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HIGHLIGHTING THE INFLUENCE OF BROCCOLI MICROPLANTS (*BRASSICA OLERACEA* VAR. *ITALICA*) ADDITION TO VEGAN YOGHURT ON THE FINAL CONSUMER PURCHASING PREFERENCES

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Abstract

Microplants (microgreens/sprouts) = MMS, are used for their culinary versatility and potential health benefits. By nutrient composition and bioactive compounds, MMS are considered edibles with significant contribution in modulating oxidative stress and inflammation in the human body. This paper explores the theoretical and practical aspects of incorporating broccoli MMS into vegan yoghurt to assess their influence on consumer purchasing preferences. The study outlines an effective protocol for cultivating and integrating broccoli MMS with comestible substrate into plant-based yoghurt formulations. The experimental process included sensory evaluations of the final products conducted by a trained panel and an on-line consumer survey. The results, presented through detailed charts and analysis, highlight the sensory attributes, consumer acceptance, and purchasing behaviours influenced by the addition of broccoli MMS. This study provides valuable insights into the potential market appeal of functional vegan yoghurt enriched with broccoli MMS and its implications for consumer preferences.

Key words*: broccoli, vegan yoghurt, microplants (microgreens/sprouts).*

INTRODUCTION

Broccoli (*Brassica oleracea* var. *italica*), a member of the *Brassicaceae* family (USDA, Agricultural Research Service, 2025), is valued for its flower buds and sprouts, which are rich in bioactive compounds like glucosinolates, flavonoids, and phenols (Hong, 2020). On the base of content in nutrients (minerals, proteins, etc.) and its health benefits broccoli is considered a superfood (Drăghici et al., 2023).

One of fhe recent studies, found higher antioxidant traits in the two broccoli cultivars at sprouts stage compared to microgreens and baby leaves (Di Bella et al., 2020).

Broccoli sprouts, have higher levels of sulforaphane, glucosinolates, flavonoids, phenols, and vitamin C than mature broccoli, and also activates detoxifying enzymes, reducing chronic disease risks (Hong, 2020).

Innovative cultivation methods enhance broccoli sprout quality, e. g.: blue LED light irradiation increases sulforaphane content (Lee, 2013); while fermentation with *Lactococcus lactis* ET45 improves antioxidant effects (Choi, 2024) and techniques like γ-aminobutyric acid with sodium chloride stress enrich lutein content (Li et al., 2024).

Cultivation involves sterilizing seeds with sodium hypochlorite and germinating them on substrates like agar or rice bran mixtures (Hong and Chen, 2021; Di Bella et al., 2020). But, in the context of plants (not sprouts), the application of microbial inoculants (*Bacillus megaterium, Pantoea agglomerans,* and *Bacillus subtilis*), has been shown to enhance chlorophyll content in *Brassica oleracea* when utilized in agricultural practices involving inoculated specimens (Barbu et al., 2022). However, in the literature reviewed for this article, it has been found that eliminating microorganisms during the germination of seeds and their conversion into sprouts is essential. There is considerable evidence supporting the importance of this process to ensure safe and healthy sprout production.

Innovative germination methods include using lukewarm water and rotary incubators to optimize growth (Yang, 2025) and lava seawater to boost sulforaphane levels (Choi[a] et al., 2020).

Far-infrared ionized water enhances microbial activity and nutritional profiles (Lee and Kim, 2013).

Broccoli sprouts are processed into powders, drinks and capsules. Lyophilized sprout powder retains bioactive compounds (Xu et al., 2013), while sprout drinks offer immune-boosting effects (Park, 2006). Broccoli sprout extract capsules, produced *via* ultrasonic oscillation and freeze-drying, offer anticancer benefits (Liu et al., 2015).

Broccoli sprouts are used in functional foods, such as extracts inhibiting *Helicobacter pylori* (Kim et al., 2013) and high-voltage pulsed electric field-treated sprouts for cognitive health (Choi[b] et al., 2020). Also, broccoli sprouts are used in heavy metal detoxification blends (Oh et al., 2007) and granulated for easy consumption (Jang, 2024).

Sensory analysis ensures marketability (Popa et al., 2022). Consumer preference studies highlight demand for functional broccoli sprout products (Geicu-Cristea et al., 2023).

Considering the information presented in this introduction, this paper introduces an effective method for cultivating and integrating broccoli microplants (microgreens/sprouts) = (MMS) into vegan yoghurt formulations using an edible substrate. The findings, presented through comprehensive charts and analyses, shed light on the sensory characteristics of the product, as well as consumer acceptance and purchasing behaviors influenced by the incorporation of broccoli MMS. These insights contribute to better understanding of the market potential for functional vegan yogurt enriched with broccoli MMS and offer important considerations regarding consumer preferences.

MATERIALS AND METHODS

Cultivation of Broccoli (*Brassica oleracea* var. *italica*) MMS. For this study, broccoli (*Brassica oleracea* var. *italica*) seeds were purchased from an on-line store. Approximately 10 g seeds were used for this experiment. The seeds underwent a sterilization process (Hong, 2021; Di Bella et al., 2020), using a 10% sodium hypochlorite solution for 3 minutes, followed by three rinses with distilled water (1.5 minutes each). A total of 50 containers with sterilized seeds and the substrate were prepared for germination. The broccoli MMS were grown on a substrate consisting of distilled water with edible agar and under aseptic conditions (Patent application No. A/00039 on 30.01.2023; Barbu et al., 2024).

The temperature during germination and growth was maintained at 24°C ± 1°C, and the MMS were collected after 14 days of growth. After collection, the broccoli MMS were used along with the substrate.

Obtaining Vegan Yoghurt

Vegan Yoghurt was purchased from the commercial source, respectivelly hypermarket chain. The vegan yoghurt used was made from coconut milk, being a vegan and eco product. A total of 600 g of vegan yoghurt were used.

Development of the new product based on broccoli MMS and vegan yoghurt

After obtaining broccoli (*Brassica oleracea* var. *italica*) MMS and vegan yoghurt, the next step was the development of the new product. To prepare the experimental samples, the broccoli MMS was chopped using a blender and then mixed with vegan yoghurt in specific ratios. Five experimental variants were prepared as follows:

- ***Control*** - composed only of vegan yoghurt with no broccoli MMS added.
- ***Variant 1*** - a mixture of vegan yoghurt and broccoli MMS in a ratio of **3:1** (corresponding to 25% broccoli MMS).
- ***Variant 2*** - a mixture of vegan yoghurt and broccoli MMS in a ratio of **1:1** (corresponding to 50% broccoli MMS).
- ***Variant 3*** - a mixture of vegan yoghurt and broccoli MMS in a ratio of **1:3** (corresponding to 75% broccoli MMS).
- ***Variant 4*** - composed only of broccoli MMS with no vegan yoghurt added (ratio **0:1**).

The study utilized sensory analysis and an online questionnaire to explore consumer preferences and the influence of broccoli MMS on purchasing behaviour

The study utilized both sensory analysis and an online questionnaire to explore consumer preferences and evaluate the influence of broccoli MMS on purchasing behavior. The questionnaire, designed using the Google

Forms platform (Geicu-Cristea et al., 2023), was disseminated via social media to facilitate efficient and cost-effective data collection. It consisted of 18 questions, structured to capture socio-demographic data and consumer insights regarding the new product.

The questionnaire was divided into two main sections:

- ***Socio-demographic profile***: Included 4 questions on age group, residence, occupation, and general familiarity with edible microplants (microgreens/sprouts).
- ***Consumer behavior and sensory preferences***: The remaining 14 questions assessed consumer perceptions regarding flavor, taste, color, texture, price sensitivity, product content, and openness to trying or recommending the broccoli MMS-vegan yogurt product. One question asked participants to indicate the price they would be willing to pay for a 50 g serving of the dish.

In addition to the online survey, sensory analysis was conducted with the same group of 45 untrained panelists, randomly selected from students and staff at the University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania. The yogurt samples were presented in matte white glasses, each labeled with a one-digit code and served in random order to reduce bias. Before beginning, participants were informed of the sensory evaluation procedure, which had received approval from the University's Ethics Committee.

Panelists were instructed to taste the samples and evaluate them based on personal preference, which may have influenced their perception of individual attributes. To ensure accurate olfactory and taste assessments and minimize cross-sample interference, room-temperature water and apple slices were provided as palate cleansers between samples. At the end of the tasting, panelists were asked to identify their preferred sample and indicate whether they would consider purchasing it.

This combined methodology offered a comprehensive overview of consumer behavior and sensory response, providing valuable insights to guide future product development and market positioning.

RESULTS AND DISCUSSIONS

After obtaining the novel product, the final step in highlighting the influence of broccoli MMS added to vegan yoghurt on the final consumer's purchasing preferences was to conduct a sensory analysis followed by an online questionnaire based on the results.

The questionnaire was completed by 45 consumers (whose socio-demographic profile is presented in Table 1).

Table 1. The socio-demographic profile of the consumer

Age Group	53.3% - between 26-25 years old 31.1% - between 18-25 years old 15.6% - between 36-48 years old
Residence	73.3% - urban 26.7% - rural
Do you know what edible microplants (microgreens / sprouts) = MMS are?	60% - yes 40% - no
Are you a consumer of dairy products with additives?	68.9% - yes 31.1% - no
Have you consumed broccoli microgreens?	42.2% - yes 57.8% - no
Are you interested in tasting a new product made from broccoli microgreens and vegan yoghurt?	75.6% - yes 24.4% - no
Would you recommend the product made from broccoli microgreens and vegan yoghurt for consumption?	62.2% - yes 37.8% - no
Occupation:	57.8% - employed 26.7% - student 11.1% - entrepreneur 4.4% - unemployed

In the first part of the questionnaire, the participants were asked how often they buy dairy products that contain additives (Figure 1). The results obtained indicate that a significant number of respondents (48.9%) never buy dairy products with additives. Additionally, 33.3% of participants purchase such products monthly, while 13.3% buy them weekly. A smaller percentage, 2.2%, reported buying these products daily or yearly. This suggests a varying level of awareness and preference regarding the consumption of dairy products

with additives, with a notable segment of the population avoiding them altogether.

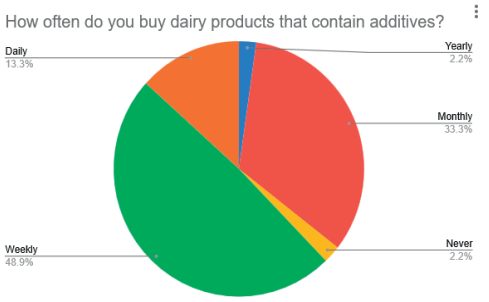

Figure 1. How often they buy dairy products that contain additives?

In the next question (Figure 2), participants were asked about the most important criterion in choosing a product from a sensory perspective. The results indicate that taste is the predominant factor, with 62.2% of respondents prioritizing it. Olfactory aspects were considered important by 22.2% of participants, while visual appeal was selected by 13.3%. Texture was the least emphasized criterion, chosen by only 2.2% of respondents. This highlights the significant role that taste plays in consumer decision-making when selecting products based on sensory attributes.

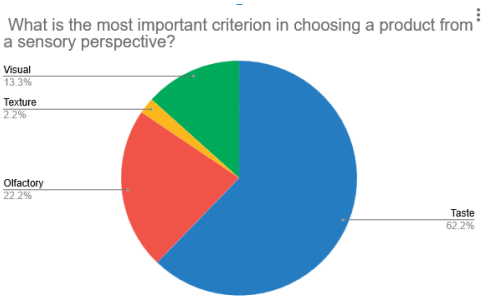

Figure 2. The most important criterion in choosing a product from a sensory perspective

In Figure 3 is presented the graph according to the results obtained for the question where participants were asked about the importance of the price of a product when making a purchase. The results show that a majority of 51.1% of respondents find the price important. Additionally, 20.0% consider it very important, while 26.7% are indifferent to the price. Only a small percentage, 2.2%, find the price to be little important. This indicates that price is a significant factor for most consumers when deciding to purchase a product.

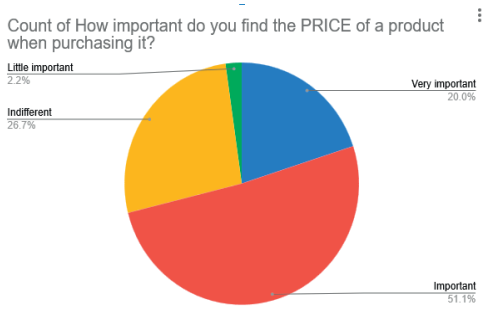

Figure 3. The importance of the price of a product when making a purchase

The Figure 4 shows the results obtained for the question regarding the importance of the content of a product when making a purchase. The results indicate that 37.8% of respondents find the content important, while 31.1% are indifferent to it. A significant proportion, 26.7%, consider the content very important, and only a small percentage find it little important. This suggests that while content is a crucial factor for many consumers, there is a notable segment that does not prioritize it as highly in their purchasing decisions.

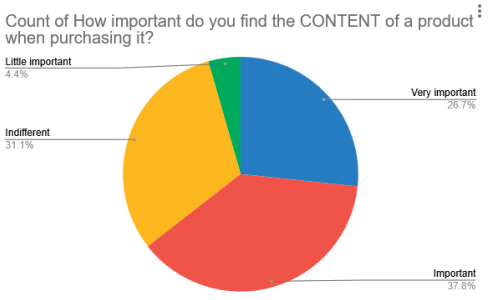

Figure 4. Importance of the content of a product when making a purchase

Figure 5 presents the results for the question related to the importance of the color of a product when making a purchase.
The results show that 37.8% of respondents find the color important, while 44.4% are indifferent to it. A smaller percentage, 6.7%, consider the color very important, and another 6.7% find it little important. Only 4.4% of participants stated that color is not important at

all. This indicates that while color plays a role for a significant number of consumers, a larger segment remains indifferent to it in their purchasing decisions.

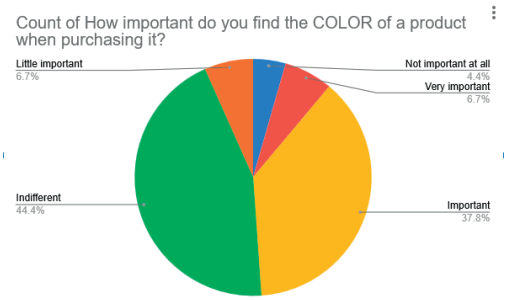

Figure 5. The importance of the color of a product when making a purchase

In Figure 6, the results presented emphasize the importance of the flavor of a food product when making a purchase.
The results reveal that 35.6% of respondents find the flavor important, while 33.3% consider it very important. A smaller percentage, 22.2%, are indifferent to the flavor, and 8.9% find it little important. This highlights that flavor is a critical factor for the majority of consumers when selecting food products, with a significant emphasis on its importance.

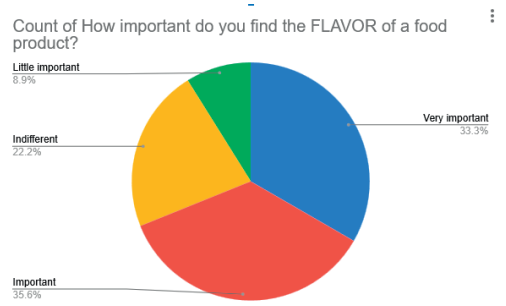

Figure 6. The importance of the flavor of a food product when making a purchase

In Figure 7, the results presented highlight the importance of the texture of a food product when making a purchase.
The results indicate that 42.2% of respondents find the texture important, while 24.4% consider it very important. A notable percentage, 31.1%, are indifferent to the texture, and only 2.2% find it little important. This suggests that texture is a significant factor for many consumers, although a considerable proportion does not prioritize it as highly in their food choices.

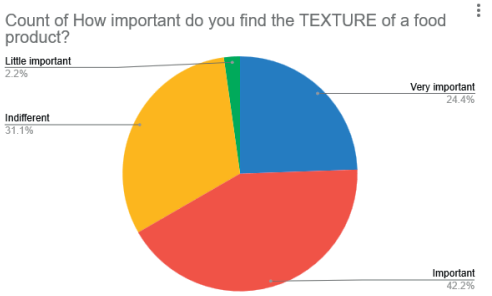

Figure 7. The importance of the texture of a food product when making a purchase

The participants were also asked about the importance of the taste of a food product when making a purchase and the results obtained are presented in the Figure 8.
The results show that 44.4% of respondents find the taste very important, while 26.7% consider it important. A smaller percentage, 20.0%, are indifferent to the taste, and 8.9% find it little important. This underscores that taste is a crucial factor for the majority of consumers when selecting food products, with a strong emphasis on its significance.

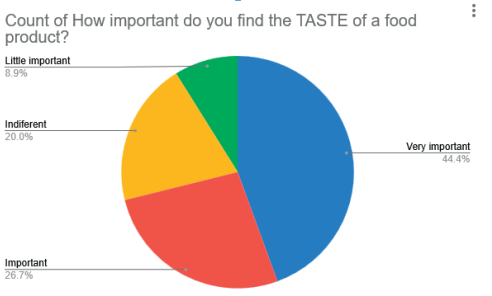

Figure 8. The importance of the taste of a food product when making a purchase

In Figure 9, participants' opinions on the importance of food packaging when making a purchase are presented.
The results indicate that 28.9% of respondents find the packaging important, while 33.3% are indifferent to it. A smaller percentage, 8.9%, consider the packaging very important, and another 8.9% find it not important at all. Additionally, 20.0% of participants find the

packaging little important. This suggests that while packaging is a factor for some consumers, a significant number of consumers does not prioritize it highly in their purchasing decisions.

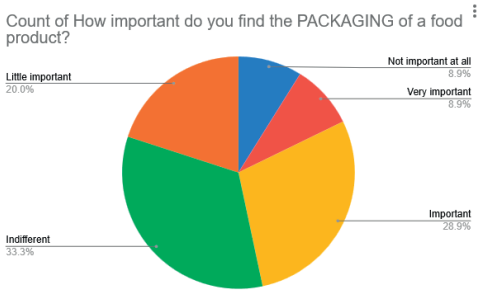

Figure 9. The importance of the packaging of a food product when making a purchase

Figure 10 presents participants' responses regarding the price they would be willing to pay for a 50 g serving of a dish composed of broccoli microgreens and vegan yogurt.

The results show that a majority of 53.3% of respondents are willing to pay between 5.10 and 10.00 RON. Additionally, 24.4% would pay between 10.10 and 15.00 RON, while 22.2% are willing to pay between 2.00 and 5.00 RON.

This indicates a range of price sensitivity among consumers, with most favoring a mid-range price point for this specific dish.

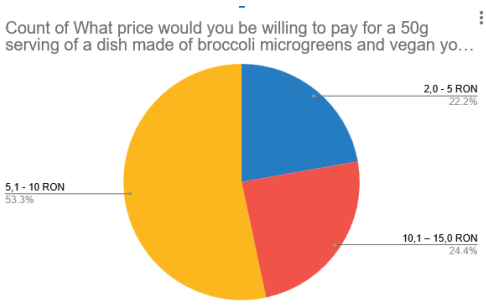

Figure 10. The price that the consumers would be willing to pay for a 50g serving of a dish made of broccoli microgreens and vegan yoghurt

Germination of seeds, both for cultivating plants and for producing sprouts, requires an adequate water source to initiate and sustain physiological processes. E.g., for cultivated plants, research has examined the characteristics and effects of adding hydrogel to the soil (Miteluț et al., 2022). In contrast, studies on sprouts highlight the use of a substrate consisting of aseptic gauze along with water to facilitate seed germination (Livadariu & Dumitru, 2019).

In our experiment, we used a substrate made from edible agar used both for obtaining of sprouts (Barbu et al., 2023) or microplants (microgreens/sprouts) of sorrel (Barbu et al., 2024), to prevent the hyperhydration of seeds and eliminate the need for periodic watering.

By incorporating the MMS along with the substrate from which they were derived, it eliminates the need for a washing step. For example, such a washing step is typically necessary when cultivating pea (*Pisum sativum* L.) sprouts in soil-based substrates (Livadariu & Dicu, 2022). This approach may offer a more efficient method for MMS utilization.

Based on the results presented in Table 1 and Figures 1 – 10, it can be concluded that this study successfully demonstrates the cultivation and integration of broccoli MMS into vegan yogurt, highlighting its potential as a functional food.

A **sensory analysis** was conducted on the five yoghurt variants (control, 25 %, 50 %, 75 % and 100 % broccoli MMS) with 45 untrained panellists (Popa et al., 2022). Variant 2 (1: 1 yoghurt: MMS) emerged as the preferred sample, achieving the highest overall acceptability score (mean ± SD: 7.4 ± 0.7). Across all variants, taste and texture received the highest hedonic ratings (mean ≥ 7.5), while color was the least-favoured attribute (mean ≈ 6.2) (Figure 11).

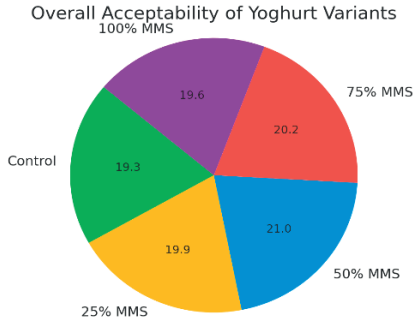

Figure 11. Overall acceptability scores of yoghurt variants with different broccoli MMS levels

Separately, the online questionnaire (18 questions, 45 respondents) showed that taste (62.2%), texture (42.2%) and price (51.1%) were the most critical purchase drivers, and that over half of participants would pay 5.10-10.00 RON for a 50 g serving.

Together, these results highlight that - both in controlled tastings and broad consumer surveys - taste, texture, and price are decisive for acceptance of a broccoli-MMS-enriched vegan yoghurt. This dual approach underlines the product's market potential and points to the importance of optimizing sensory attributes and pricing strategy in future commercialization efforts.

CONCLUSIONS

This study investigates consumer preferences for a novel food concept combining vegan and eco yoghurt with broccoli microplants (microgreens/sprouts, referred to as MMS). Using an online questionnaire, the study aimed to assess consumer attitudes, purchasing behavior, and key decision factors related to such a product.

Results from the questionnaire indicated that taste was the most influential factor in purchasing decisions (62.2%), followed by texture (42.2%) and flavor (35.6%). Price (51.1%) and product content (37.8%) were also considered important, while color and packaging had less impact on consumer choice. In terms of pricing expectations, most respondents (53.3%) expressed willingness to pay between 5.10 and 10.00 RON for a 50g serving, reflecting a mid-range price sensitivity.

These findings highlight the significance of taste, texture, and price in consumer acceptance of plant-based, health-oriented products, and suggest promising potential for a broccoli microgreen and vegan yoghurt-based product in the market. Further research should focus on optimizing the product's sensory qualities and identifying effective marketing strategies for its commercial launch.

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