PHOTOMETRIC COLOR INDEX OF WALNUT OIL

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Abstract: This article presents a bibliographic and experimental study of the quality of vegetable oils, including walnuts oil, using fluorescents spectra. Pigments are the most important cause of food color. Each pigment has an absorption spectrum with peaks at characteristic wavelengths. Absorbance or absorbance ratios at those wavelengths can be used to estimate pigment concentrations. It is known that the tocopherols and carotenoids affect the oxidative stability of the oil, while the chlorophyll is in charge of photo–oxidation. The article includes some results on stability assessment of walnut cold pressed oil by calculating Photometric color index (PCI), Lovibond method approved by AOCS. This indicator allows us to compare quickly the influence of different processing methods and storage conditions of walnuts oils.

Keywords: walnut oil, Photometric Color Index, Lovibond method

Introduction

There is a growing interest in the study of the chemical composition of vegetable oils since knowledge of oil allows the assessment of the quality of the products on the market. It is known that tocopherols and carotenoids act on the oxidation stability of oils, while chlorophyll is responsible for the photooxidation [11].

Color is a sensory property with a strong influence on food acceptance as it contributes decisively to the initial perception that one can acquire of the condition, ripeness, degree of processing, and other characteristics of foods [2].

Sensory evaluation is a fundamental tool during product development or in quality control processes. During the evaluation, the organoleptic characteristics and the appearance attributes, color in particular, are judged and rated.

Oils and fats from different sources vary in color. But if refined, oil is darker than expected, it is probably an indicative of improper refinement or abuse [15]. Though the spectrophotometric method is specifically developed for testing the color of cottonseed, soybean, and peanut oils, it is probably applicable to other fats and oils.

There are a number of works that investigate the contents of vegetable oils using fluorescence spectroscopy [1, 11, 13, 16]. Color of fats and oils is commonly assessed using the Lovibond. Pigments are the most important cause of food color. Each pigment has an absorption spectrum with peaks at characteristic wavelengths. Absorbance or absorbance ratios at those wavelengths can be used to estimate pigment concentrations. Using absorption at 455nm (carotene) and 640 nm (chlorophyll), the effect of the concentration of these pigments in the color of olive oil has been reported [8].

Virgin olive oil is a natural product whose color depends exclusively on biological compounds such as the chlorophyll and carotenoid pigments, their identification and individual evaluation make it possible to relate oil color to the content and type of these present compounds. Oil appearance might be an indicator of a quality problem having occurred during blending, storage, crushing, and extraction or the refining process. The American Oil Chemists’ Society (AOCS) has proposed four official methods for the color determination of fats and oils. Related methods are Lovibond color, Wesson color, spectrophotometer color and chlorophyll color. Presently, CIE L*a*b*, XYZ, Hunter Lab, and RGB (Red, Green, Blue) are the alternative color models that might be used in objective oil color evaluation [9].

Color is an important quality parameter of edible oil, both in the refining process and marketplace. It is also frequently monitored in the product line according to some commercial standard in order to maintain a consistent quality. Primarily owing to naturally polyphenolic pigments, gossypol, chlorophyll, carotenoids, and so forth, each oil has its own characteristic color [19].

The color of fats and oils is most commonly evaluated using the Lovibond method. Though specifically developed for testing the color of cottonseed, soybean and peanut oils, the spectrophotometric method is probably applicable to other fats and oils as well.

Materials and methods

Materials

Walnuts (Juglans regia L.) from Cogalniceanu variety, harvested in Moldova. Oil extraction was carried out with mechanical press. After extraction oil was filtered, treated with antioxidants sych as ascorbic acid and betacarotebe. After the treatment, oil was stored at different temperatures and then used for experiments.

Medods – Photometric color index(PCI) [17].

There were used two methods for measuring the fats and oils: the Lovibond method and spectrophotometric method. According to the Lovibond method, oil is placed in a standard sized glass cell and it is compared visually with red, yellow, blue, and neutral color standards. Results are expressed in terms of the numbers associated with the color standards. Automated colorimeters are available.

For the spectrophotometric method, the sample is heated to 25–30ºC, placed in a cuvette, and absorbance is read at the following wavelengths: 460, 550, 620 and 670 nm. The photometric color index is calculated as shown in Equation [1] AOCS Method Cc 13c–50.

$$PCI = 1.29\,(A_{460}) + 69.7(A_{550}) + 41.2(A_{620}) - 56.4(A_{670}) \qquad (1)$$

where: PCI – photometric color index;

A – absorbance read at the following wavelengths: 460, 550, 620, and 670nm.

Absorbance of the samples was measured in UV/Vis spectrometer HACH–LANGE DR–5000 at 460, 550, 620 and 670nm using quartz cuvette 10x10mm.

Results and discussion

Walnut oil is versatile oil that is cold pressed from dried Persian walnuts. The lightly colored oil is well liked in salad dressings, on pastas and in many desserts. It can be used as cooking oil; however, high temperatures can alter the taste and the quality of the oil.

In the 1860s, Joseph Lovibond, the founder of The Tintometer Ltd, developed the original Lovibond Color system, which was based on a calibrated series of red, yellow and blue glass color standards. Today, companies throughout the world use Lovibond colorimeters in the analysis of products such as edible and industrial oils, fuel oils, chemicals, coatings and beverages. Over the years the Lovibond brand has become the hallmark for color measurement in processing industries, recognized by major international standardizing bodies, who quote our equipment in their specifications for color management (in particular ASTM standards and AOCS methods).

Lovibond color measuring instruments meet the requirements specified in the internationally recognized standard test methods for colorimetry, in particular table 1.

Table 1 Standard test methods for colorimetry [14]

AOCS Method	Scope	Color Scale/Test
AOCS Cc 13a	Animal fats and all fats and oils too dark to be graded by the Wesson method	FAC Color
AOCS Cc 13b (Wesson Method)	Normal oils and fats	AOCS–Tintometer Color
AOCS Cc 13e	Normal animal and vegetable oils and fats	Lovibond RYBN Color
AOCS Cc 13j	Color refined oils and tallows	AOCS–Tintometer Color, Lovibond RYBN Color
AOCS Td 1a	Natural and synthetic drying oils, fatty acids and oil derivatives	Gardner Color
AOCS Td 1b	Light colored industrial oils and derivatives such as certain fatty nitrogen compounds	Platinum Cobalt Color, Hazen Units, APHA Color

In a later study under the auspices of the Color Committee of the AOCS, more than 30,000 spectrophotometric Lovibond, and other visual assessments of the color of different oils (soy, cotton, and peanut) were made in 9 laboratories. After statistically analyzing the data in 4 of the laboratories, 4 equations were proposed. By recommendation of the Color Committee of Oils, one of these equations was unanimously accepted by the AOCS [1]. In this equation, which appears in the current spectrophotometric method for the determination of the color of soy, cotton and peanut oils [5, 6], the transmittance readings at 460, 550, 620 and 670 nm are taken into account, with their corresponding coefficients:

$$R = 1.29D_{460} + 69.7D_{550} + 41.2D_{620} - 56.4D_{670}, \qquad (2)$$

where: R – red Lovibond;
D – optical density.

The correlation found with the red Lovibond color was very high (r= 0.993).

The spectrophotometric measurement has been proposed to establish a method to control the decolorization of oils, considering especially the olive oils in which absorption maxima corresponding to the pigments appearance. The absorption spectrum changes considerably as a function of the relative percentages of pigments occurring in them [18].

A large part of fluorescence in vegetable oils is caused by the presence of chlorophyll groups, β–carotene and tocopherols. The parameters indicated of the samples are shown in Table 2 [12].

Table 2 Content of chlorophyll a, β–carotene and tocopherols in vegetable oils [12]

Type of oils	Chlorophyll a, (ppm)	β–Carotene, (ppm)	Tocopherols, (mg/%)
Sunflower	0.045	2.29	79
Sunflower	0.019	2.64	218
Olive	33.60	6.092	–
Walnut	1.701	33.69	350
Hazelnut	0.014	22.32	292

International Collection of Walnut Oil has a delicate nutty taste that enhances salads, marinades, dressings and dips without overpowering the dish. It is produced primarily in France, the Mediterranean and the USA by expeller pressing walnut kernels to produce delicious oil that is golden yellow in color. The color of fats and oils is most commonly evaluated using the Lovibond method.

Table 3 Standard color walnut oils

Type of oils	Color	Index	Standard
English Walnut Oil	Color (51/4 Lovibond Scale)	10Yellow/1,5Red Typical	LVO STANDARDA
Walnut Oil	Lovibond (Red)	1,5R Max	Kosher certification available
Walnut Oil	Lovibond tintometer 133,4mm	Y 30 max. R 4,0 max	
Natural walnut oil for cooking, Henan China (Mainland)	A clear bright yellow oil	–	SGS 8024–09–07
Walnut Oil, R. Moldova	Color, GOST 5477–93 (at the request of the benefit or in case of dispute)	Yellow, max30 $mgI_2/10cm^2$	GD Nr.434 27.05.2010 TR Edible vegetable oils

The objective of this paper is to establish a link between the optical properties of cold pressed walnut oil, processed and stored by different methods. Below there are the experimental data across the photometric method for evaluating color of walnut oil Juglas regia L. (Table 4, Figure 1, 2). Photometric color index (PCI) was evaluated and calculated by the method AOCS Method Cc approved by 13c–50.

Table 4 Changing the Optical density and Photometric color index walnut oil

Type of oils	**Storage time, days**	**Optical density(D)**				**PCI**
		λ 460	**λ 550**	**λ 620**	**λ 670**	
Walnut oil, stored at 20 °C	control	0.469	0.156	0.129	0.122	9.91
	3	0.429	0.097	0.077	0.074	6.31
	7	0.428	0.089	0.067	0.067	5.96
	10	0.472	0.137	0.116	0.113	8.56
	14	0.404	0.077	0.061	0.061	4.96
Walnut oil, stored at 40ºC	control	0.469	0.156	0.129	0.122	9.91
	3	0.329	0.051	0.039	0.041	3.27
	7	0.267	0.009	0.001	0.005	0.73
	10	0.326	0.067	0.057	0.060	4.05
	14	0.279	0.033	0.024	0.308	–13.72

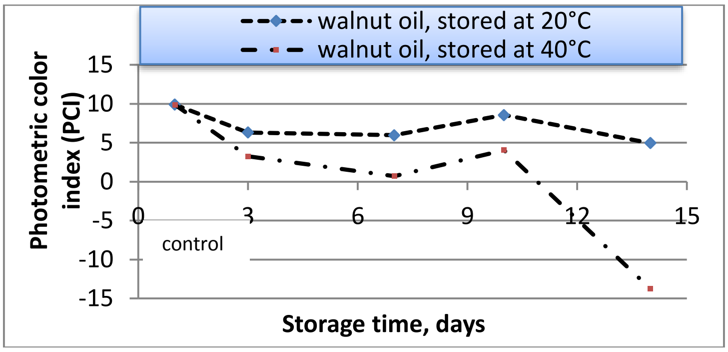
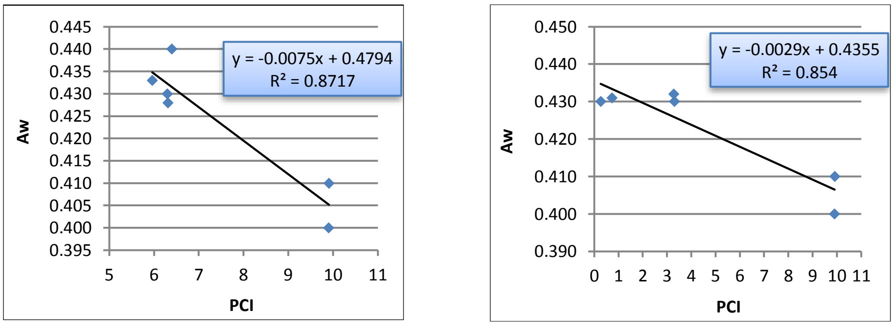


Fig. 1 The color change of walnut oil stored at different temperatures evaluated by the index PCI



a. b.

Fig 2.The correlation between the index PCI and Aw of walnuts oil:
a. – walnut oil, stored at 20°C; b. – walnut oil, stored at 40ºC

Conclusion

The conducted bibliographic and experimental study shows that the spectroscopy can be used to identify quickly edible oils. It was found that some types of oils differ significantly from each other in their spectra shows. Also, there are differences in color between the studied groups of vegetable oils.

Lovibond and Photometric method can quickly appreciate the quality of vegetable oils, including nut oil without using any reactive. Photometric color index (PCI) allows us to determine quickly if there were physico–chemical and biochemical changes that lead to a reduced quality of oils, especially those high in polyunsaturated fatty acids.

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