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PREFERENCE MAPPING OF DIFFERENT VARIETIES OF GARLIC (*ALLIUM SATIVUM*)

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ABSTRACT

In this work we evaluated different varieties of garlic. All varieties of garlic are rated from one harvest year. Compared samples were different in shape, taste, aroma and characteristics, which were likely to impact on consumer choice and deciding on purchases garlic. Selected indicators were part of internal sensory evaluations, which were evaluated by experts in the sensory laboratory. External part of the preference mapping was conducted among consumers relying on different varieties of garlic under their consumption. Using the internal part of the preferential mapping we summarize randomly selected characteristics within the textural properties and characteristics of taste in which we consider the possible impact on consumer´s choice. In the sensory evaluation assessors used 9 point scale to evaluate 15 selected properties across the texture, taste and aroma on 10 selected varieties according to the degree of preference. Garlic odour and textural properties were evaluated by the normal procedure, though the taste because of intense lingering aftertaste of has been evaluated in a prepared mixture after cooking. For external evaluation, we designed a questionnaire in which consumers can express their preference for individual samples based on photo and variety characteristics, using a hedonic scale from 1 to 9. Obtained data from sensory evaluation and a questionnaire survey were evaluated using statistical software XLSTAT. Preferential map summarise results from internal and external evaluation. We identified characteristics affecting the degree of consumer preferences according to the visualization of our results.

Keywords: garlic; preference mapping; aroma; taste

INTRODUCTION

Preferential mapping is a way to statistically combine analytical sensory results, consumer information and product perception. Using analytical sensory data and consumer technology, it is possible to obtain a complete product image **(Risvik, McEwan and Rødbotten, 1997)**. Preferential mapping uses a set of statistical methods aimed at detecting consumer preferences of the compared products using sensory profiles. This method is used in the food industry to develop new products, especially according to consumer requirements **(Meullenet, Xiong and Findla, 2007)**. Preferential mapping was used in previous studies of fresh fruit, including raspberries **(Villamor et al., 2013)**, apples **(Jaeger et al., 1998)**, strawberries **(Lado et al., 2010)** and tomatoes **(Sinesio et al., 2010)** to confirm product attributes on the basis of which the consumer decides. These studies focused on taste intensity, texture and appearance/colour, which are important for consumer acceptance of the product **(Oltman, Yates and Drake, 2016)**. The perception of the sensory characteristics (appearance, colour, taste, smell, texture), which determine the so-called "organoleptic characteristics", is essential to create consumer perceptions about food quality. Based on the outputs of the sensory profiles, it is possible to subtract the information obtained from the analyses **(Vietoris et al., 2014)**. External factors (size, colour, appearance) of tomatoes have been shown to be important to consumers as well as taste **(Hetherington and MacDougall, 1992; Pagliarini, Monteleone and Ratti, 2001)**. The texture also plays a major role in consumer perception of quality and taste **(Causse et al., 2003; Aurand et al., 2012)**. Taste is the biggest indicator of quality for consumers **(Aurand et al., 2012)**, but texture and appearance are crucial for fresh fruits and vegetables purchased on the basis of external characteristics where taste or taste cannot be directly assessed. By texturing is mean all mechanical, geometrical and surface properties of the products, perceptible by mechanical, tactile or auditory and visual receptors **(Dimitreli and Thomareis, 2007)**. **Oltman, Jervis and Drake (2014)** have recently demonstrated with target groups and pooled research that appearance and strength were the main drivers of buying fresh tomatoes.

Garlic (*Allium sativum* L.) is one of the oldest cultural plants used both for food and for medical use. It is a rich source of several phyto-nutrients recognized as important elements of the Mediterranean diet but is also used in the treatment and prevention of many diseases. These effects are associated with thiosulfinates and volatile sulphur compounds, which are also responsible for the distinctive, pungent odour and taste of this vegetable **(Lanzotti, 2006)**. Various varieties of garlic are available on the market, which differ from each other in their properties, size, shape, colour and taste. By determining the odour and taste components more closely, differences were found between examined garlic varieties. Their chemical composition and variety also suggest various changes in the use or changing properties after adding to the product **(Calle, 2016)**.

Scientific hypothesis

The aim of the study was to determine consumer preferences to selected varieties of garlic. By selecting different varieties, we wanted to highlight the diversity of garlic offered on market and identify the properties that are decisive for the consumer.

MATERIAL AND METHODOLOGY

We evaluated ten samples (Figure 1) of winter garlic varieties obtained from one grower harvested in one harvest year stored one month under the same storage conditions and temperature regime. Groups of thirty assessors familiar with evaluation methodologies have compared the shape, size, colour, appearance to cut, hardness, odour intensity, spicy, sweet, sour and earthy odour, authentic taste, spicy, sweet, sour, and earthy taste. We used two types of scale, an intensity scale to assess the intensity of a certain property, and a hedonic scale to assess the degree of acceptability. The assessors wrote their perceptions on a pre-prepared paper form.

Apples were used as a neutralizer for odour determination. We have included the odour neutralizer in the review due to the intense sensory burden of the evaluators that we have been alerted to during the trial evaluation. Similarly, due to the extreme sensory load and the long-lasting aftertaste when using a raw garlic sample, we chose to evaluate the taste properties of the mixture. The prepared appetite blend comprised: 250 g of chicken, 15 extruded garlic, 2 g of salt, 1 g of pepper and 2 g of red pepper. The mixture was heat treated. Garlic was added to the mixture 2 minutes before the end of the heat treatment. The external part of the evaluation was done by using a questionnaire. The questionnaire included a description of the characteristics of the varieties with the attached photographs. The evaluators had the opportunity to express their preferences on a 9 point hedonic scale. 150 respondents were involved in the evaluation.

Statistic analysis

The data obtained from sensory evaluation and questionnaire survey, were evaluated using the XLSTAT statistic software (v. 2019.1.2, Addinsoft). Internal data sets from the sensory analysis were evaluated by principal component analysis (PCA). External data sets were evaluated by agglomerative hierarchical clustering (AHC). By combining these data set we have obtained preference map.

RESULTS AND DISCUSSION

From the PCA (Figure 2), we can observe that four groups of samples have been specified. Samples 1, 5, 9, 7, 3 and 8 show similarity in all of the odour, texture, and taste characteristics. Sample 10 obtained a higher rating compared to the other samples when evaluating the sour smell of odour intensity, colour, and sour taste. Samples 6 and 4 had similar ratings.

Figure 1 Samples of winter garlic varieties.

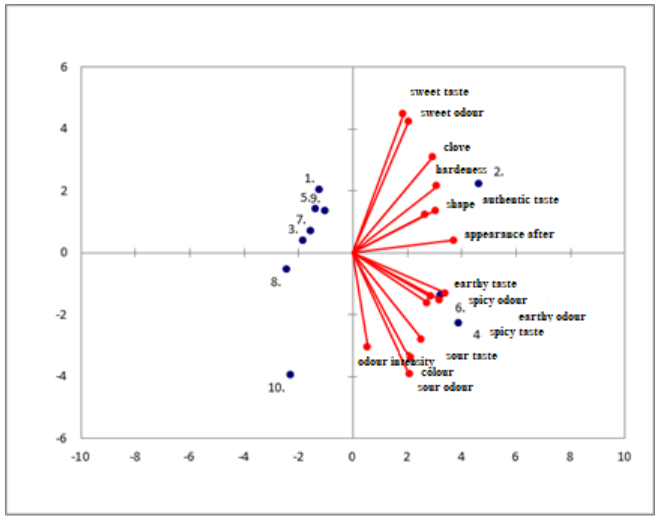

Figure 2 Evaluation using principal component analysis (PCA).

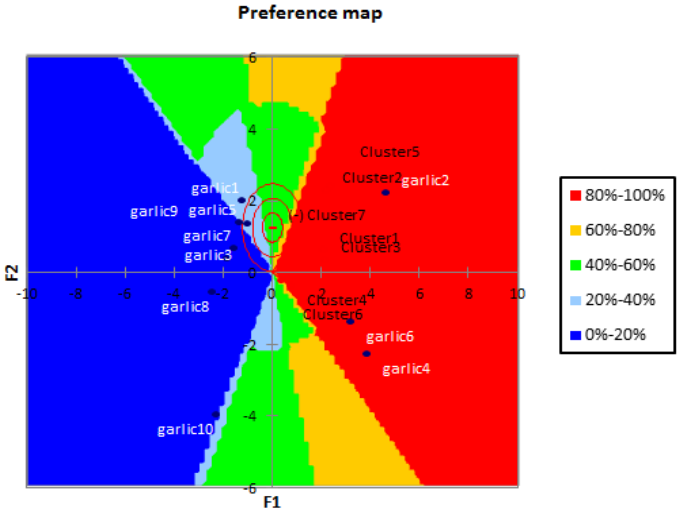

Figure 3 Preference map.

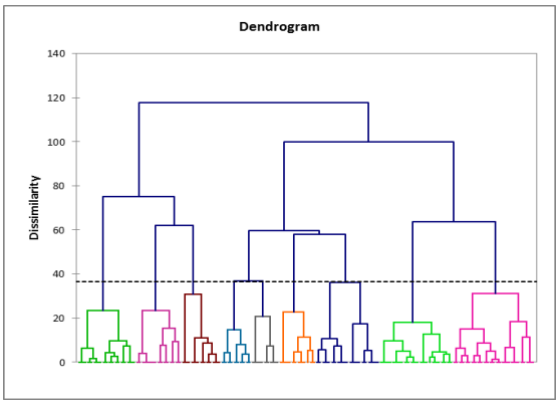

Figure 4 Agglomerative hierarchical clustering.

High values have been observed in the evaluation of the earthy taste, spicy odour, earthy odour and colour. In general, these samples, along with sample 2, had high ratings in all selected properties. Sample 2 recorded slightly lower ratings when assessing the odour intensity, spicy, sour odour and colour. **Drdolová, Golian and Vietoris (2015)** analysed the chemical composition of garlic by gas-chromatographic analysis (GC-MS) of an Agilent 6890N gas chromatograph coupled with Agilent 5973 inert mass spectrometry detector. Differences in the chemical representation of individual varieties of garlic have been noted in the intermodality. Significant differences in relative abundance have been reported for dialyl disulfide, methyl-allyl-thioacetate, and allyl-methyl-

disulfide, which are important compounds in terms of flavor formation and garlic odour. In assessing the rate of representation of these compounds, a varying proportion of the identified compounds has been demonstrated in the cross-industry comparison.

By processing the survey data for the 150 respondents (Figure 3), we reached the following results. In the highest consumer preference zone (80 – 100%), a sample of 2, 4 and 6 was placed on the basis of the specific characteristics of the products included in the survey. These samples, based on the analysis of PCA showed the following characteristics: shape, size, colour, appearance after cutting, hardness, odour intensity, spicy, sweet, sour, earthy odour, authentic taste, spicy, sweet, sour and earthy taste. The lower scoring was observed for sample 2 when evaluating colour and odour intensity. Sample 4 reported a lower rating for the sweet odour and sweet taste. Sample 6 did not report a low score in either of the endpoints, however, it received moderate evaluations in assessing hardness and spicy taste.

Samples placed in the lower consumer preference zone 5, 9 and 1 received average ratings in assessing the shape, size, appearance after cutting, hardness, sweet and earthy odour, sweet and earthy taste. Low ratings have received these samples in evaluating colour, odour intensity, spicy and sour odour, authentic taste, spicy and sour taste. Samples 3, 7, 8, and 10 were placed in the lowest consumer preference zone (0 – 20%). These samples were evaluated based on a PCA of average rating for colour, sour and earthy odour, authentic taste, spicy and sour taste. Samples 3, 7, 8, and 10 received a low rating in assessing the shape, size, appearance after cutting, hardness, sweet and earthy taste. In consumer studies on tomatoes, the consumer's emphasis on commodity appearance was more pronounced than the taste of subsequent tasting **(Sinesio et al., 2010)**.

In a similar study comparing the importance of external and internal properties of tomatoes on the market, the colour was the most significant attribute, followed by size and juiciness (evaluated after slicing), followed by strength after hand pressure, the taste itself was much less important **(Oltman et al., 2014)**. The current results from tomato evaluation confirm the importance of tomato taste and aroma, which is a key attribute for the variety modification progress. However, during the evaluation of appearance, colour, colour intensity, and size for evaluation, the assessors proceeded as in previous tomato market studies **(Oltman et al., 2014)**.

Eight clusters (Figure 4) were selected for data analysis. By a more detailed analysis of the clusters, it was found that the vast majority of the respondents, who were involved in the research, focused on garlic-based textural properties, especially shape, colour, size and hardness. The observations also show that the basic indicative characteristics of the evaluation are the sweet and spicy taste and smell as well as the degree of acidic and earthy taste and aroma in evaluating the taste and odour characteristics of garlic. **Oltman et al. (2016)** in his study distinguished consumer clusters according to the specific taste of tomatoes, which correlated with colour, taste/aroma and textural properties. Clusters consisting of assessors who consume tomatoes often submitted samples and their properties as more differentiated and concretized their evaluated properties.

Consumers focus on textural features when buying **(Causse et al., 2003)**. Another study identified a group of tomato consumers where the external strength assessed by touch was as important as the sliceability and compliance of tomatoes in the mouth. High strength was characterized in the best rated varieties in the tomato study, which was aimed at analyzing variable physico-chemical and sensory parameters and their role in the perception of tomato taste **(Piombino et al., 2012)**.

Kitchen garlic is a plant which is very often used in traditional and modern gastronomy. It is part of many foods and food products. Garlic with its distinctive taste and odour characteristics is a diversification of every meal. There are many varieties of garlic in the world that differ from those native to garlic, which are significant in addition to the taste and smell indications of their broad-spectrum positive health effects. Evaluators of garlic are very demanding, and it is necessary to select a sensitive methodology to achieve the desired result. Especially the intense smell and the long-lasting aftertaste of garlic, which prevents the ingestion of multiple samples in a row in the raw state, is a complication in sensory analysis. For this reason, we evaluated the scent neutralizer and the taste evaluation in the mixture after the heat treatment to evaluate the flavour intensity and its overwhelming after ingestion. By processing the data, we found that the evaluators in the internal evaluation section, as well as the respondents involved in the external part of the preference mapping, were key features for decision-making colour, hardness, size and appearance after cutting, and thus predominantly textural features of the evaluated plant commodity. In the highest consumer preference zone (80 – 100%), samples 2, 4 and 6 was placed on the basis of the specific characteristics of the products included in the survey. These samples, based on the analysis of the PCA of the evaluation of the characteristics examined, showed the following characteristics: shape, size, colour, appearance after cutting, hardness, odour intensity, spicy, sweet, sour and earthy odour, authentic taste, spicy, sweet, sour and earthy taste. The lower scoring was observed for sample 2 when evaluating colour and odour intensity. Sample 4 reported a lower rating for the sweet odour and sweet taste. Sample 6 did not report a low score in either of the endpoints, however, it received moderate evaluations in assessing hardness and spicy taste.

Samples placed in the lower consumer preference zone 5, 9 and 1 received average ratings in assessing the shape, size, appearance after cutting, hardness, sweet and earthy odour, sweet and earthy taste. Low ratings have received these samples in evaluating colour, odour intensity, spicy and sour odour, authentic taste, spicy and sour taste. Samples 3, 7, 8, and 10 were placed in the lowest consumer preference zone (0 – 20%). Based on the PCA, these samples received average ratings for colour, odour, sour and earthy odour, authentic taste, spicy and sour taste. Samples 3, 7, 8, and 10 received a low rating in assessing the shape, size, appearance after cutting, hardness, sweet odour, sweet and earthy taste.

CONCLUSION

Based on the results we would like to state that the samples with attractive appearance are partly overestimated by the assessors in all evaluated properties. The findings from the internal part of the evaluation were confirmed by the analysis of the clusters, which suggests that the vast majority of respondents in the research focus on garlic based on the perception of textural properties of garlic, especially shape, colour, size and hardness. The observations also show that the basic indicative characteristics of the evaluation are the sweet and spicy taste and odour as well as the degree of acidic and earthy taste and aroma in evaluating the taste and odour characteristics of garlic.

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