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INFLUENCE OF PHOTOSELECTIVE PROTECTIVE NETS ON THE SENSORY CHARACTERISTICS OF FRUITS OF THE PINOVA APPLE CULTIVAR

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Abstract

Changing the light regime during the growing season by using photoselective nets in devices protecting against hail can have an impact on the yield and its quality. The white and black nets used do not change the spectral composition of the light passing through the grids, but act as shades, reducing the amount of light that passes through the grids. The influence of this effect on the sensory characteristics of Pinova apple fruits was investigated in an orchard with a support structure with an anti-hail net located in Northern Bulgaria. The sensory evaluation of the Pinova cultivar shows that the fruits under the most commonly used black net in orchards do not differ significantly in taste, aroma, and consistency from those grown under white, yellow, and red coverings. Only the influence of different types of nets on the appearance of the fruits of the Pinova apple cultivar has been statistically proven..

Key words*: Pinova, photoselective net, sensory analysis, appearance, color, taste and aroma.*

INTRODUCTION

The use of photoselective nets in modern fruit growing is increasingly being applied as a safe alternative to successfully address the challenges of various stressors threatening fruit production.

Net systems are usually used to protect orchards from hail. Today, they are also designed to screen spectral bands of solar radiation and transform some of the direct light into diffuse. This process controls the physiological changes occurring in the plants and can direct them in the direction desired by the producer related to fruit quality (Raveh et al., 2003).

Photoselective nets, through their ability to scatter light, can improve the efficiency of their use by fruit plants (Meena et al., 2016). According to Sivakumar et al. (2017) this would change metabolic processes and positively affect the retention and development of quality fruits.

The emerging new microclimate under the nets affects fruit color and flesh quality differently. This is the reason for the different relationship between plants and the environment in areas without nets and those covered with nets (Bosco et al., 2015; Brglez Sever et al., 2015; Dussi et al., 2005; Reay et al., 1998).

In studies on the influence of nets on fruit flesh quality, parameters such as firmness, ripeness, sugar content, and acidity were less affected than parameters determining the appearance of the fruit - size and color. The firmness of the fruit flesh under the differently colored nets is different. Differently colored photo selective nets provoke different reactions regarding the flesh of the fruit species. According to Giaccone et al. (2012) covering with white nets increased fruit sugar content, in contrast to red ones. Other authors did not indicate differences in the acidity of the fruits of trees covered with differently colored nets (Ordóñez et al., 2016).

Sunburn is one of the factors that can reduce the quality of fruits. It can cause a 10-50% reduction in apple fruit yield (Wünsche et al., 2001; Kalcsits et al., 2017). Some cultivars are very susceptible to these damages (Dussi et al., 2005). Black nets are more effective in shading and reducing burn rates compared to white nets (Amarante et al., 2011).

Safety nets in fruit growing are constantly being improved. Attention is paid to their characteristics affecting the quality of fruit production. Research on the impact of photo selective nets on the physicochemical and sensory quality characteristics of fruits in apple cultivars is insufficient. In our experiment, we set ourselves the task of studying them in the Pinova cultivar. Pinova apple cultivar was obtained in Germany by crossing Clivia and Golden Delicious performed at the Institute of Fruit Growing in the city of Pilnitz. The ripening period is in the last ten days of September (Lichev et al., 2012). The aim of the present work is to evaluate the influence of photoselective nets on the sensory characteristics of Pinova apple fruits based on the overall sensory evaluation and the average evaluations for the indicators of appearance, color, consistency, aroma, and taste.

MATERIALS AND METHODS

The physico-chemical and sensory quality characteristics of apple fruits of the Pinova cultivar, grafted on M9 T337 rootstock and grown in an apple orchard located in Northern Bulgaria, were studied. The planting density is 250 plants per decare. A sod-mulch system is applied to maintain the soil surface and trees are drip irrigated. The anti-hail net system has been built in white, yellow, red, and black colors.

The analyzes were carried out in the Food Testing Laboratory at the Institute of Food Preservation and Quality - Plovdiv using standardized methods and adapted methodologies.

Five fruits per variant were obtained on the day of harvest and stored for one day at 20 ± 5°C until the sensory evaluation.

When assessing the quality of Pinova apple fruits, a descriptive method was used with a specific description of the sensory indicators appearance, color, consistency, taste and aroma depending on the characteristics of the cultivar and according to Commission Regulation (EU) No. 1580/2007 of December 21, 2007 to determine the rules for the implementation of Council Regulation (EU) No. 2200/96, (EU) No. 2201/96 and (EU) No. 1182/2007 in the fruit and vegetable sector (Table 1). The advantage of this method is that it is carried out by experienced professionals.

The analyzes were carried out in a training room by a committee including five trained experts, who were provided with apple fruits, as coded samples of the four growing variants and the specific descriptions of the indicators with weighting factor respectively for appearance - 0.30; colour - 0.20; consistency - 0.20; taste - 0.20 and aroma - 0.10.

Table 1. Description of the studied sensory indicators of apple fruits, cultivar Pinova

Parameters	Description
Appearance - Fruit shape; - Size	Globose-conical, regular with a smooth surface; Handle and calyx fossa - wide and deep, without specific features. Medium to large, according to the size in Commission Regulation (EU) No. 1580/2007 of December 21, 2007, the fruits belong to group L Medium to large 150 to 300 grams - Section diameter: = extra - 60mm; = 1st quality - 55 mm. = 2nd quality - 50 mm - Weight: = extra 90 g = 1st quality - 80 g = 2nd quality - 70 g
Skin color	According to the coloring in Commission Regulation (EU) No. 1580/2007 of December 21, 2007, Pinova cultivar belongs to group "C" - cultivars colored in stripes, but weakly colored.
Strength of fruit skin	The general surface of the fruit with a pale red coloration/slight reddening or streaking coloration or yellow-green color with red-orange fuzzy color or striped cover color covering 90% of the fruit or yellow main color and bright red covering color covering 70% of the fruit in stripes for; = "Extra" - 1/3; = 1st quality - 1/10. Strong, thick, and shiny
Color of fruit flesh	Light yellow to a yellowish tinge
Consistency	Juicy, with rather rough cells
Taste	Thick, sweet-sour or pleasantly sweet - sour
Aroma	Fine aroma to aromatic, strongly aromatic

The evaluation was carried out terminologically, then quantified on a five-point hedonic rating scale, in which these indicators are present in the considered sample, by awarding points or by constructing graphs.

All fruits in the quality determination group were measured for weight, height, and width. Fruit weight was determined with a laboratory technical balance A200 S, expressed in grams (g). Fruit height and width were measured with a digital caliper, values were expressed in

millimeters (mm). The data were averaged for each variant.

The physicochemical indicators were determined: the soluble dry matter - BDS 17257:1991, the content of titratable acidity - BDS 6996:1993, and the content of total sugars - BDS 7169:1989 to determine the relatively objective state of the fruits and to facilitate the trained tasters to interpret the sensations for taste, sweetness, and acidity.

Mathematical and statistical processing

Results presented are arithmetic means of at least three parallel determinations, with coefficients of variation less than 5%. The statistical processing of the data was carried out with the STATISTICA and ANOVA programs, Microsoft Excel.

RESULTS AND DISCUSSIONS

The appearance and sensory qualities of the flesh of the fruit are important for the acceptance of a cultivar, as they influence consumer choice. Figure 1 shows the average evaluation of the experts for the appearance indicator. The committee of experts evaluated the appearance of apple fruits from all growing variants of Pinova cultivar with scores above 4.45 in the description of the attractiveness of appearance, taking into account the shape, uniformity, size, and background color of the coating. The description of the indicator characteristic of the cultivar is that the fruits are uniform, globular-conical in shape, medium-large in size with an average weight over 170.00 g, a diameter of the section over 70 mm, and a smooth surface.

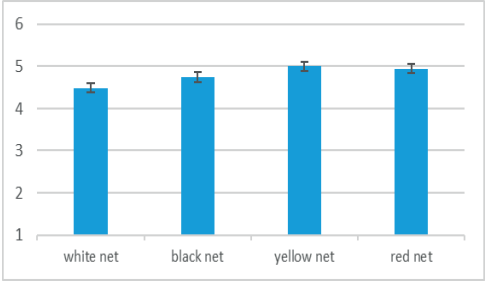

Figure 1. The appearance of fruits of cultivar Pinova grown under different photoselective nets

The experts defined descriptions of the skin color of the apple fruits on the differently colored networks and gave average ratings above 4.5 (Figure 2).

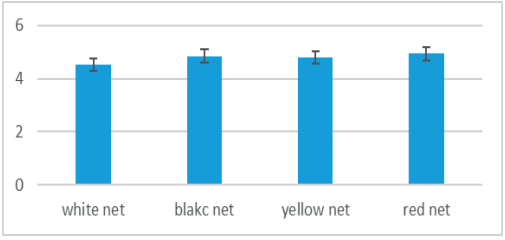

Figure 2. Color of fruits of cultivar Pinova grown under different photoselective nets

The maximum score for fruit skin color was given for fruit grown under the red net (4.95) (Figures 2). The fruits have a yellow-green main color with small brown lenticel dots and red-orange vertical stripes covering 90% of the fruit (Figure 3).

Figure 3. Apple fruits of Pinova cultivar, grown under the red net

Apple fruits grown under the black and yellow net did not have a statistically distinguishable mean skin colour score (4.85 and 4.80, respectively) (Figure 2).

The skin colour of fruit grown under the black net is mainly yellow-green with small brown lenticel dots, red vertical stripes fuzzy over 90% of the fruit surface, and pale cream dots (Figure 4).

Figure 4. Apple fruits of Pinova cultivar, grown under the black net

Fruits grown under the yellow net are primarily yellow with brown lenticel dots, with red vertical stripes diffused over 2/3 or 70% of the fruit surface and pale cream dots (Figure 5).

Figure 5. Apple fruits of Pinova cultivar, grown under the yellow net

Fruits grown under the white net are yellow main colour with brown lenticel dots, with red colored vertical stripes covering 1/3 to 2/3 better percentage of the fruit surface with pale cream dots (Figure 6). Experts rated the fruits of this variant with a relatively lower average rating of 4.54 (Figure 2).

Figure 6. Apple fruits of Pinova cultivar, grown under the white net

The flesh of the fruits of the white and red net variants is slightly yellow-cream colored, and of the other two net variants, yellow and black, the flesh is cream-colored.

Regarding the consistency indicator, the committee rated all fruit variants with high average scores above 4.7 (Figure 7) as statistically indistinguishable. All apple fruits are technologically ripe, the skin is strong, thick, and shiny. The experts defined the fruit flesh of all variants as firm with rough cells and juicy. In the case of apple fruits grown under the yellow net, the commission found juicier fruit flesh, which is separated from the fleshy part when compressed when chewing. There is no significant influence of differently colored photoselective networks on the quality indicator consistency.

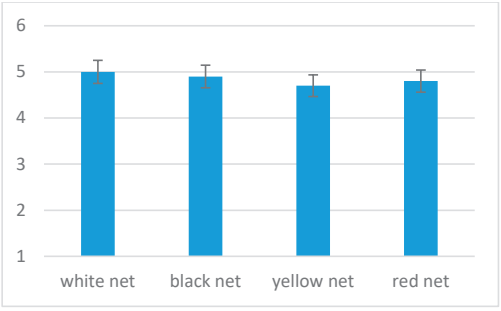

Figure 7. Consistency of fruits of cultivar Pinova grown under different photoselective nets

Regarding the determination of the quality of apple fruits, not unidirectional opinions can be found in the literature in terms of which indicators dominate. Important indicators of quality are color, size, and wax cover (Hansen, 2003), recent studies on taste indicators show that many consumers choose apple fruits based on taste, aroma, and other intrinsic quality attributes (Harker, 2002; Moxham, 2003).

Research was carried out to determine soluble dry matter and the results showed that all apple fruits have dry matter of about 15.0%, with the same values for the fruits grown under white and black net 15.6%, with the highest value being the fruits under the red net 15.7% and with the lowest 15.0% the fruits obtained under the yellow net.

The sugar coefficient varies from 83% for fruit under the black net to 88% for fruit under the white net. The values for this indicator are the same for fruits below the yellow and red nets - 85%. The sugar-acid ratio is the lowest for fruits under the black net -12.76% and the highest for fruits under the white net - 19.13%. The fruits under the yellow and black nets occupied intermediate position in this parameter with 17.70% and 14.65%, respectively.

These data on the indicators cited above helped the experts in the interpretation of the sensations.

The committee assessed the taste of all apple fruits as thick and juicy, with average scores above 4.5 (Figure 8).

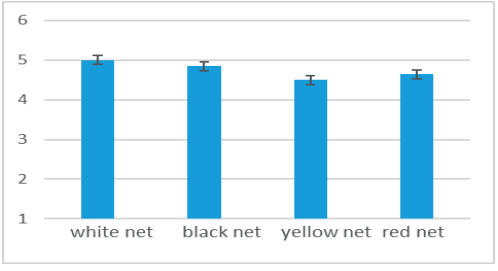

Figure 8. Taste of fruits of cultivar Pinova grown under different photoselective nets

A linear relationship with an average coefficient of determination R^2= 0.59 was found between the evaluations of the taste and consistency indicators. For the rest of the sensory indicators, such dependencies were not established.

The fruits grown under white and black nets have a medium sweet to sweet taste. A maximum score of 5 given by the experts was obtained for fruits under the white net, which confirms the conclusion of Giaccone et al. (2012). A positive correlation was established between the sensory-determined taste and the analyzed soluble dry matter and sugar coefficient of the fruits. Apple fruits grown under the yellow net have a sweet-sour taste, and under the red mesh, they have a sweet taste. The fruits grown under the yellow net -4.50 are rated lower. To form the sweetness and aroma of apple fruits, the plants need high temperatures and constant sunshine. Since apple fruits rarely develop their full aroma immediately after harvest, fruit aroma is defined as slightly aromatic to aromatic (Figure 9).

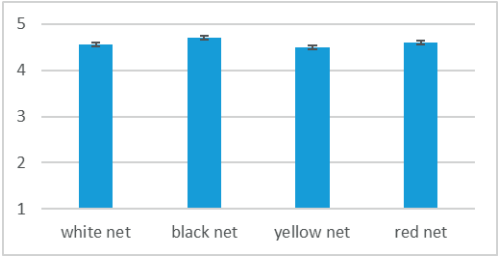

Figure 9. Aroma of fruits of cultivar Pinova grown under different photoselective nets.

The experts rated the fruits grown under the red and black nets as having aromatic intensity and the fruits under the yellow and white nets as having low aromatic intensity.

The general sensory evaluation containing all indicators of the apple fruits from the studied four variants is presented in Figure 10. All apple fruits have a total sensory score above 4.5. Fruits grown under the red and black net have a rating of 4.8, and those grown under the white and yellow net 4.7.

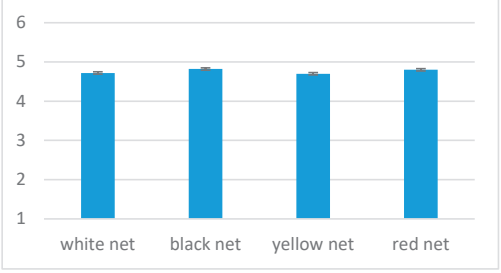

Figure 10. Summary sensory evaluation of fruits of cultivar Pinova grown under different photoselective nets

CONCLUSIONS

A study was conducted to evaluate the influence of photoselective nets on the sensory characteristics of apple fruits of Pinova cultivar based on the overall sensory evaluation and the average evaluations of the appearance, colour, consistency, aroma, and taste indicators.

The average ratings of apple fruits according to the studied indicators can be summarized as follows:

- apple fruits grown under a white net have maximum marks in terms of consistency, taste, the content of soluble dry substances, and sugar coefficient;
- the fruits grown under a yellow net have maximum marks in terms of appearance, weight, and size;
- the fruits under the red net have the highest scores for the colour indicator;
- the apple fruits under the black net have the highest score in terms of aroma and general sensory evaluation.

Summary sensory scores were statistically indistinguishable.

From the analysis of variance conducted at a significance level $\alpha = 0.05$ to establish the influence of the colour of the photoselective nets on the sensory indicators of the studied apple cultivar, it was found that the factor of the colour of the net affects the indicator of the appearance of the fruits.

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