, maintaining soil fertility, attracting beneficial insects, and enhancing crop health. Specific companion plants, such as flower strips (e.g., *Borago officinalis* L., *Calendula arvensis* L.), trap plants, and cover crops, each provide unique ecological services that contribute to the overall health of the crop and its surrounding environment.

In the context of strawberry and raspberry cultivation, several technologies have been employed to enhance growth, with varying degrees of success. Traditional strawberry farming methods, such as wide row spacing, often leave a significant portion of the soil unused (Dane et al., 2016), leading to inefficiencies. With an increased focus on sustainability, intercropping has emerged as a promising solution to better utilize available land (Dane et al., 2016). Similarly, raspberry cultivation has evolved, with high tunnels and protected environments becoming more common for long-cane varieties, although field cultivation remains a challenge for maximizing production (Qiu, 2017; Takeda & Soria, 2011).

Both strawberries and raspberries are highly valued fruits, rich in bioactive compounds and micronutrients that contribute to their unique taste, nutritional value, and organoleptic qualities (Dane et al., 2019; Giampieri et al., 2012). Strawberries, for example, contain a blend of antioxidant and anti-inflammatory compounds beneficial for cardiovascular health (Sparacino et al., 2024), while raspberries are rich in vitamins, phytochemicals, and minerals, making them highly recommended for a healthy diet (Bobinaitė, 2016). Visual quality, including size, color, and freshness, is a key factor in consumer purchasing decisions for both fruits (He et al., 2020). As consumer preferences are heavily influenced by sensory attributes, such as taste and appearance, it is crucial to understand how different cultivation techniques, including companion planting, impact these qualities (Moazzem et al., 2024).

This study aims to assess the effects of various companion plants on the sensory quality and nutritional content of strawberries and raspberries. By evaluating how companion plants influence attributes such as taste, appearance, and consumer acceptance, this research seeks to provide insights into how sustainable practices can enhance berry crop production without compromising fruit quality.

MATERIALS AND METHODS

Samples

Samples of both strawberries (Amandine variety) and raspberries (Kwanza variety) were harvested in September 2022 from the Rodagria Produce Agricultural Cooperative in Ogoru village, Călărași County. All samples were stored under controlled conditions at 1±0.2°C and 90±5% relative humidity for 12 hours prior to being washed and presented to the evaluation panel.

For the strawberry assessment, two sample types were analyzed: a control group and strawberries cultivated with borage as a companion plant (Figure 1). In the raspberry evaluation, the panel assessed four sample types: a control group and raspberries grown with annual, perennial, and borage companion plants (Figure 2).

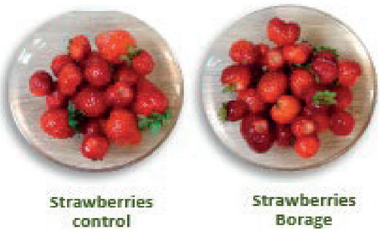

Figure 1. Strawberry samples

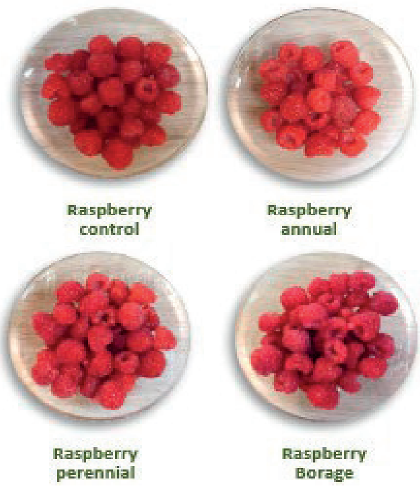

Figure 2. Raspberry samples

Consumer acceptance analysis

Consumer acceptance testing was conducted in the Sensory Analysis Laboratory at the Research Center for Studies of Food Quality and Agricultural Products, part of the University of Agricultural Sciences and Veterinary Medicine of Bucharest (USAMV of Bucharest).

The sensory evaluation of the fruits was conducted to observe the impact of cultivation technology on their sensory characteristics.

The sensory evaluation focused on key properties, including color intensity, aroma, primary taste components, taste intensity, and aftertaste duration, as well as the percentage of participants indicating an intention for repeat consumption. Assessments were carried out during two separate sessions for strawberries and raspberries, as detailed in Table 1.

Table 1. Sample codification and panel description

Samples	Code	Total number of respondents
Strawberry control	SC	32
Strawberry borage	SB	
Raspberry control	RC	41
Raspberry annual	RA	
Raspberry perennial	RP	
Raspberry borage	RB	

Participants from various age groups were selected to assess the acceptance of fruits cultivated using different agricultural techniques. They evaluated the sensory attributes of the fruits using a 7-point hedonic scale, with ratings ranging from "1 - very unpleasant" to "7 - very pleasant."

The scores for each attribute were calculated as the arithmetic mean ± standard deviation, providing a quantitative measure of sensory acceptance.

RESULTS AND DISCUSSIONS

Sensory evaluations were conducted to assess various attributes of fresh strawberries and raspberries, including color intensity, aroma, primary taste components, taste intensity, after-taste duration, and intention to repurchase (%). The sensory panel for strawberries consisted of 72% female and 28% male participants, while for raspberries, 66% were female and 34% male. As shown in Table 2, the control samples (SC and RC) achieved higher scores in aroma, and taste intensity, particularly in the strawberry control (SC), which scored the highest in aroma (6.13 ± 1.11). In contrast, raspberries intercropped with borage (RB) received higher ratings for aroma (5.32 ± 1.02) than other treatments.

Table 2. Consumer evaluation of key aspects as color, aroma, and taste

Samples analyzed	Color level of the product	Product aroma	Taste intensity level	Post-taste duration level
Strawberries				
SC	5.84±1.28	6.13±1.11	6.00±1.09	5.91±1.01
SB	6.09±0.84	5.16±1.52	5.75±1.52	5.56±1.58
Raspberries				
RC	6.20±0.80	5.28±1.12	5.54±1.27	5.39±1.25
RA	6.37±0.62	5.10±1.16	5.51±1.36	5.24±1.38
RP	6.37±0.65	5.08±1.12	5.61±1.36	5.66±1.26
RB	6.20±1.09	5.32±1.02	5.68±1.02	5.46±1.13

No significant differences were observed between strawberries grown in the control group and those intercropped with borage (*Borago officinalis* L.) (Figure 3). In the control group (SC), the taste profiles were as follows: 6.25% of participants identified a sour taste, 9.37% detected a sweet-tart taste, 37.50% perceived a sweet taste, 3.12% noted a balanced taste, 12.50% found the characteristic strawberry flavor, and 18.75% described it as aromatic. For the strawberries intercropped with borage (SB), the taste profile showed slight alterations: 9.37% of consumers detected a sour taste, 12.50% found a sweet-tart taste, 37.50% a sweet taste, 6.25% described the taste as balanced, 9.37% identified the characteristic strawberry flavor, and 12.50% found it aromatic (Figure 3).

The overall sensory score for strawberries from the control group (SC) was the highest, achieving 23.88 out of 30, indicating the best overall sensory performance. Strawberries intercropped with borage (SB) received a slightly lower score of 22.56 (Figure 5). These results suggest that while borage intercropping did not result in significant changes to the sensory profile of strawberries, it did lead to a slight reduction in overall consumer acceptance.

For raspberries, no significant differences were observed between the control group (RC) and those intercropped with various plants (annual plants, perennial plants, or borage). The primary taste components for raspberries in the control group (RC) were sour (36.58%), sweet-tart (24.39%), and sweet (9.76%). Raspberries intercropped with annual plants (RA), perennial plants (RP), and borage (RB) showed minor variations in taste profiles: 29.51%, 26.83%, and 24.39% of participants, respectively, identified a sour taste. The sweet-tart taste remained prevalent in all variants, though no significant differences were observed in overall flavor descriptors between treatments (Figure 4). Raspberries from the control group (RC) scored 22.40, while those intercropped with annual (RA), perennial (RP), and borage (RB) plants scored 22.22, 22.71, and 22.66, respectively (Figure 5). These results indicate that while intercropping slightly reduced the sensory scores for raspberries, the differences were minor, suggesting limited impact on the sensory quality due to companion planting

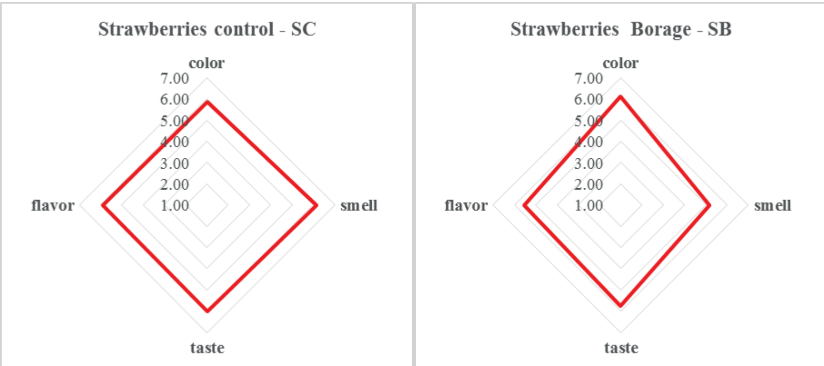

Figure 3. Consumer acceptance evaluation of strawberries using a 7-point hedonic scale

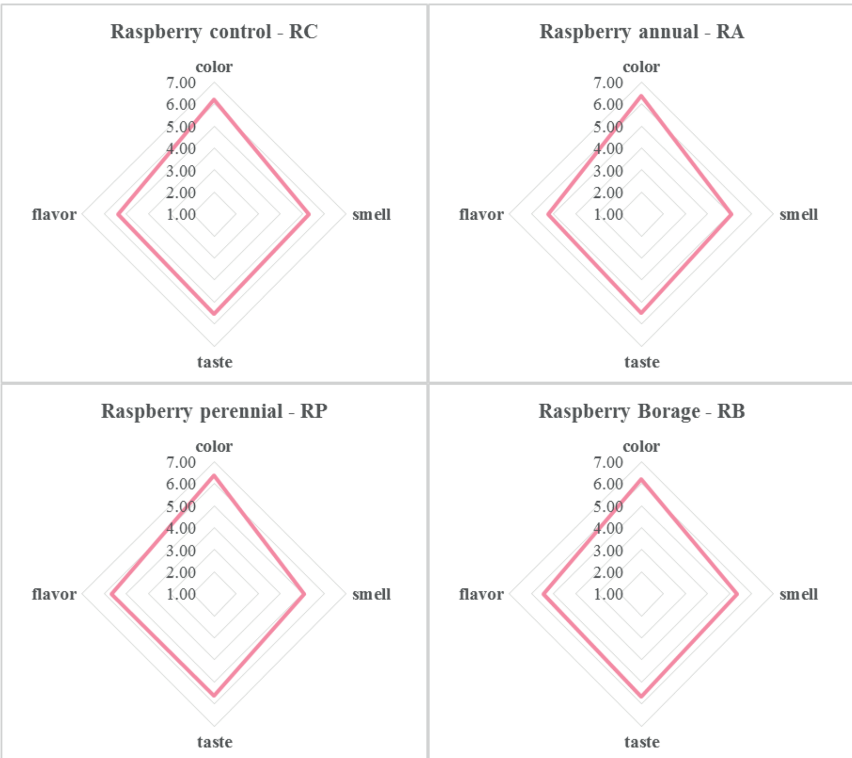

Figure 4. Consumer acceptance evaluation of raspberry using a 7-point hedonic scale

Repurchase intention was evaluated for all treatments. For strawberries, the control group (SC) achieved the highest re-consumption rate, with 93.75% of participants indicating "YES" and only 6.25% selecting "NO." Strawberries intercropped with borage (SB) had a slightly lower re-consumption rate, with 84.38% responding "YES" and 15.63% "NO" (Figure 6). For raspberries, the control group (RC) had a 78.05% "YES" rate, while raspberries intercropped with annual (RA), perennial (RP), and borage (RB) plants showed a reduced re-consumption rate, with 64.29% selecting "YES" for RA and RP, and 78.57% for RB. The reduced repurchase rates for raspberries intercropped with annual or perennial plants suggest that the sensory characteristics of these variants did not meet the expectations of some consumers.

Both strawberries and raspberries demonstrated positive consumer acceptance, with control groups consistently achieving higher scores in sensory evaluations and repurchase intentions. Intercropping with companion plants, such as borage, had minimal impact on sensory attributes. While the use of intercropping aligns with sustainable farming practices, its effect on improving sensory quality was limited. This suggests that environmental benefits associated with intercropping may not necessarily translate into enhanced consumer satisfaction.

In particular, raspberries showed strong performance in visual appeal but had lower scores for sensory attributes like odor and texture. These findings highlight the potential for further improvements through optimized post-harvest handling or additional cultivation techniques. Enhancing these sensory traits could elevate consumer preferences for raspberries, aligning with observations from Ingrassia et al. (2018) and other studies.

This research supports the conclusions of Aoki and Akai (2023) and Sparacino et al. (2024), emphasizing the intricate interplay between cultivation methods, sensory attributes, and consumer behavior. Aoki and Akai (2023) focused on the economic valuation of sustainable farming practices, while Sparacino et al. (2024) identified appearance, health benefits, and sustainability as key consumer drivers. Together, these studies underscore the importance of integrating sensory quality with sustainability practices to enhance consumer acceptance and market success of berry products.

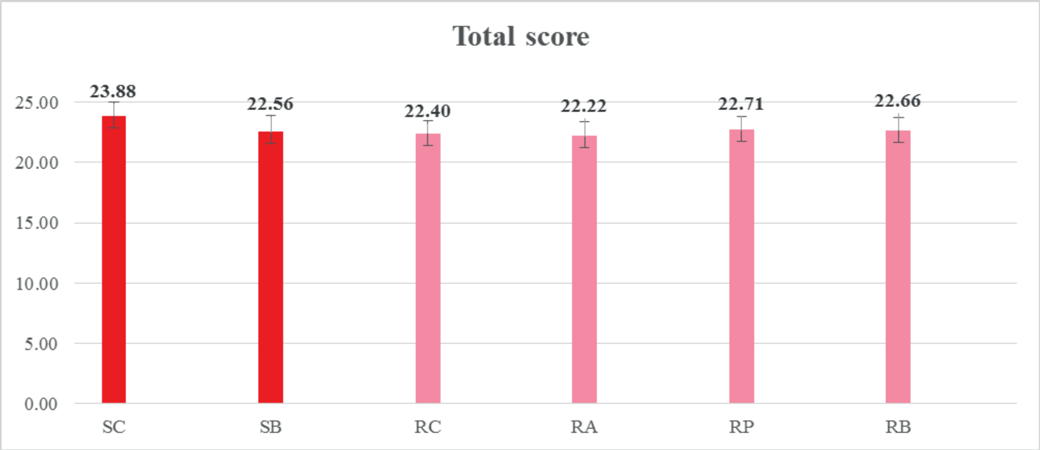

Figure 5. Consumer acceptance evaluation of fresh strawberries and raspberries (total score)

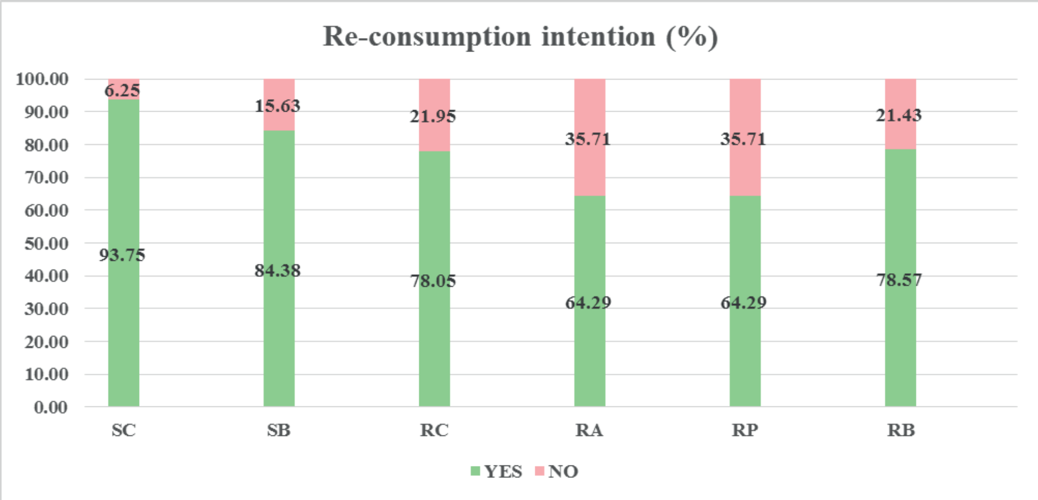

Figure 6. Re-consumption intent of fresh strawberries and raspberries (%)

CONCLUSIONS

The results indicate that control groups of both strawberries and raspberries were preferred by consumers, with higher re-consumption intentions and sensory scores, suggesting a stronger preference for traditionally grown fruits. While the introduction of *Borago officinalis* L. as a companion plant slightly reduced re-consumption intention, the differences in total sensory scores were minimal, indicating that intercropping had little impact on overall fruit quality. However, raspberries intercropped with *Borago officinalis* L. performed better than those with annual or perennial plants. These findings suggest that while companion planting may not drastically affect fruit sensory quality, it can still be a viable sustainable practice in organic agriculture, with potential benefits for biodiversity and environmental sustainability. Future research could explore innovative cultivation methods or advanced post-harvest techniques to further improve sensory attributes, particularly odor and texture, ensuring a balance between environmental sustainability and consumer satisfaction.

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