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A design aproach for improving the quality of olive oil mixtures

Planski pristup popravljanju kakvoće mjašavina maslinova ulja

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Abstract

In this paper the mixture experimental methodology based on Scheffe simplex-lattices was employed to carry out a study on olive oil mixtures obtained by different cultivars coming from Pula and the island of Krk. The purpose was to point out the advantages of this experimental approach permitting analysis of the evolution of a phenomenon by means of a limited number of trials. The studied response was the sensory quality, determined by the panel test carried out according to the criteria set up by the International Olive Oil Council (IOOC), of the olive oil mixtures prepared by following the scheme of Scheffe' mixture matrices.

Key word: olive oil, mixture quality

Sažetak

U radu je primjenjena mješavina eksperimantalnih metodologija zasnovanih na Scheffeovim simpleks tablicama za proučavanje mješavina maslinova ulja iz Pule i otoka Krka. Svrha je bila da se naglase prednosti ovakvih eksperimentalnih pristupa koji omogućuju analizu razvoja fenomena preko ograničenog broja proba. Istraživani odgovor bio je senzorna kakvoća, određena panel testom prema kriterijima International Olive Oil Council (IOOC), za mješavine pripravljene prema shemi Scheffeovih mješanih matrica.

Ključne riječi: maslinovo ulje, kakvoća mješavine

Introduction

In recent years sensory analysis has acquired a more important role in food industry. Nowadays, in fact, the attention is no longer focused only on the conformity to the physico-chemical parameters of the final product, but also on its

sensory attributes that make it more desirable to the consumers. Hence, as it was easy to foresee this new market trend has consequently contributed to the spread of sensory analysis in food production and quality control processes.

As far as olive oil is concerned, since February 1992 by Council Regulation of European Economic Community (EEC) the commercial classification of virgin olive oils provides for four classes (extra virgin, virgin, ordinary and lampante) according to both their acidity value and sensory characteristics 1 . Therefore, the total absence or presence of some defects, their possible intensity or gravity that can be perceived by a panel of experts, and the olive fruitiness flavour have become important parameters for defining olive oil quality. After being experimented for some years by the IOOC (International Olive Oil Council), the 'panel test' methodology has become the official method for the sensory analysis and classification of virgin olive oil within the Community (2).

In the present paper, sensory analysis has been employed to define the quality of olive oil samples produced in Pula and Krk areas, where olive oil productin has derived from different olive cultivars and by separate processes. As each olive oil presents different sensory characteristics, in order to obtain an optimal sensory quality a mixture of them was taken into consideration. As in the case of wine production (3, 4) in olive oil making mixtures are commonly made to achieve the sensory attributes most appreciated by the consumer. In order to obtain the best mixtures, the traditional procedures usually employ empirical methods according to which either small quantities of different oils can be added to the best olive oil or to a mixture determined on the basis of previous experiences, or different olive cultivars are blended before olive oil making process begins.

Whereas the last mentioned method is seldom applied, since afterwards the final product composition cannot be modified, the first two are widely used by most of the olive oil producers farms, though such trial-and-error procedures show some clear limits, particularly when they are compared to the Experimental Design approach applied in this research. By employing them, in fact, no information is available about both the best mixture and mixtures of similar quality. On the contrary, suh knowledge allows the producer to take in consideration different factors, such as the raw material availability, economic costs, or even the consumes preferences conditioning the local market.

Experiment

The olive cultivars considered for the mixture experiments presented in this paper are Buza, Bianchera, Leccino and Karbonaca (olive crop 1992/93) for the olive oil supplied by Agropoduct Farm of Pula (labelled with capitals A, B, C and D) and Drobnica-Naska, Oblica-Debela, Rosulja and Slatka-Plominka (olive crop 1993/94) for the olive oil supplied by Maslina of Punat (labelled with E, F, G and H).

Sensory analysis

The sensory assessment of the olive oil mixtures has been made by a panel of judges trained on the fundamental tastes (sweet, salt, sour and bitter) and on four defects of virgin olive oils, such as bitter, marc, wined and rancid. Each panellist had to evaluate the intensity of sensory characteristics giving a score on a 9-point scale according to the defects and good qualities detected in every sample. The final values correspond to the average of the scores given by each taster, a calculation made by the head panellist at the end of the tasting session.

For the sensory analysis olive oil is classified as extra virgin when it gets a score equal or superior to 6.5 (in this case, in fact, it is sensorially without defects), whereas it is classified as virgin if its score is equal or superior to 5.5 (1).

Mixture design for the sensory analysis

For the sensory evaluation of oil mixtures it was decided to develop a strategy consisting of planned points by applying an experimental design known as Scheffe Simplex Lattice (5, 6). In the case of the sensory analysis the experimental points correspond to each tasting sample, in other words to the blendings tasted by the panel during the assessment. Every mixture is obtained by blending different proportions of the starting olive oil cultivars (named pure components). Thus, it is possible to evaluate how each component influences the sensory quality of the blend and, moreover to point out the existence of synergism or antagonism that may occur among the pure components.

Results and Discussion

The olive oil produced in Pula

In table 1 are displayed the composition of 18 mixtures prepared by following the scheme of the Scheffe matrix, along with the panel scores. The proportions of each olive oil variety are here expressed as a percentage. Actually, the first four mixtures are named so improperly, since the samples represent the pure components, namely, Buza, Bianchera, Leccino and Karbonaca cultivars. Beside the "pure mixtures" there are the binary, ternary and quaternary blends, prepared, as their name suggests, with two, three and four pure components, respectively. The last four mixtures, marked by an asterisk are used as check points to test the mathematical model fitted to the experimental data (7). The co-ordinates of the experimental points (the tasting samples) are plotted in Figure 1. The tetrahedron represents the three-dimensional simplex corresponding to the factor space when four components are considered.

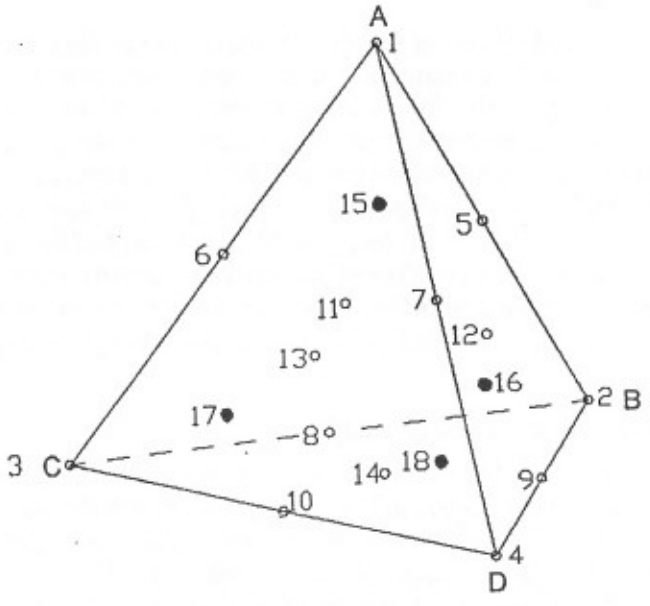

Figure 1 Distribution of the experimental (O) and check points (●)
Fraf. 1. Raspodjela eksperimentalnih (O) i stvarnih vrijednosti (●)

From table 1 it can be seen that among the cultivars here considered, Karbonaca is the only olive oil variety that according to the panel test can not be considered extra virgin oil, though in a former research it resulted flawless as far as the chemical analysis is concerned (8).

The best score, has been attributed to the olive oil obtained from Leccino cultivar, owing to the absence of any defects and its intense olive taste. Among the binary mixtures (5-10 in the table), the best and most interesting blending is mixture 5, obtained by Buza and Leccino cultivars, to which the highest score has been attributed, and that might suppose the existence of possible synergistic effects.

However, among all mixture samples tasted by the panel the most appreciated was the ternary mixture 11, obtained by blending Buza, Bianchera and Leccino, corresponding to a final product characterised by a sweet almond taste typical of some Tuscan olive oils. An interesting panel score was also been obtained by the four-component mixture 17, a good perfumed olive oil (initially sweet, then hot and with a bitter artichoke taste) that, though characterised by a good sensory quality, could probably be too refined for the consumer.

Table 1.: Simplex co-ordinates according to Scheffe matrix given by component proportions expressed as a percentage, along with panel scores (*indicates test mixtures).
Tablica 1. Simpleks koordinate prema Scheffeovoj matrici dobivene od proprocija komponenti u postocima duž bodova prema panel testu (*označava test mješavine)

Mixture mješavina	A	B	C	D	Panel Test
1	100	0	0	0	6.86
2	0	100	0	0	6.50
3	0	0	100	0	7.29
4	0	0	0	100	5.88
5	50	50	0	0	7.31
6	50	0	50	0	6.94
7	50	0	0	50	7.38
8	0	50	50	0	7.00
9	0	50	0	50	7.13
10	0	0	50	50	7.31
11	33	33	33	0	7.56
12	33	33	0	33	7.25
13	33	0	33	33	7.31
14	0	33	33	33	7.38
15*	62.5	12.5	12.5	12.5	7.36
16*	12.5	62.5	12.5	12.5	7.16
17*	12.5	12.5	62.5	12.5	7.50
18*	12.5	12.5	12.5	62.5	7.12

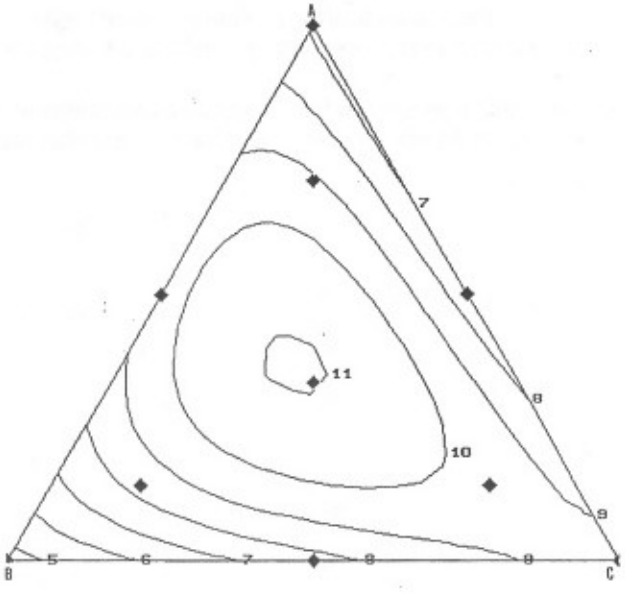

Fig. 2. Sensory isoresponse surface of a virgin olive oil blending according to the composition triangle A+B+C=1 and D=0. Response correspondence line 11: response 7.56, 10: 7.39, 9: 7.22, 8: 7.06, 7: 6.89, 6: 6.72, 5: 6.55.
Graf. 2. Površina senzorskih izoodgovora mješavina djevičanskih maslinovih ulja u odnosu kompozicijski trokut A+B+C=1 i D=0. Linija podudarnosti 11: odgovor 7.56, 10: 7.39, 9: 7.22, 8: 7.06, 7: 6.89, 6: 6.72, 5: 6.55.

Figure 2 displays the sensory response contours obtained when only A, B, C components are considered. Different ternary mixtures correspond to each of these contours, even if characterised by the same sensory quality level. As far as this ternary system is concerned, the maximum of the surface is observed in connection with its centre, implying that an equal part composition of these cultivar olive oils is to be considered optimal. However, appreciable mixtures can be also the ones comprised mostly marked by figure 10. This area includes various mixtures and, in particular, the blends, that are obtained with only small amount of Leccino, are close to the surface maximum. The broadness of this area allows choosing among various ternary mixtures, even, as aforementioned, according to the economic constraints and market demand.

In figure 3 the response contours referring to the ABD simplex shows the evolution of sensory quality of the ternary system, component C excepted.

All response contours here presented were carried out by means of NEMROD software (9).

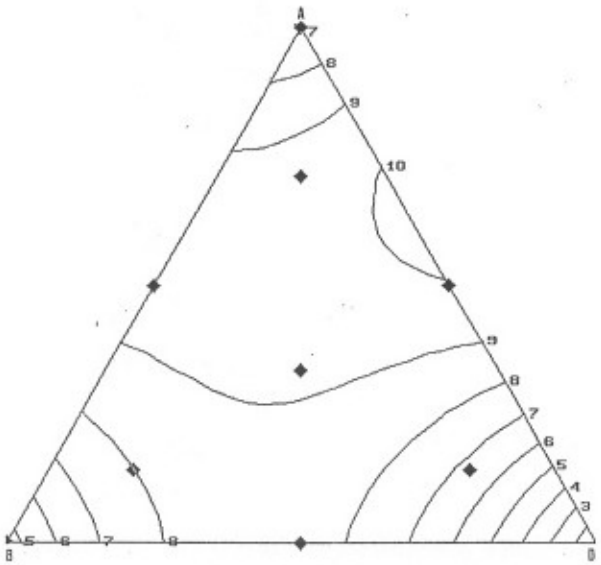

Fig. 3. Sensory isoresponse surface of a virgin olive oil blending according to the composition triangle A+B+C=0.9 and D=0.1. Response correspondence: see Fig. 2.
Graf. 3. Površina senzorskih izoodgovora mješavina djevičanskih maslinovih ulja u odnosu kompozicijski trokut A+B+C=0.9 i D=0. Odgovor podudarnosti: vidi Graf. 2.

The olive oil produced on the island of Krk

Unlike the olive oil produced in the area of Pula, for the mixture experiments with the Krk olive oil it was necessary to take into account some constraints on the available percentage of every cultivar. In the presence of constraints in the pure components the experimental region, representing every possible combination among them, is no more the whole tetrahedron displayed in figure 1, but a limited area inside the simplex, such as the one presented in figure 4, determined according to the limits given for each component. The experimental mixture design applied for the Krk olive oil is the one displayed in table 2. The first four oil samples correspond to the pure components (E, F, G and H), the others represent the six vertices of the overturned tetrahedron and its gravity centre, respectively (figure 5). The last two paragraphs report on the sensory scores obtained during two panel sessions carried out by different groups of experts. However, as the quality of all pure components was very high (the olive oils involved were all extra virgin), every blend resulted without defects. Undoubtedly, the experimental design approach appears more useful when in a multicomponent system the peculiar characteristics of each component are different, so that the quality enhancement of the final product may be obtained just blending them in virtue of the existence of synergisms.

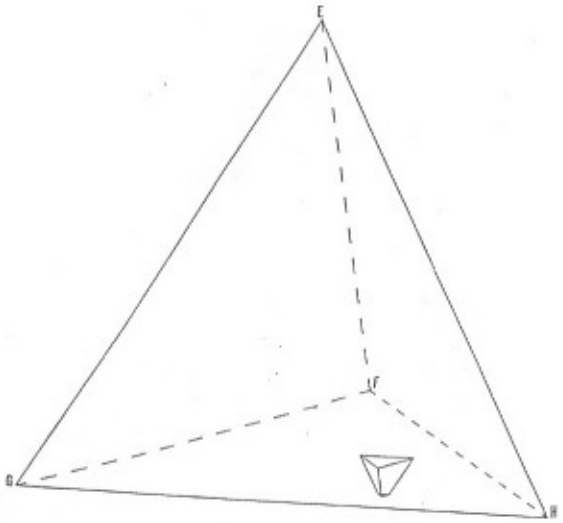

Figure 4: The overturned tetrahedron resulting from the predetermined constraints inside the four-component simplex (E, F, G and H).
Graf. 4. Obrnuti tetraeder razultira prethodno određenim ograničenjima unutar četverokomponentnog simpleksa (E,F,G i H)

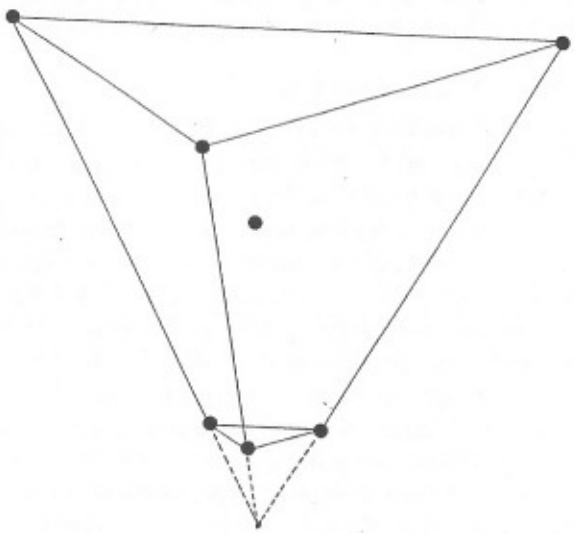

Figure 5: The vertices and the gravity center of the experimental region determined according to the constraints on the pure components.
Fraf 5. Okomice i gravitacijski centar eksperimentalnog područja utvrđeni prema ograničenjima čistih komponenti

Table 2: Simplex co-ordinates given by component proportions expressed as a percentage, along with the sensory scores obtained by two different panel test.
Tablica 2 Simpleks koordinate dobivene od proporcija komponenti izraženih u postocima duž bodova dva različita panel testa

Mixture	E	F	G	H	Panel Test*	Panel Test**
1	100	0	0	0	7.0	7.00
2	0	100	0	0	6.9	6.50
3	0	0	100	0	7.2	7.69
4	0	0	0	100	7.2	7.63
5	0	12	26	62	7.3	7.56
6	8	12	18	62	7.3	7.19
7	0	10	28	62	7.1	7.38
8	8	2	28	62	7.2	7.13
9	0	12	28	60	7.1	7.44
10	8	12	28	52	7.1	7.50
11	4.5	9.8	25.8	59.8	7.3	7.50

* Istituto Speimentale per la Elaiotecnica di Pescara
** Carapelli S.p.A., Firenze

However, as far as the olive oil production is concerned, this methodology can be certainly employed to run the tastings for the panel test when blends of different olive oils are involved. This method allows for analysing the influence of every single mixture component on the sensory quality, so that it becomes possible to single out the blends satisfying booth the consumer and producer. In fact, the panel test carried out according to the experimental mixture design may supply some helpful information that can be employed for a marked-oriented production, or even in view of a tipical regional product.

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