

CONSUMER PREFERENCES DEPENDING ON THE VARIETY OF FRESH PEPPERS, FOR HELPING FARMERS, WHAT CULTIVARS TO GROW

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Abstract

Rich in nutrients, especially vitamin A and vitamin C, with an impressive range of colors, sweet peppers are loved for their pleasant taste and mild flavor. Used in many different culinary recipes, peppers bring variety to the Romanian diet. People's preferences for sweet peppers are important for producers, so they can grow cultivars that are appreciated by consumers. In addition, pepper breeders are also interested in these preferences, so they can focus on creating varieties that answer the consumer's demands. This study presents a sensorial analysis of more than 40 sweet pepper cultivars in the period 2022-2024. Every year, in the first weekend of October, the Faculty of Horticulture is the host of the "Horticultural Autumn of Bucharest" event. The visitors had the opportunity to taste and evaluate the sweet pepper cultivars. Several varieties were assessed every year, indicating how Romanian preferences have evolved during this period. The common indicators evaluated in all three years are color, taste, size, and shape. Juiciness and flavor are extra indicators evaluated only in 2022, and pericarp thickness is an extra indicator evaluated only in 2023. The best-ranked cultivar in 2022 was "Temes F1", in 2023 it was "SVPB 1112", and "Patrol F1" was highly appreciated in 2024. With an average production of 80 t/ha and an average selling price of 4.5 lei in 2024, the profit rate for the sweet pepper crop is close to 1.4 %, being one of the profitable crops in Romania.

Key words: *Capsicum annuum L.*, trends, consumer preference, sensorial analysis

INTRODUCTION

Native to Central and South America, peppers have an important health and economic value. Loved due to their pleasant taste and mild flavor, sweet peppers (*Capsicum annuum L.*) are used in daily-based diets worldwide. Every year, new cultivars are introduced, pleasing people with a variety of colors and shapes, but also promoting health and nutritional qualities (Żurawik et al., 2021) [26].

Sweet pepper, also known as bell pepper, is mainly cultivated for its pleasant taste, flavor, and diverse colors with nutritional benefits. Paprika is a well-known condiment made from dried red sweet peppers used in various dishes all over the world, containing useful molecules (Kostrzewa et al., 2023; Sood et al., 2023) [13, 24].

As a source of antioxidants, vitamins, carotenoids, flavonoids, polyphenols, or lycopene, peppers, both sweet and spicy, protect the human body against free radicals and play an important role in disease prevention (Medina-Juarez et al, 2012; Batiha et al., 2020; Pham-Huy et al., 2008) [15, 2, 18]. It is known that having a rich fruit and vegetable diet is a powerful and helpful method for maintaining good health. Using diet to prevent chronic diseases is a highly recommended method in times when the world's population is increasing and medical support is sometimes expensive (Ribes-Moya et al., 2014, Sanatombi, 2023) [21, 22]. The color diversity of peppers is due to carotenoids, anthocyanins, and chlorophyll content, which is also responsible for different tastes. Different colors mean different

bioactive compounds, and new varieties have been developed lately to benefit our health (Choi et al., 2023; Dlundla et al., 2023; Pratas et al., 2024) [7, 9, 20].

It is proven that fertilization methods influence the quality of peppers, and the yield is affected without fertilizer supplements (Becherescu et al., 2023) [3].

The producers use it for their crops with good results. In recent years, organic fertilization has been preferred by consumers, and current results show that fruit quality is increased as the vitamin C content, dry matter, and total soluble solids contents are increased, influencing the taste and flavor of peppers and subsequently human health as well (Barcanu-Tudor et al., 2018; Buțerchi et al., 2024; Toma et al., 2020) [1, 5, 25].

Genetic diversity and pepper population structure are studied at present based on agromorphological and microsatellite markers (Sood et al., 2023) [24].

Romania has good soil and climate conditions to produce various types of vegetables, tomatoes, and peppers, occupying an important place in the cultivated area and production (Soare et al., 2016; Popescu, 2018; Giuca, 2021) [23, 19, 10].

In this context, the purpose of the study is to provide an overview of the evolution of people's preferences for sweet peppers, studied in three consecutive years. The objective is to make the connection between the consumer's preferences related to sweet peppers, and producers, who can make a profit from growing the preferred cultivars.

MATERIALS AND METHODS

In 2022, the sensorial test included 43 sweet pepper varieties, in 2023, the test was made with 53 varieties, and in 2024, 57 varieties were included. Fifteen varieties were assessed in all three years. Four varieties were evaluated in 2022 and 2023, six varieties were evaluated in 2023 and 2024, and four were evaluated in 2022 and 2024.

Sweet pepper varieties were cultivated in the southeast part of Romania, and some varieties were cultivated in the west of Romania. The

same cultivar was provided from different counties with specified names (Table 1).

Table 1. Sweet pepper cultivars enrolled in tasting sessions

2022	2023	2024
1425 F1 Matca-Galați	Ar 371039	Apulum F1
Ardanza F1 Matca-Galați	Ardanza F1	Ardanza F1
Ardanza F1 Pucheni-Dâmbovița	Barbie F1	Asteroid
Barbie F1 Izbiceni-Olt	Barlem F1	Barbie F1
Beniel F1 Izbiceni-Olt	Burabella Rz F1 - Galați	Barlem F1
Bihar F1 Rusănești-Olt	Burabella Rz F1 - Giurgiu	Belo Uvo
Burati F1 Izbiceni-Olt	Burabella Rz F1 - Olt	Beniel F1
Burati F1 Matca-Galați	Burabella Rz F1 - Prahova	Blanciana F1
Burati F1 Prahova-Ploiești	Burrati Rz F1 - Dâmbovița	Burabella F1
Carcassone F1 Izbiceni-Olt	Burrati Rz F1 - Galați	Burrati F1
Carcassone F1 Pucheni-Db	Burrati Rz F1 - Prahova	Carcasson F1
Carpatin F1 CâmpiaTurzii-Cluj	Bw 1623 Rz F1	Carpatin F1
Coloreta F1 Matca-Galați	Bw 1624 Rz F1	Coloreta F1
Daciana F1 CâmpiaTurzii-Cluj	Carcasson F1	Eugenia F1
Galia F1 CâmpiaTurzii-Cluj	Carpatin F1	Favorit
Hek 500 F1 CâmpiaTurzii-Cluj	Coloreta F1	Hek 21 P685 F1
Ipon F1 Tecuci-Galați	Daciana F1	Hmc 572207 F1 (1)
Isabel F1 Ceptura De Jos	Galia F1	Hmc 572207 F1 (2)
Isabel F1 Matca-Galați	Galia F1	Insighia
Kaamos F1 Matca-Galați	Isabel F1	Isabel F1
Kaprima F1 Izbiceni-Olt	Kaprima F1	Kaprima F1 (1)
Kaptur F1 Dumbrăvești-Prahova	Kaptur F1	Kaprima F1 (2)
Kaptur F1 Izbiceni-Olt	Kr Rz 1505 - Galați	Kaprima F1 (3)
Kr 1505 Matca-Galați	Kr Rz 1505 - Olt	Kaptur F1 (1)
Lores F1 Matca-Galați	Kr Rz 1505 - Prahova	Kaptur F1 (2)
Napoca F1 CâmpiaTurzii-Cluj	Kubat F1	Karpathos F1 (1)
Palermo Obedius F1 Racovița	Lores F1	Karpathos F1 (2)
Palermo Radius F1 Racovița	Mauricio F1	Kr 1505 Rz F1
Palermo River F1 Racovița	Nirvin F1	Kubat F1 (1)
Palermo Yosemite F1 Racovița	Piedone F1	Kubat F1 (2)
Piedone F1 Matca-Galați	Posonium F1	Kubat F1 (3)
Potaisa F1 Dumbrăvești-Prahova	Pritannia F1	Kubat F1 (4)
Pritannia F1 Izbiceni-Olt	Red Jet Rz F1 - Galați	L 80
Rubicon F1 Tecuci-Galați	Red Jet Rz F1 - Prahova	L225
Scorilo F1 CâmpiaTurzii-Cluj	Redpia F1	Massouda Rz F1
Temes F1 Drăgășani-Valcea	Silver Star F1	Moscato F1
Tiberius F1 CâmpiaTurzii-Cluj	Svpb 1112	Napoca F1 (1)
Traian F1 CâmpiaTurzii-Cluj	Tallante F1	Napoca F1 (2)
Turda F1 CâmpiaTurzii-Cluj	Tiberius F1	Patrol F1
Valahia F1 CâmpiaTurzii-Cluj	Top Gear Rz F1 - Dâmbovița	Piedone F1
Vitalica F1 Clinceni-Olt	Top Gear Rz F1 - Giurgiu C	Potaisa F1
Vitalica F1 Matca-Galați	Top Gear Rz F1 - Giurgiu V	Pritannia F1
Vitalica F1 Prahova-Ploiești	Top Gear Rz F1 - Olt	Scorilo F1
	Top Gear Rz F1 - Prahova	Sv 0102 F1
	Turda F1	Sweet Palermo

		Chocolony Rz F1
	Valahia F1	Sweet Palermo Obedius Rz F1
	Verdejo F1	Sweet Palermo Radius Rz F1
	Vinalles Rz F1	Sweet Palermo Yocarino Rz F1
	Vitalica Rz F1 - Dâmbovița	Tallante F1
	Vitalica Rz F1 - Galați	Temes F1
	Vitalica Rz F1 - Giurgiu	Tiberius F1
	Vitalica Rz F1 - Olt	Tonton F1
	Vitalica Rz F1 - Prahova	Topgear Rz F1
		Turda F1
		Verdejo F1
		Vitalica Rz F1 (1)
		Vitalica Rz F1 (2)

Source: Original data from the sensorial analysis.

The testing sessions were conducted as a part of the event "Horticultural Autumn of Bucharest", an event that is currently held at the start of October every year, at the Faculty of Horticulture. The hedonic method was used for testing the preferences, with five points on the scale. The criteria range used for evaluation for every indicator was from 1, meaning 'I don't like it' (insufficient), to 5, meaning 'I love it' (excellent).

The common indicators for expressing quality in all three years were: size, shape, color, and taste. In 2022, juiciness and aroma were extra indicators tested, and in 2024, the thickness of the pericarp was the extra indicator tested.

The respondents for all tasting sessions were participants of the "Horticultural Autumn of Bucharest" event, from a wide economic background, with ages between 9 and 77 years old. Sixty-six assessors participated in 2022, 63 in 2023, and 31 assessors responded in 2024.

For an objective evaluation, the average score was calculated for every sweet pepper cultivar, in every year tested. Data analysis was done using the Microsoft Excel Software, version 2401.

RESULTS AND DISCUSSIONS

All the scores were summed per year, and the varieties were ranked from the highest value to the lowest. The best score in 2022, with 26.8 points from a total of 30 points, is the 'Temes F1' variety from Drăgășani, Vâlcea County, followed by 'Ardanza F1' with 26.1 points, 'Kaamos F1' and 'Coloreta F1' with 26.0 points, all from Matca – Galați county.

In 2023, the highest scores went to line 'SVPB 1112' with 18.2 points from a total of 25 points, followed by 'Coloreta F1' with 17.8 points, 'Red Jet RZ F1' from Galați county with 17.7 points, and 'Verdeho F1' with 17.6 points.

The same variety 'Red Jet RZ F1' but from Prahova County scored 17.5 points, close to the first-ranked varieties, meaning that this variety was appreciated by respondents even if it was cultivated in different areas of the country.

2024 brings 'Patrol F1' to the top with 22.6 points from a total of 25 points, followed by 'Insignia' with 22.3 points. 'Kubat F1' and 'Pritannia F1' both with 21.9 points, and also 'Napoca F1', 'Carpatin F1', and 'Coloreta F1' had close values: 21.7 points.

Figure 1 shows that the differences between varieties are quite small, and the top five have varieties with close values, making it very difficult to express an exact ranking.

The size, shape, color, and taste were indicators common for all three years analyzed. These indicators are related in the literature to fertilization use and water supply. The size is usually influenced by fertilization methods, grafting, and constant water amount, while the color, taste, and quality performance are attributed to organic fertilization (Brezeanu et al., 2022; Caruso et al., 2019; Cojocaru et al., 2022; Homma et al., 2022; Jasim et al., 2019; Murcia-Asensi et al., 2024) [4, 6, 8, 11, 12, 16]. Regardless of the technology used, the best score for size in 2022 goes to two varieties: 'Coloreta F1' from Matca – Galați and 'Temes F1' from Drăgășani – Vâlcea both with 4.7 points. 'Galia F1' from Câmpia Turzii – Cluj and 'Kaprima F1' along with 'Kaptur F1' from Izbiceni – Olt had 4.6 points, followed by eleven varieties with 4.5 points. (Fig. 2).

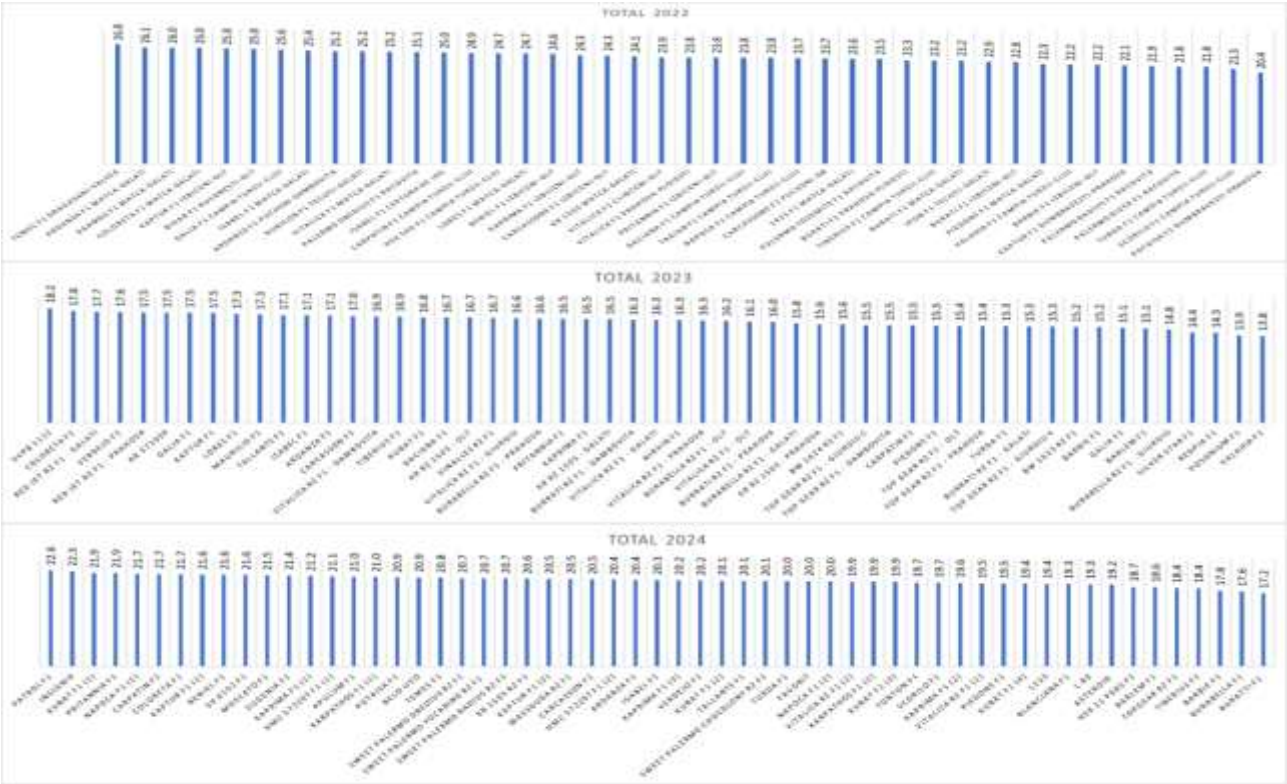


Fig. 1. Total score for sweet pepper varieties, tested in 2022, 2023, and 2024
Source: Original data

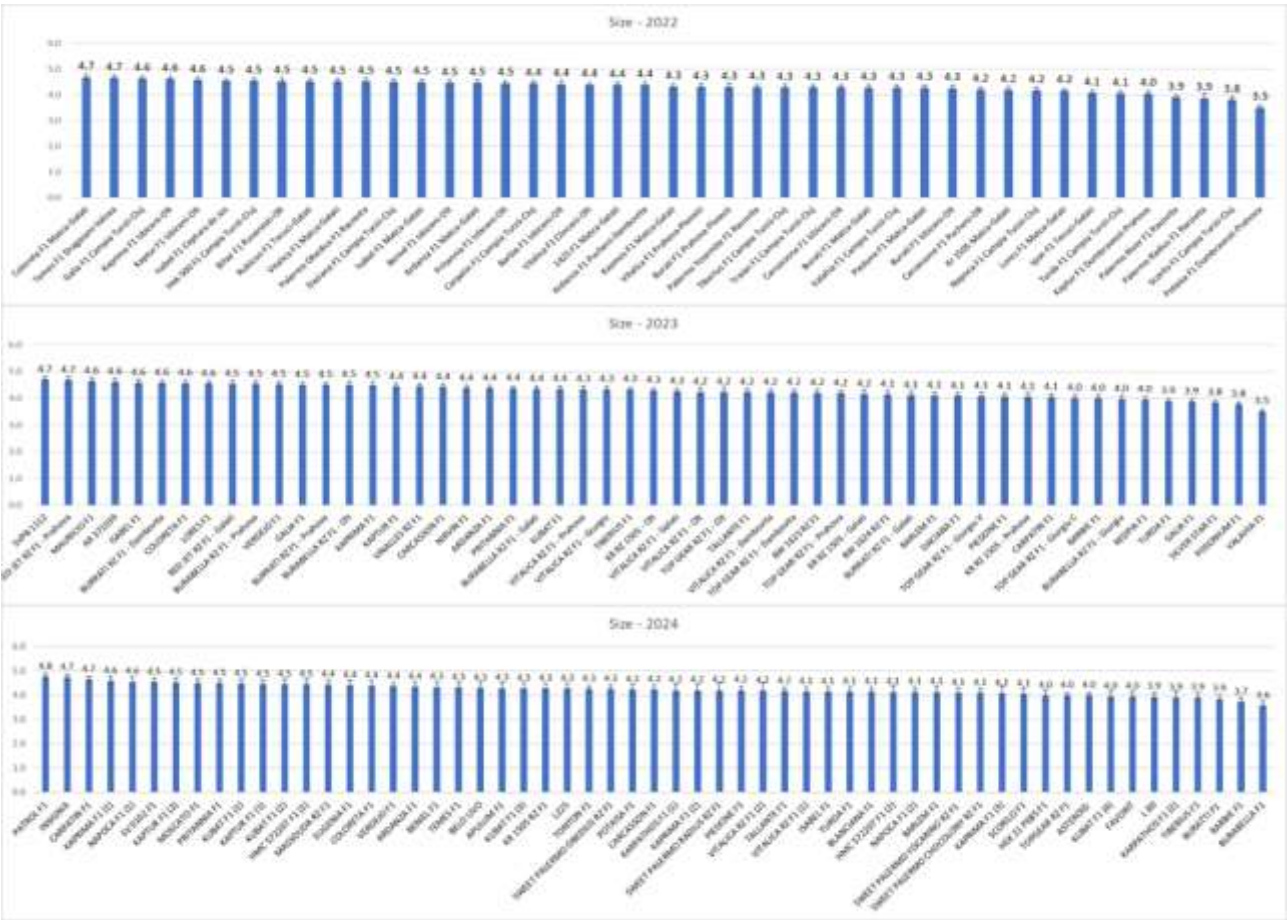


Fig. 2. Size appreciation in 2022, 2023, and 2024. Error bars represent the standard error of the mean.
Source: Original data.

In 2023, the line ‘SVBP 1112’ and ‘Red Jet RZ F1’ from Prahova had the highest rank with 4.7 points. Next was ‘Mauricio F1’, the line ‘AR 37 1039’, ‘Isabel F1’, ‘Burrati RZ F1’ from Dâmbovița, ‘Coloreta F1’, and ‘Lores F1’, all with 4.6 points. With 4.5 points, there were seven varieties (Figure 2).

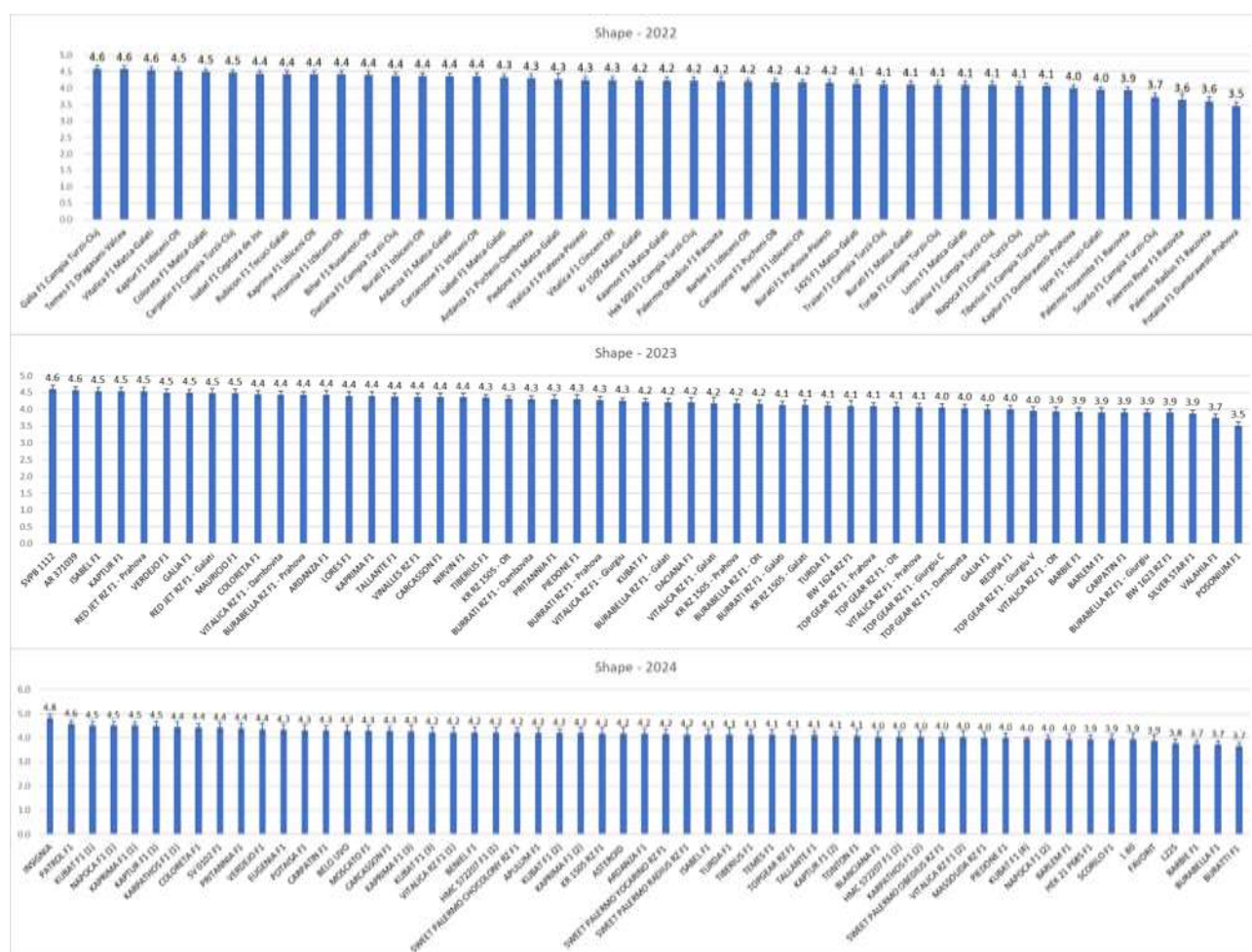
The highest rank in 2024, with 4.8 points, is occupied by ‘Patrol F1’, followed with 4.7 points by ‘Insignia’ and ‘Carpatin F1’, and continued by ‘Kaprima F1’ and ‘Napoca F1’ with 4.6 points.

Besides size, the shape of sweet peppers was also evaluated, and the best scores in 2022 go to ‘Galia F1’ from Câmpia Turzii – Cluj, ‘Temes F1’ from Drăgășani – Vâlcea, and ‘Vitalica F1’ from Matca – Galați, all with 4.6 points. ‘Kaptur F1’, ‘Coloreta F1’, and

‘Carpatin F1’ scored 4.5 points, and ‘Isabel F1’, ‘Rubicon F1’, ‘Kaprima F1’, ‘Pritannia F1’, ‘Bihar F1’, ‘Daciana F1’, ‘Burati F1’, ‘Ardanza F1’, and ‘Carcassonne F1’ scored 4.5 points.

Having the highest score for size in 2023, the line ‘SVPB 1112’ also had the highest score for shape in the same year, along with the line ‘AR 371039’ with 4.6 points. ‘Isabel F1’, ‘Kaptur F1’, ‘Red Jet RZ F1’ from Prahova and Galați, ‘Verdeho F1’, ‘Galia F1’, and ‘Mauricio F1’ scored 4.5 points, followed by ten varieties with 4.4 points.

In 2024, ‘Insignia F1’ and ‘Patrol F1’ are also at the top, the first variety with 4.8 points, and the second one with 4.6 points. ‘Kubat F1’, ‘Napoca F1’, ‘Kaprima F1’, and ‘Kaptur F1’ gathered 4.5 points each (Fig. 3).



500 F1', 'Kaptur F1', 'Kaprima F1', 'Galia F1', 'Ardanza F1', 'Palermo Obedius F1', 'Daciana F1', 'Carpatin F1', 'Bihar F1', 'Carcassone F1', 'Kaamos F1', and 'Rubicon F1'.

The line 'SVPB 1112' had the best score for color also in 2023, with 4.7 points. 'Talante F1' ranked the same value. 'Verdeho F1' was next with 4.6 points, and seven varieties gathered 4.5 points: 'Red Jet RZ F1', 'Coloreta F1', 'Kaptur F1', 'Carcassone F1', 'Daciana F1', 'Galia F1', and 'AR 371039'.

The same varieties with the highest scores in size and shape also had the best scores in color in 2024. 'Patrol F1', 'Insignia F1', 'Coloreta F1' and 'Kubat F1' had 4.6 points, followed by 'Carpatin F1', 'Kaptur F1', 'Beniel F1' and 'Pritannia F1' with 4.5 points, and 4.4 points ranked eleven varieties: 'Napoca F1', 'Carcassone F1', 'Potaisa F1', 'Moscato F1', 'Massouda RZ F1', 'Favorit', 'SV 0102 F1', 'HMC 572207 F1', 'Karpathos F1', 'Temes F1', and 'Sweet Palermo Radius RZ F1' (Fig. 4).

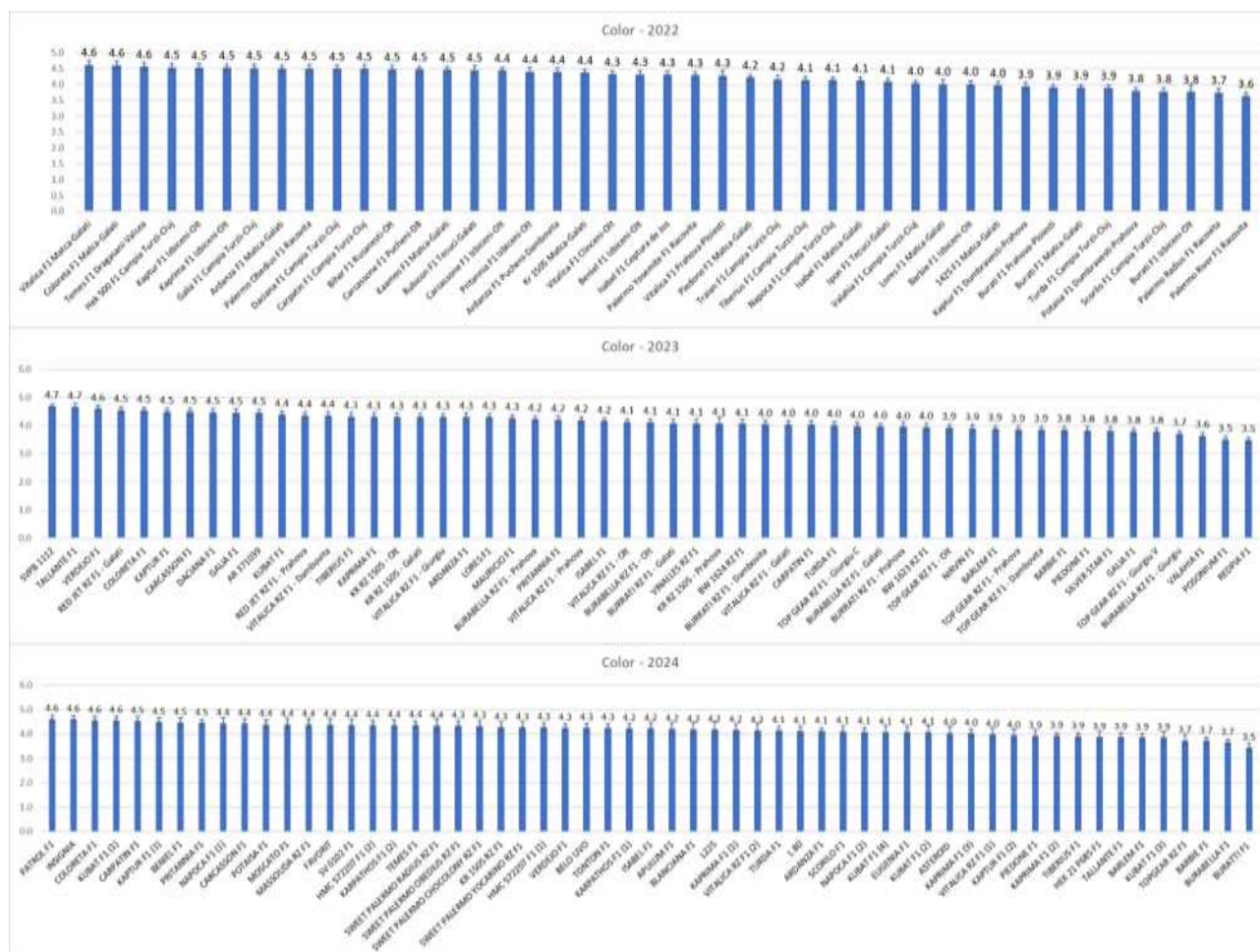


Fig. 4. Color appreciation in 2022, 2023, and 2024. Error bars represent the standard error of the mean
Source: Original data

The taste criteria respected the trend and the varieties with the best scores for size, shape, and color, ranked in the same positions for taste. 'Kaamos F1', 'Temes F1', and 'Ardanza F1' from Matca – Galați were favorites in 2022 with 4.3 points, followed by 'Lores F1', 'Isabel F1', and 'Ardanza F1' from Pucheni – Dâmbovița with 4.2 points. 'Bihar F1',

'Coloreta F1', and 'Kaptur F1' gathered 4.1 points.

'SVPB 1112' had the highest score for taste in 2023, along with 'Coloreta F1' with 4.2 points. 'Red Jet RZ F1' from Galați and 'Lores F1' gathered 4.1 points, followed by six varieties with 4.0 points: 'Galia F1', 'Ardanza F1', 'Verdeho F1', 'Kaptur F1', 'Daciana F1', and 'Red Jet RZ F1' from Prahova.

For the year 2024, the varieties ranked first in taste criteria were some varieties with average scores in the other criteria. ‘Sweet Palermo Obedius RZ F1’ had the highest score with 4.3 points, followed by ‘Sweet Palermo Yocarino

RZ F1’, ‘Sweet Palermo Radius RZ F1’, ‘Pritannia F1’, ‘Patrol F1’, and ‘Eugenia F1’ with 4.2 points. The rank is completed by ‘Beniel F1’ and ‘Coloreta F1’ with 4.1 points (Fig. 5).

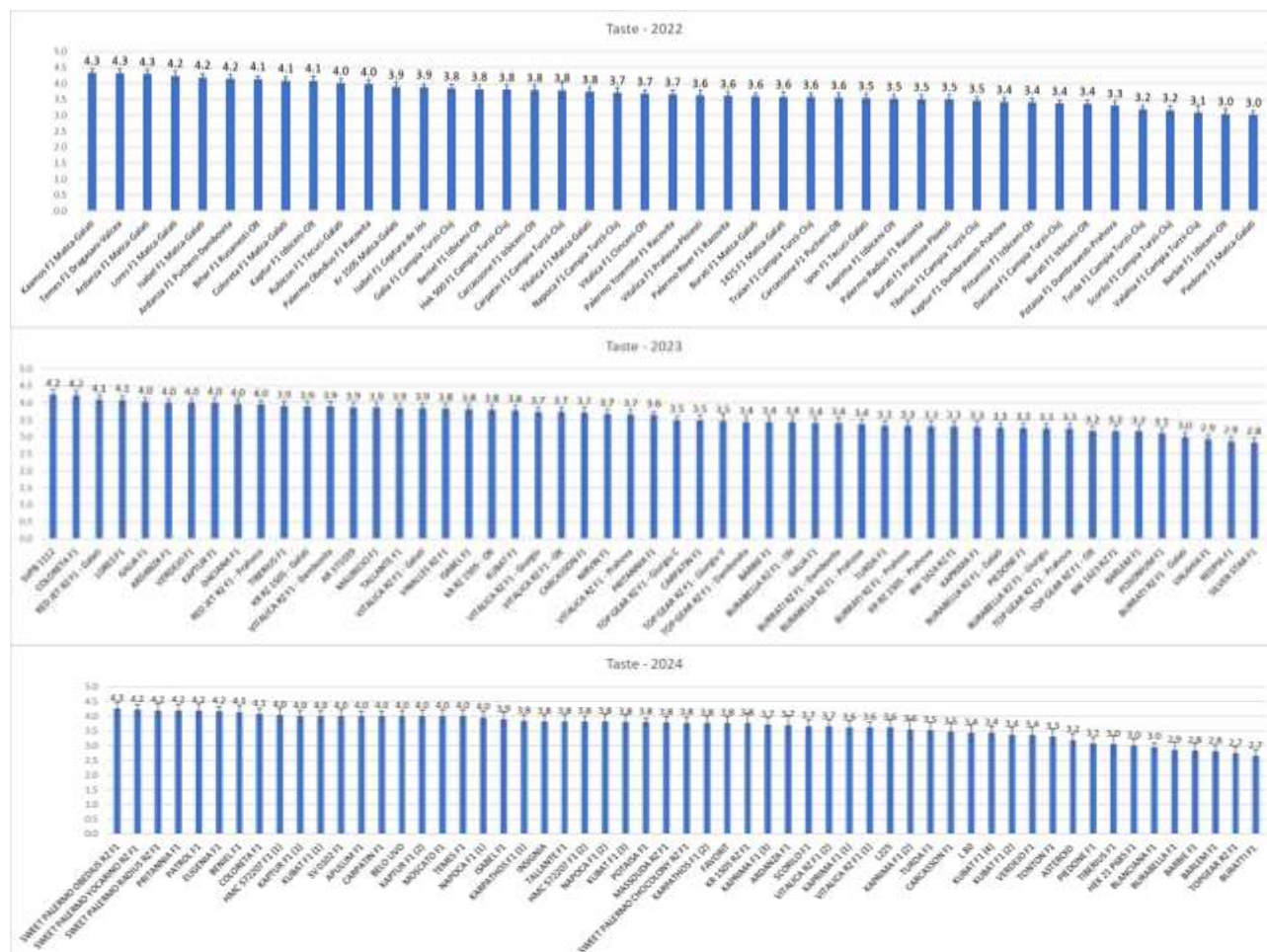


Fig. 5. Taste appreciation in 2022, 2023, and 2024. Error bars represent the standard error of the mean
Source: Original data

In 2022, there were two extra criteria evaluated in the tasting session: juiciness and flavor. These two criteria didn't change the ranking in general; the same varieties had the biggest scores, but they gave more weight to the total scores.

In the first positions for juiciness were placed ‘Temes F1’ from Drăgășani – Vâlcea and ‘Kaamos F1’ from Matca – Galați, scored 4.4 points, followed by ‘Galia F1’, ‘Ardanza F1’ from Matca – Galați, ‘Lores F1’, ‘Coloreta F1’, ‘Kaptur F1’, ‘Isabel F1’, and ‘Bihar F1’ with 4.2 points.

Not only for juiciness but for flavor too, ‘Kamos F1’ and ‘Temes F1’ from Drăgășani – Vâlcea are the varieties with the biggest score – 4.3 points, followed by ‘Ardanza F1’ from Matca – Galați with 4.2 points. ‘Isabel F1’ and ‘Bihar F1’ are also ranked in third place with 4.1 points (Fig. 6).

The additional criteria in 2024 were pericarp thickness, an indicator with a direct implication for fruit weight, and yield (Madosa et al., 2008) [14]. The cell wall structure, the texture, is an important factor for the consumer's sensory experience as well as for fruit hardness and storage resistance.

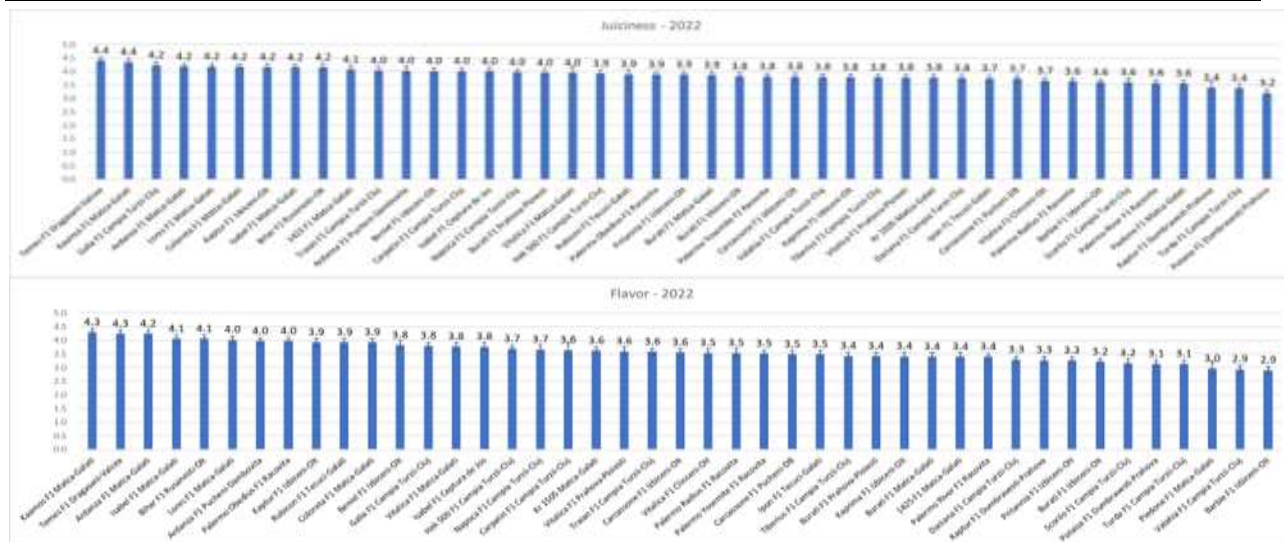


Fig. 6. Additional criteria 2022 (juiciness and flavor). Error bars represent the standard error of the mean
Source: Original data.

The sweet pepper has a crisp texture, and although it is considered a non-climacteric fruit, it loses its crispness and firmness if stored for a long time (O'Donoghue et al., 2020) [17].

The consumer's preferences were 'Patrol F1' with 4.5 points and 'Beniel F1', 'Eugenia F1', 'Kubat F1', and 'Pritannia F1' with 4.4 points, followed by seven hybrids with 4.3 points (Fig. 7).

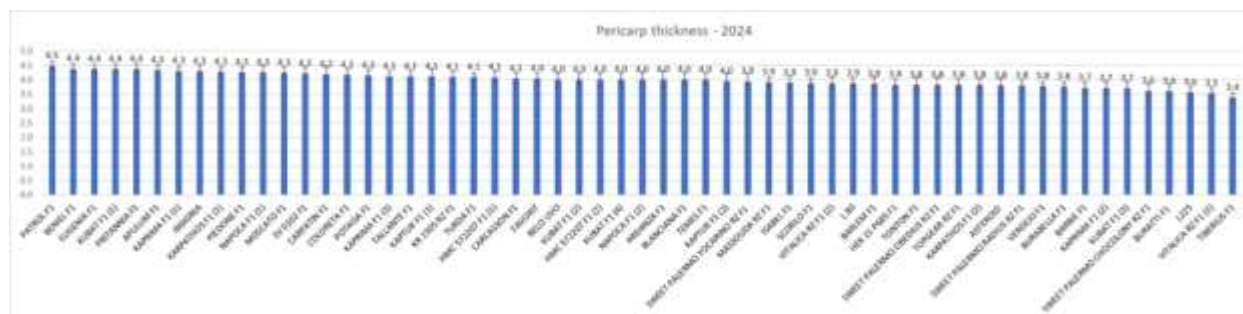


Fig. 7. Additional criteria 2024 (pericarp thickness). Error bars represent the standard error of the mean
Source: Original data.

The producers manifested interest in participating in the three consecutive years in the tasting event at the Faculty of Horticulture to discover the consumer's choices, fifteen varieties of sweet peppers being assessed every year.

Consumers' predilections changed from year to year (Fig. 8) for the common traits (size, shape, color, and taste). Most hybrids remain constant in the consumer's favorites with slight ups and downs. 'Ardanza F1', 'Barbie F1', 'Burati F1', 'Isabel F1', 'Piedone F1', 'Vitalica F1', and 'Tiberius F1' had a consistent

decrease of almost 1 point each in all three years.

'Carpatin F1', 'Kaptur F1', 'Pritannia F1', and 'Turda F1' had a slightly increased average with a range between 0.5 and 1 point.

Consistency is seen at 'Carcassonne F1', 'Coloreta F1', 'Kaprima F1', and 'Kr 1505 F1' with fluctuations under 0.5 points (Fig. 8).

Assessed only in 2022 and 2023 were four varieties: 'Daciana F1', 'Lores F1', 'Valahia F1' varieties which remain constant in people's choices, and 'Galia F1' with a decrease of 1.3 points (Fig. 9).

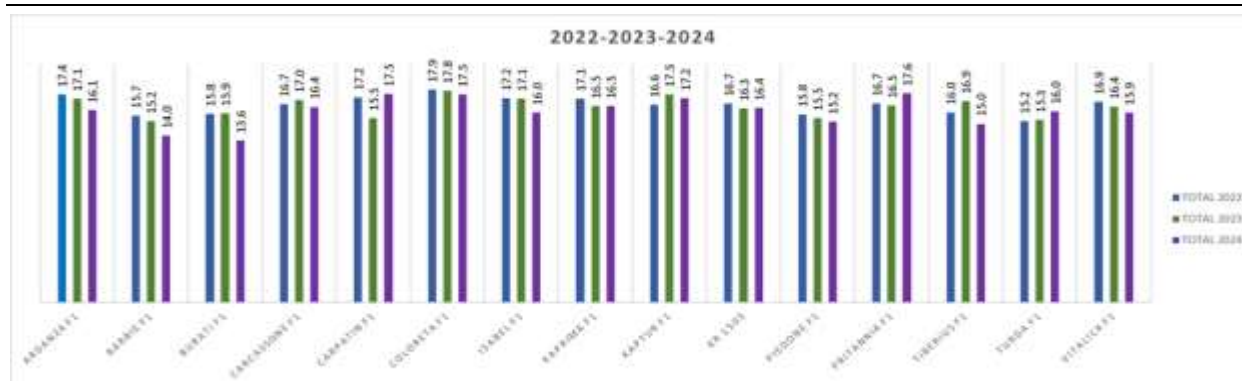


Fig. 8. Comparison of sweet pepper varieties assessed every year for size, shape, color, and taste
Source: Original data.

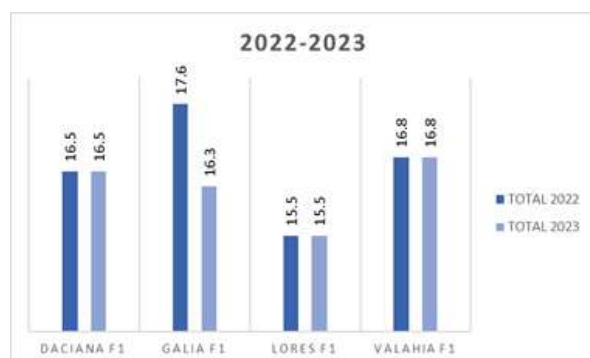


Fig. 9. Sweet pepper varieties common in 2022 and 2023
Source: Original data.

Six varieties were assessed only in 2023 and 2024, and all of them showed an increase between 1.7 and 3.5 points (Fig. 10).

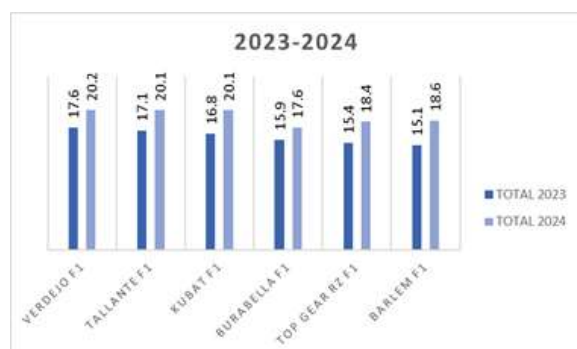


Fig. 10. Sweet pepper varieties common in 2023 and 2024
Source: Original data.

For 2024, the financial data indicates that the sweet pepper crop is a profitable one. With an average production of 80 t/ha, an average production cost of 99,000 lei, and an average selling price of 4.5 lei/kg, the average profit for 1 ha is 262,000 lei, showing a profit rate of 1.4% (original data from one producer who participated with 8 varieties at the sensorial analysis). A detailed financial analysis will be performed in a further article.

CONCLUSIONS

There were four indicators assessed in all tasting sessions: size, shape, color, and taste, with additional flavor and juiciness indicators in 2022 and pericarp thickness indicator in 2024. As expected, the hybrids with the highest total scores also had the best scores for every criterion tested.

The highest-ranked hybrid in 2022 is 'Temes F1', followed by 'Ardanza F1', 'Kamos F1', and 'Coloreta F1'. For 2023, the highest-ranked cultivar is 'SVPB 1112', followed by 'Coloreta F1' and 'Red Jet RZ F1'. In 2024, the top is occupied by 'Patrol F1', 'Insignia F1', 'Kubat F1', and 'Pritannia F1'.

Sensorial tests show the consumer's favorite varieties at one moment in time. Analyzing three consecutive years and having hybrids assessed on all three tasting sessions brings new information about how these varieties are perceived from year to year and is a significant tool for breeders who work to improve the quality of cultivars.

The consumers are expressing their preferences, but the growers have the final decision, which involves the financial data for every crop and variety. With an average profit rate of 1.4%, the sweet pepper crop could be a good investment, linking the consumer's preferences with a good financial rate.

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