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VIRGIN OLIVE OIL ADULTERATION WITH OTHER EDIBLE OILS: INFLUENCE OF SUBSTITUTION ON PHYSICOCHEMICAL PROPERTIES

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Abstract:*Adulteration is a common practice in the field of virgin olive oil industry because of its greater demand at European and international level. The olive oil represents around of 4% of the edible oil at international level.The aim of this paper is to study the influence of olive oil adulteration by substitution with other types of edible oils (sunflower, corn and groundnut) in different percentages (10%, 20%, 30%, 40% and 50%, respectively). The physicochemical properties studied were: density, refraction index and saponification index. The suitable parameter for the adulteration identification is the density, at percentages of substitution greater than 5% it can be observed that the parameter values is getting out of the domain from the EU regulations. The refractive index is not a proper tool for the adulteration identification, because its values are in the normal range in all the substitutions levels. The saponification index can be used for the identification of virgin olive oil adulteration with sunflower and corn oils in substitutions greater than 30%.*

Keywords:*olive oil, adulteration, substitution, physicochemical properties*

1. Introduction

Extra virgin olive oil is obtained from the olive fruit named *Olea europaea*. The extra virgin oil (EVOO) is extracted by only mechanical procedure without application of refining process [1]. The EVOO is practically the only vegetable oil that can be consumed directly in its raw state as well as it contains important nutritional elements (fatty acids, vitamin, sterols, etc.) [2]. The quality of olive oil ranged from the high quality of EVOO to the low quality olive pomace oil [3]. It is one of the primary ingredients of the Mediterranean diet [4].

Adulteration of food products involves the replacement of high-cost ingredients with lower grade and cheaper substitutes [5]. Due to its sensory quality andnutritional benefits extra-virgin olive oil is often adulterated withless expensive oils. Adulteration of olive oil is a serious problemfor regulatory agencies, oil suppliers and could also threat healthof consumers. The substitution of adulteration of EVOO with cheaper ingredients is not only economic fraud, but may also on occasion have severe health implications for consumers [6]. Because of the high value of EVOO, it can be adulterated with other oils of lower commercial value. The most common adulterants found in EVOO are refined olive oil, seed oils and nut oils.Actually, blend edible oils can be prepared only forsuitable products, but if the resulting blend deviates from the mixture proportions given on the label, or if the blend is traded as genuine, it means the oil is adulterated [7,8].

The aim of this study is to investigate the influence of virgin olive oil substitution with other edible oils (sunflower, corn and groundnut oils) on the physicochemical parameters.

2. Materials and methods

Materials

Olive oil, sunflower oil, corn oil and groundnut oil were purchased from the local market of Suceava.

Methods

Density measurements

Density (ρ) of the oils samples was measured using pycnometer with an accuracy 10^{-4} gm/cm^3. The calibration of pycnometer was made with ultrapure water. Temperature was kept constant within ±0.1 °C using PID controller and circulating water using thermo static-fluid bath.

Refraction index

The refraction index of the analysed samples was measured using an Abbe refractomer Leica at 20 °C.

Saponification index

Saponification value is expressed by potassium hydroxide, in mg, required to saponify one gram of fat [9]. It depends on the kind of fatty acid contained in the fat. The sample is first saponified by adding 0.5 mol/L potassium hydroxide ethanol, and then the excessive potassium hydroxide is titrated with 0.5 mol/L hydrochloric acid until the end point is reached. The reactions which occur are:

$C_3H_5(OOCR)_3 + 3KOH \rightarrow 3RCOOK + C_3H_5(OH)_3$

3. Results and discussions

The influence of different percentage of olive oil substitution of its physicochemical properties has been studied. Firstly, the olive oil purchased from the local market of Suceava was studied to see if the density, refraction index and saponification index, respectively, are according to the range established by the EU regulations [10]. The density of virgin olive oil must range between 0.914 and 0.919 g/cm^3, the refraction index must range between 1.467 and 1.470 and the saponification index must range between 184 and 196. In the table 1 are presented the density, refraction index and saponification index of virgin olive oil purchased from the local market.

Table 1.
Physicochemical parameters of virgin olive oil

Parameter	Value
Density	0.915 g/cm^3
Refraction index	1.467
Saponification index	187.51

According to the values presented to the table 1, the virgin olive oil meets the threshold set by the EU regulations [10].

Substitution influence on the virgin olive oil density

In table 2 are presented the evolution of virgin olive oil density with different percentages substitution.

Table 2.
Oil samples density: A- virgin olive oil substituted with sunflower oil, B- virgin olive oil substituted with corn oil and C – virgin olive oil substituted with groundnut oil

Substitution percentage	A (g/cm^3)	B (g/cm^3)	C(g/cm^3)
0	0.9150	0.9150	0.9150
5%	0.9204	0.9250	0.9350
10%	0.9225	0.9252	0.9350
20%	0.9226	0.9261	0.9354
30%	0.9227	0.9271	0.9356
40%	0.9230	0.9280	0.9359
50%	0.9235	0.9282	0.9365

According to the EU regulations [10], the virgin olive oil density must range between

0.914 and 0.919 g/cm³. It can be observed that the substitution of the virgin olive oil with other types of edible oil with 5%, the density is increasing greater than the maximum allowable value for the density (0.919 g/cm^3). The highest density value was observed in the case of the sample C (virgin olive oil substituted with 50% groundnut oil). It can be observed a positively correlation between the substitution of virgin olive oil and density.

Substitution influence on the virgin olive oil refractive index

In figure 1 is presented the evolution of the virgin olive oil refractive index – pure and substituted.

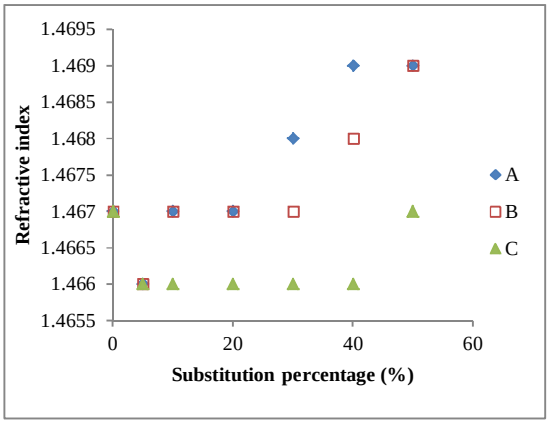

Fig. 1. Refractive index evolution: A- virgin olive oil substituted with sunflower oil, B- virgin olive oil substituted with corn oil and C – virgin olive oil substituted with groundnut oil

According to the EU regulations [10], the refractive index must range between 1.467 and 1.470. The EVOO substation with groundnut oil (in all the substitution percentages) decreases the value of the refractive index. The substitution of EVOO with 10%, 20%, 30%, 40% and 50% corn oil and sunflower oil maintain the refractive index at normal levels. The substitution of EVOO with sunflower oil had the highest influence on the refractive index.

Substitution influence on the virgin olive oil saponification index

In table 3 is presented the evolution of the saponification index of the virgin olive oil.

Table 3
Oil samples saponification index:
A- virgin olive oil substituted with sunflower oil,
B- virgin olive oil substituted with corn oil
C – virgin olive oil substituted with groundnut oil

Substitution percentage (%)	A	B	C
0	187.5	187.5	187.5
5	206.1	200.2	185.2
10	216.2	203.1	183.2
20	223.2	205.8	180.9
30	228.6	217.8	178.2
40	230.2	219.2	175.4
50	232.5	223.6	176.1

The values of saponification index for the virgin olive oil, according to the EU regulations [10], range between 184 and 196. The most visible adulteration is that with sunflower oil, which at a percentage of substitution of 50%, the saponification index is reaching the value of 240. In smaller percentages, the virgin olive oil adulterated with sunflower oil is maintained the saponification index value closer to the normal ones. For observing the adulteration of virgin olive oil with sunflower oil is needed at least a substitution percentage of 30%. In the case of EVOO adulteration with corn oil, the saponification index values are smaller than in the case of sunflower oil, but the adulteration can be observed if the substitution percentage is greater than 30%.
In the case of EVOO adulteration with groundnut oil, the saponification index cannot be used as an indicator, because the values of the adulterated samples are in the range of EVOO.

4. Conclusions

Food adulteration is a common practice for the olive oil industry due to its great demand at European and international level because of the great positively influence of it on the human body. The adulteration of virgin olive oil with different edible oils can be observed using the values for density, refractive index and saponification index. The substitution of virgin olive oil with sunflower can be observed using: the density determination for substitutions greater than 5%, the saponification index greater than 5%, while the refractive index determination cannot be used. In the case of the substitution of EVOO with corn oil, the density and saponification index can be used for the identification of the adulteration greater than 5%. The saponification index cannot be used for the identification of the substitution of EVOO with groundnut oil.

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