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Consumer sensory evaluation of Bulgarian sweet pepper mutant genotypes

Dida Iserliyska [1*], Nasya Tomlekova[2]

[1*]Institute of Food Preservation and Quality-Plovdiv, 154 Vasil Aprilov Blvd., 4003 Plovdiv, Agricultural Academy-Sofia, Bulgaria

[*]E-mail: *dida_isser@yahoo.com*

[2]Maritsa Vegetable Crops Research Institute, 32 Brezovsko shosse St, 4003 Plovdiv, Agricultural Academy-Sofia, Bulgaria

Dida Iserliyska ORCID: https://orcid.org/0000-0001-9950-082X

Nasya Tomlekova ORCID: https://orcid.org/0000-0003-0965-170X

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Abstract: Sensory characteristics of fruits of pepper from two mutant genotypes were compared in order to evaluate their quality for market performance. Consumer sensory evaluation was engaged to identify the key sensory properties and to determine overall acceptability of pepper mutant genotypes with orange fruits "kapia" associated with high fruit β-carotene concentrations in comparison to the corresponding initial genotype (red fruits). Consumer acceptance test was run at the Sensory Analysis Laboratory of the Institute of Food Preservation and Quality (IFPQ), Plovdiv. Consumers (n=80) tasted two canned (marinated) samples of fruits of peppers (Albena and OKal38) assessing the overall liking, appearance, color, aroma, flavor, pepper flavor, sweetness and mouthfeel/texture of each genotype using a 9-point hedonic scale with descriptors: 1=dislike extremely, 5=neither like nor dislike, 9=like extremely. Analysis of variance (GLM) determined the significant differences between pepper samples and Fisher's Least Significant Difference (LSD) test was performed to differentiate between the samples means (α=0.05). Regression analysis established the relationship between sensory attributes and overall acceptance. The orange-fruited mutant cultivar, which is associated with high fruit β-carotene concentrations rated higher on sensory attributes "color", "flavor" and "sweetness". It was determined the sensory attribute of flavor the most critical factor for consumer acceptance for pepper mutant genotypes evaluated. Enhancement of nutrients that are not major yield components takes new importance in breeding programs as market demands. Thence, the breeders may opt to raise cultivars of orange-colored flavorful sweet peppers that are high in carotenoids.

Key words: sensory quality; advanced mutants; *Capsicum annuum* L.; β-carotene; consumer acceptance

INTRODUCTION

Public awareness concerning health benefits of dietary antioxidants has increased the demand for fruit and vegetable produce with recognized and improved antioxidant quality and has created new opportunities for the horticulture and food industry to improve fruit and vegetable quality by enhancing antioxidant content (Kalt, 2005). Processing can alter and often damage fruit and vegetable antioxidants. This is particularly true in the case of vitamin C and phenolic antioxidants. However, in the case of carotenoids, processing can lead to a dissociation of antioxidants from plant matrix components, an increase in carotenoid antioxidants, and improved digestive absorption (Bartz & Brecht, 2002).

Peppers are a major natural source of β-carotene. However, as with other nutritional components, β-carotene content appears to be cul-

tivar dependant (Wall et al., 2021; Ha et al., 2007). It's proven "Kapia" red pepper cultivars have a lower provitamin A content than that of orange cultivars (Tomlekova et al., 2021).

The appearance of pepper fruits is the primary means of evaluation when consumers make purchasing and consuming decisions, this quality of appearance is affected by factors such as shape, size, gloss, color, and lack of defects and decay (Resurreccion, 1998; Knee, 2002). According to a study undertaken in Australia (its results should easily transfer to the population of other countries, at least until such research is completed in those areas) consumers preferred red (41%) and green (34%) bell peppers to other color varieties, although they did indicate that these preferences were due to the lack of familiarity with the other color varieties (Imran et al., 2020). This indicates that it might be possible to increase the sales of other color cultivars by educating consumers about their flavors and uses. Consumers are often easily influenced by preconceived ideas about the qualities a particular fruit should have, marketers can often influence consumers through these preconceived ideas (Musacchi & Serra, 2018).

In the current study sensory characteristics of fruits of pepper from two mutant genotypes were compared in order to evaluate their quality for market performance. The objective of this research was to determine consumer acceptance of a selected pepper mutant line (orange fruits) to compare with the "Albena" initial cultivar (red fruits).

MATERIAL AND METHODS

Preliminary work. In the current study the orange-fruited trait of the mutant cultivar Oranzheva kapia (Daskalov et al., 1995), which is associated with high fruit β-carotene concentrations was introduced to the mutant red-fruited cultivar Albena (Daskalov, 1975). In result OKal38 mutant line was developed.

Samples. Ten plants of each genotype were grown in the fields of Maritsa Vegetable Crops Research Institute, Plovdiv, Bulgaria, following conventional practice for mid-early pepper production. The commercial maturity was assessed using nineteen green fruits from "Albena" towards nine green fruits from OKal38, both at commercial maturity, and for botanical maturity fifteen red fruits from "Albena" against ten orange fruits from OKal38 at botanical maturity, were analyzed. The uniform size and color characterized fruit of each maturity x genotype (Tomlekova et al., 2017). The formulation and processing steps for canned peppers were based on Bulgarian State Standard (BSS: Amd.1:1991) and preliminary preparation trials were performed at the Institute of Food Preservation and Quality (IFPQ).

Measurements of β-carotene (mg%), ascorbic acid (mg%), dry matter (by weight/refractometry, %) and total sugars (%). The β-carotene concentration was determined spectrophotometrically by acetone extraction (Manuelyan, 1991). The dry matter content, ascorbic acid concentration and total sugars of the fresh and canned samples were determined in accord with BSS EN 12145:2000, BSS 11812:1991 and BSS 7169:1989.

Consumer panel. Consumer acceptance test (Resurreccion, 1998) was carried out at the Sensory Analysis Laboratory of the IFPQ. Eighty participants were recruited, mostly students from the University of Food Technologies. Consumers were screened to be regular consumers of peppers either processed or unprocessed, like canned vegetable products and had no allergies towards canned peppers, between 18 and 24 years of age, must like and consume canned products at least once in two weeks and available and willing to participate in the tasting sessions.

Test procedure. On the test dates panelists came to the sensory laboratory as scheduled. The sessions were conducted for a total of four days within two consecutive weeks. At every session, panelists were welcomed by a greeter and given a brief overview on how to operate the signal light buttons in the sensory booths. Prior to the sensory evaluation, they were asked to provide information on their consumption of canned peppers. Evaluators tested the samples using environmentally-controlled partitioned booths illuminated

with two 50-watt indoor reflector flood lamps, which provided 738 lux of light. A whole fruit of pepper was placed in pre-coded with three-digit random number white plate and served on a tray along with Styrofoam cup with lid for expectoration, a cup for drinking water and unsalted crackers. Consumers tasted two canned genotypes of peppers (Albena and OKal38) in monadic order of presentation. They assessed the samples using a 9-point hedonic scale with descriptors: 1=dislike extremely, 2=dislike very much, 3=dislike moderately, 4=dislike slightly, 5=neither like nor dislike, 6=like slightly, 7=like moderately, 8=like very much, 9=like extremely (Peryam & Pilgrim, 1957). Every panelist rated on paper ballot the overall liking of the samples, appearance, color, aroma, flavor, pepper flavor, sweetness and mouthfeel/texture.

Statistical analysis. Statistical analysis was carried out using STATISTICA software (STATISTICA, StatSoft Inc. Version 12.5.192.7). Analysis of variance using the general linear model (GLM) was applied to determine the means, standard deviation and significant differences between pepper genotypes for each given attribute. Fisher's Least Significant Difference (LSD) test was performed to determine which sample means were significantly different (α=0.05). Regression analysis was used to determine the relationship between sensory attributes and overall acceptance.

RESULTS AND DISCUSSION

Biochemical assay. The ascorbic acid content was significantly higher (120 mg/100 g) in the fresh orange fruited peppers as well as the β-carotene concentration (7.03 mg/100 g). This is in accord with some Bulgarian authors (Tomlekova et al., 2021) findings that compare the levels of the carotenoid compounds (α-carotene, β-carotene, lutein, β-cryptoxanthin, zeaxanthin) between mutant variety Oranzheva kapia (high ß-carotene) and a corresponding initial pepper variety Pazardzhishka kapia 794. The fruit (either commercial or botanical maturity) from mutant variety had greater α-carotene and β-carotene concentrations to the initial variety (7.49 and 1.94 fold higher, respectively).

The dry matter content of the orange mutants was found insignificantly higher (9.17%) and the total sugars showed lower value (4.66%). The significant losses of ascorbic acid and total sugars were registered in the canned samples, while the β-carotene and dry matter content remained about the same.

When red peppers are processed, part of ascorbic acid and total sugars are lost. However, the canning industry is in demand of raw material (fresh pepper fruits) high in the latter compounds. From the sensory point of view the total sugars content is important, above all, for the organoleptic characteristics of the fruits, giving a particular density to the taste. The higher amount of sugars increases the sensory ratings of fresh peppers, roasted peppers and puree. The consumers in general prefer high dry matter varieties of sweet peppers.

Overall acceptance: The mean ratings for overall acceptance were equal and above 7.0 (like moderately, x=7.39,), indicating that both of the pepper genotypes were equally accepted by the consumers.

Appearance: The appearance of the orange and red fruited peppers was rated again above 7.0 (like moderately, x=7.55; x=7.05, respectively), indicating that both of the genotypes were accepted well by the consumers.

Color: The color of the orange fruited sample was rated above 8.0 (like very much, x=8.11) and significantly higher than the red fruited pepper that was above 7.0 (like moderately, x=7.39), meaning consumers preferred the orange fruited peppers over the red fruited ones.

Aroma: The ratings for aroma of the orange and red fruited peppers were above 6.0 (like slightly, x=6.83; x=6.50, respectively), meaning that both of the samples were equally accepted by the consumers.

Flavor: The flavor of the orange fruited sample was rated above 7.0 (like moderately, x=7.28) and the flavor of the red fruited sample was above 6.0 (like slightly, x=6.50), with no significance.

Pepper flavor: The pepper flavor of the orange and red fruited samples scored above 7.0 (like moderately, x=7.33; x=7.05, respectively), indicating that both of the pepper's genotypes were accepted well by the consumers.

Sweetness: The sweetness of the orange fruited sample was above 7.0 (like moderately, x=7.22) and the flavor of the red fruited sample was above 6.0 (like slightly, x=6.61) with no significance.

Mouthfeel/texture: The mean ratings for mouthfeel/texture scored above 7.0 (like moderately, x=7.12; x=7.00), indicating that both of the pepper genotypes were liked by the consumers.

The orange-fruited mutant cultivar, which is associated with high fruit β-carotene concentrations rated higher on sensory attribute "color", "flavor" and "sweetness" (Figure 1).

Significant differences of the hedonic ratings for all the sensory attributes are shown in Table 1.

The mean consumer ratings for all the sensory attributes were rated as highly acceptable for both red fruited cultivar Albena and the orange

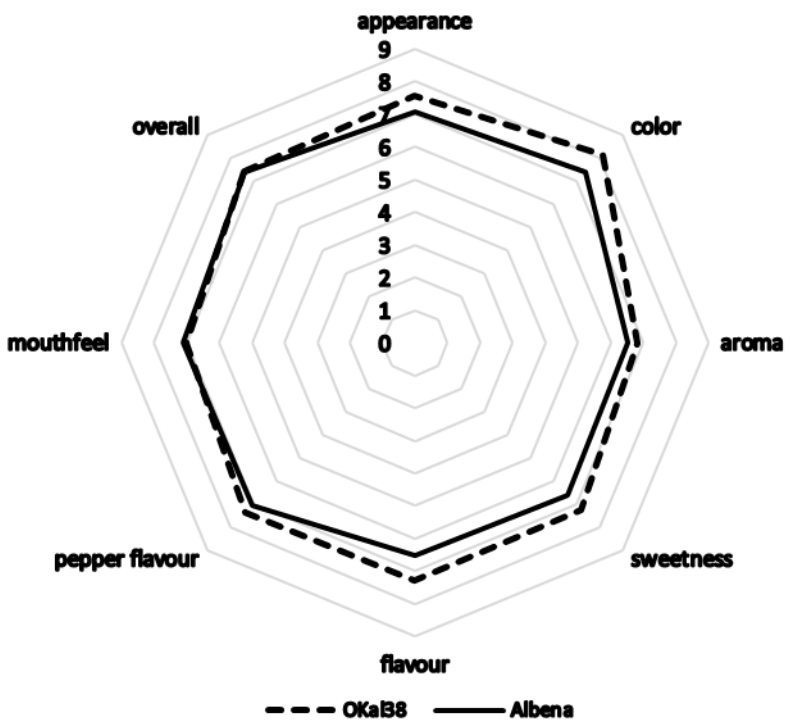

Figure 1. Mean hedonic ratings for overall acceptance and acceptance of appearance, colour, aroma, flavour, pepper flavour, sweetness, and mouthfeel/texture for the orange-fruited mutant cultivar (OKal38) associated with high fruit β-carotene concentrations and the mutant red-fruited initial cultivar Albena

Table 1. The differences between means of hedonic ratings of high in β-carotene concentrations canned pepper samples

Samples	Overall acceptance	Appearance	Color	Aroma	Flavour	Pepper flavour	Sweetness	Mouthfeel/ Texture
Orange-fruited mutant line (OKal 38)	a	a	a	a	a	a	a	a
Red-fruited initial cultivar "Albena"	a	a	b	a	ab	a	ab	a

[a, b] *Different letters in a column are significantly different (P<0.05)*

fruited mutant line OKal38 (x≥6.5). The sensory attribute colour was significantly different and the fruit of the orange pepper scored higher as "like it very much" (x=8.11, p=0.05).

Relationship between overall acceptance and sensory attributes. A relatively strong relationship between overall acceptance and sensory attributes was found (R^2=0.85). The coefficient of multiple regression between overall acceptance and sensory attributes (Table 2) showed flavour significantly affected overall acceptance.

Table 2. Regression coefficients between overall acceptance and sensory attributes

Parameter	Overall acceptance estimate
Intercept	1.85 ns
Appearance	0.01 ns
Colour	0.08 ns
Aroma	0.12ns
Flavour	0.74*
Pepper flavour	0.10 ns
Sweetness	-0.04 ns
Mouthfeel/Texture	- 0.17 ns

**=significant at 0.001, ns=nonsignificant.*

CONCLUSION

The orange-fruited mutant cultivar, which is associated with high fruit β-carotene concentrations rated higher on sensory attribute "color", "flavor" and "sweetness". It was determined the sensory attribute of flavor the most critical factor for consumer acceptance for the two pepper mutant genotypes. Hence, consumers could expect more flavorful peppers. Currently there is an increasing preference among consumers for foods that contain not only traditional nutrients but also provide other compounds that are beneficial to health and well-being. Such foods may be designated as "functional foods" or foods with functional nutrients. Therefore, enhancement of nutrients that are not major yield components takes new importance in breeding programs as market demands and research efforts focused on genes will result in manipulation of its quantity in crop. Thence, it may be advisable to breeders to raise varieties of orange-colored flavorful sweet peppers that are high in carotenoids.

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