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preliminary communication

Effect of Storage Conditions on the Quality of Unrefined Sunflower Oil

Utjecaj uvjeta skladištenja na kakvoću nerafiniranog suncokretovog ulja

*Rada Stanić and Dubravka Štrucelj**

IPK Osijek, Poljoprivredno–znanstveni centar, Vinkovačka cesta 63, 54000 Osijek, Croatia
* Prehrambeno–biotehnološki fakultet Sveučilišta u Zagrebu, 41000 Zagreb, Croatia

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Summary

In order to determine the effect of storage conditions on the quality of sunflower oil, the samples of cold pressed oil with and without added tocopherol, as well as samples of refined oil, were stored at room temperature over a longer period of time. They were packed in glass bottles and cans and kept either in light or dark places. In addition to monitoring the major indicators of oil quality (free fatty acid content, peroxide, anisidine and oxidative value), and organoleptic analysis of the oil during the entire storage period, the total content of tocopherol and oil colour were determined at the end of the storage and compared with the initial values. It was established that the light, in the course of storage at room temperature, had the highest impact on the quality change of unrefined sunflower oil.

Sažetak

Za određivanje utjecaja uvjeta skladištenja na kakvoću suncokretovog ulja, uzorci industrijski priređenog hladno prešanog ulja s dodatkom i bez dodatka tokoferola, kao i rafinirano ulje, skladišteni su pri sobnoj temperaturi dulje vrijeme u staklenim bocama na svjetlu, u tami, te u limenki. Osim praćenja osnovnih pokazatelja kakvoće ulja (udio slobodnih masnih kiselina, peroksidni broj, anisidinski broj i oksidacijska vrijednost) i organoleptičkog ocjenjivanja ulja tijekom cijelog razdoblja skladištenja, na kraju su određeni tokoferoli i boja ulja, što je uspoređeno s početnim vrijednostima. Utvrđeno je da u uvjetima skladištenja pri sobnoj temperaturi svjetlo najviše utječe na promjenu kakvoće nerafiniranog suncokretovog ulja.

Introduction

Cold pressed sunflower oil is produced from healthy, air-dried sunflower seeds by the procedure of cold pressing without heat treatment and additional refining *(1)*. The oil discussed in this article was specifically scored due to high content of α-tocopherol and essential fatty acids, particularly of linoleic acid *(2)*. Some authors have studied the effect of production and storage conditions on the quality of cold pressed sunflower oil, stating that the oil quality could be only slightly changed in comparison with the oil in seeds. As for oxidative rancidity it should be only very slight or, if possible, even absent, so that peroxide value should not exceede 3.5 mmol O_2/kg and linolenic acid content should not be higher than 0.4 % *(1,3)*. Tocopherols in unrefined sunflower oil are partially destroyed by technological treatments whereas further decomposition during storage is possible by influence of light, oxygen and temperature. As for light, it always has higher effect at room temperature than oxygen from air *(4)*. In comparison with refined oil, tocopherol decomposition is slower than in cold pressed oil. Oil colour also changed depending on whether the oil was stored in light or dark places. In the course of warming up or oxidation, the carotenoids lose their chromogenic properties, so that oils during the thermic treatment get lighter in colour *(5)*. A more effective method of saving the oil quality, and at the same time avoiding loss of carotenoids and tocopherols, is storing the oil in glass bottles of dark colour *(6)*.

The results presented in this study constitute only a part of a more extensive research *(7)*.

Experimental

In order to determine the effect of storage conditions on the quality of unrefined sunflower seed oil, the tests

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presented here, were conducted on the sunflower seeds grown by the Industrial Agro Combined Enterprise in Osijek, Slavonia province, Croatia. The sunflower seed containing 43.5 % oil and 5.5 % water *(8)* was used for industrial processing of cold pressed oil (at temperature up to 40 °C and a pressure of 10 MPa) (Fig. 1).

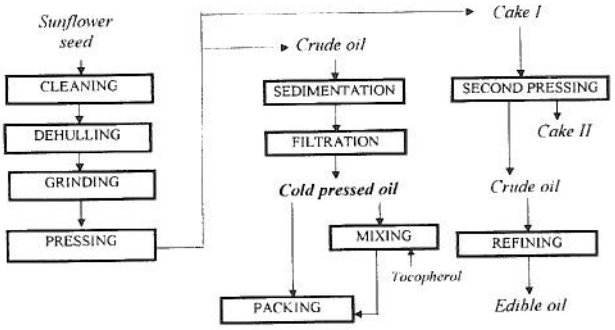

Fig. 1. Scheme of sunflower seeds processing in oil plant for the production of cold pressed sunflower oil
Slika 1. Blokovska shema prerade suncokretovog sjemena u pogonu za proizvodnju hladno prešanog suncokretovog ulja

The cake obtained after the first pressing, containing still about 40 % of oil, was treated by heat at temperatures of 115–125 °C with the addition of water, and pressed again during regular industrial treatment. The crude oil obtained by this warm pressing was refined. One part of cold pressed oil, after sedimentation and filtration, was enriched by adding tocopherol, whereas the other was packed without added tocopherol. The samples of industrially prepared sunflower oil (refined and cold pressed, with added tocopherol and free of it), were stored at room temperature during a longer period of time. The samples were packed either in colorless glass bottles, stored in light or dark places, or in cans. The symbols of all the tested samples are indicated in Table 1.

In addition to monitoring the major indicators of oil quality: free fatty acids content (FFA), peroxide (PV), anisidine (AV) and oxidative value (OV), and organoleptic analysis of the oil during the entire storage period, the total content of tocopherol and oil colour were determined after storage and compared with the initial values. FFA were determined by titration with sodium hydroxide, c(NaOH) = 0.1 mol/L *(9)* and PV by the standard method according to Wheeler *(10)*. On the basis of the data for PV the curves of oxidation were plotted (Math Cad Computor Programme), which are the polynoms of the third order, having the following form:

$$PV = a + bt + ct^2 + dt^3 \qquad /1/$$

where PV is the peroxide value expressed in mmol O_2/kg; t is time expressed in hours; a,b,c,d are coefficients calculated by the least-squares method.

The curve served for determination of stability as the time necessary to achieve the accepted PV, which is for cold pressed oils 3.5 mmol O_2/kg *(1)* and for the refined ones 5 mmol O_2/kg *(11)*. AV was determined based on the reaction of p-anisidine with aldehyde compounds in acetic acid solution and absorbance measurement at 350 nm *(12)*. OV was calculated from double value of PV added to AV *(2)*. Total tocopherols were determined by the method according to Emmerie-Engel *(13)* whereas oil total colour was determined spectrophotometrically, expressed as a colour index *(14)*. Organoleptic evaluation of the tested oil was done by the scoring method (maximum of 20 scores) until it was established that the evaluated samples did not conform (less than 11.2 scores) to the organoleptic evaluation *(15)*. The list for cold pressed oils was made following the model as described above. Values of some properties responsible for flavour, clearness and odour were adjusted to cold pressed oil, which is an usual practice for any other unrefined oil such as, for example, olive oil *(16)*.

Results and Discussion

The applied tests and analyses have shown that the storage period for both cold pressed and refined sunflower oil affected only insignificantly the changes of FFA content (Fig. 2) if compared with the initial values, as well as that the changes occurred for other tested components. The results of PV determination (Fig. 3) during the course of storage at room temperature showed that the fastest deterioration occurred with the R_l samples.

The samples CP and CPT showed that the oxidation process was more expressed with the samples stored in light places (CPT_l and CP_l) in relation to the samples

Table 1. Symbols of the studied samples of sunflower oil
Tablica 1. Oznake ispitivanih uzoraka suncokretovog ulja

Sunflower oil		
Manufacturing procedure	Storage conditions	Symbol
Cold pressing, without added tocopherol (CP)	glass bottles, light	CP_l
	glass bottles, dark	CP_d
Cold pressing, with added tocopherol (CPT)	glass bottles, light	CPT_l
	glass bottles, dark	CPT_d
	cans (500 mL)	CPT_c
Refining	glass bottles, light	R_l

Table 2. Content of total tocopherols before and after storage of unrefined and refined sunflower oil at room temperature (samples description indicated in Table 1)
Tablica 2. Maseni udio ukupnih tokoferola nerafiniranog i rafiniranog suncokretovog ulja prije i nakon skladištenja pri sobnoj temperaturi (opis uzoraka vidi u tablici 1)

Oil*	w (total tocopherols)/(mg/kg)	
	Before storage	After storage
CP_l	760	565
CP_d	760	759
CPT_l	1528	1274
CPT_d	1528	1363
CPT_c	1528	1276
R_l	592	**

* Samples description indicated in Table 1
** Not determined

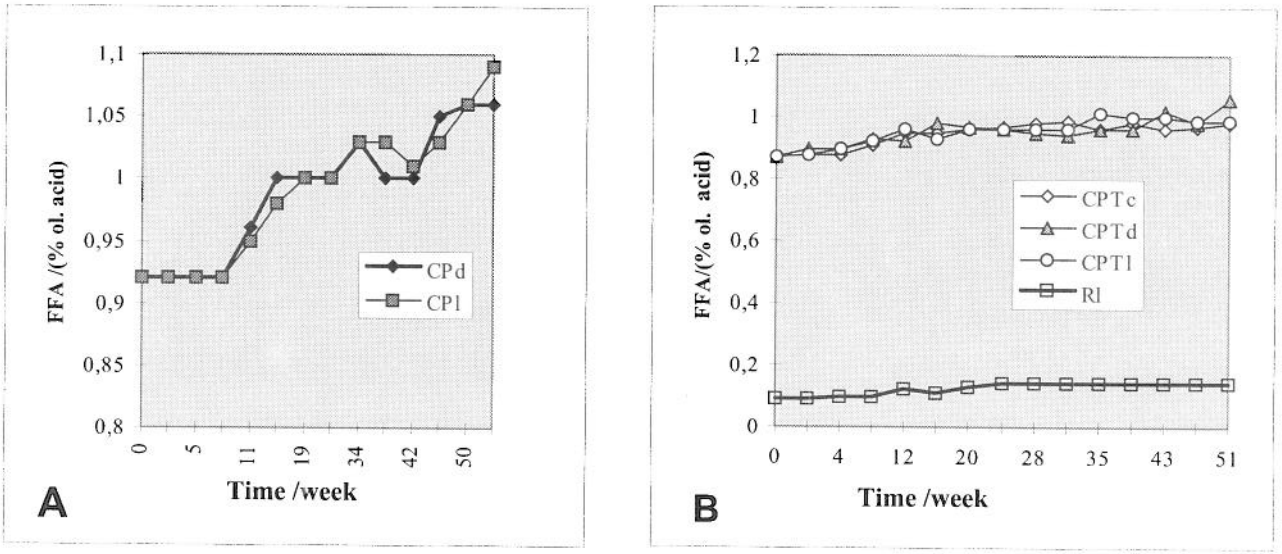

Fig. 2. Free fatty acid (FFA) content of refined and cold pressed sunflower oil without (A) and with (B) the added tocopherol stored at room temperature (samples description indicated in Table 1)
Slika 2. Udio slobodnih masnih kiselina rafiniranog i hladno prešanog suncokretovog ulja bez (A) i s (B) dodatkom tokoferola tijekom skladištenja pri sobnoj temperaturi (opis uzoraka vidi u tablici 1)

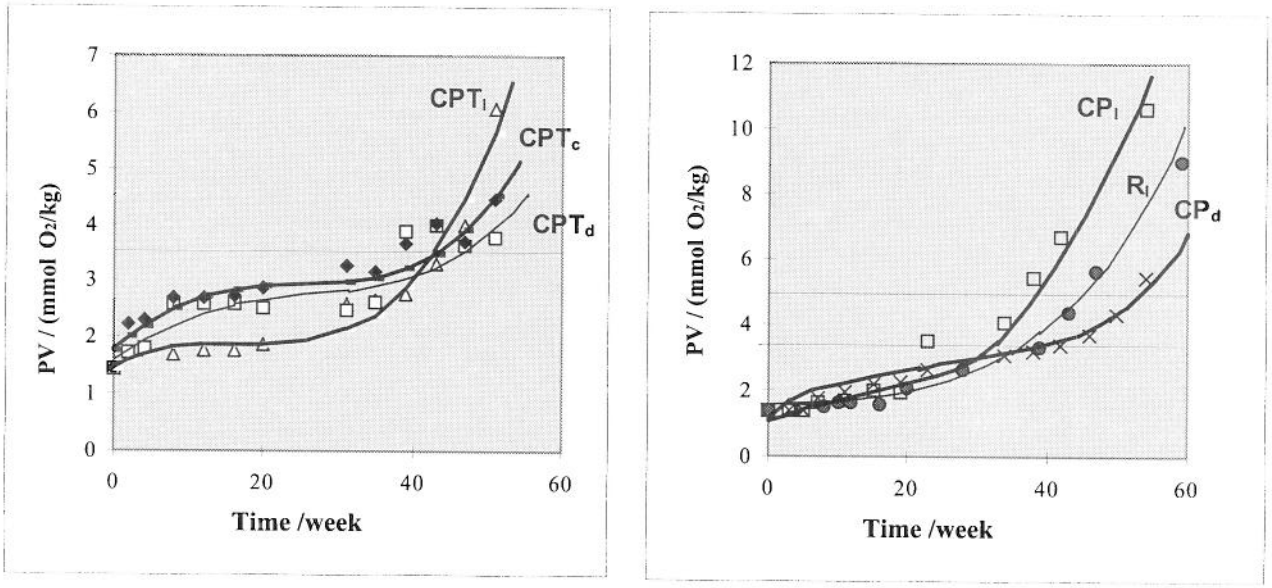

Fig. 3. Peroxide value (PV) of the cold pressed and refined sunflower oil stored at room temperature (samples description indicated in Table 1)
Slika 3. Peroksidni broj (PV) hladno prešanog i rafiniranog suncokretovog ulja tijekom skladištenja pri sobnoj temperaturi (opis uzoraka vidi u tablici 1)

stored in dark places (CP_d, CPT_d). The oil in cans (CPT_c) was more subjected to deterioration than the same oil packed in colorless glass bottles stored in dark places (CPT_d). The sample CPT_d reached the accepted PV limit of 3.5 mmol O_2/kg after the storage period of 46 weeks, unlike the CP_l sample that achieved the same limit in only 32 weeks of storage. The accepted PV limit of 5 mmol O_2/kg, established for refined oils, was achieved in this test after 47 weeks of storage.

The oxidative value (Fig. 4) showed that its rate was affected to a considerable extent by refining, so that the refined oil achieved the highest OV rate. In the tested cold pressed oils the OV rate was slightly lower in CPT_d samples in relation to the CPT_c samples. Total tocopherols (Table 2) in unrefined oils have been partially destroyed during refining. Further tocopherol decompositions (down to 27 %), natural and added tocopherol alike, occurred at storage, particularly in light places. The sample CP_d had

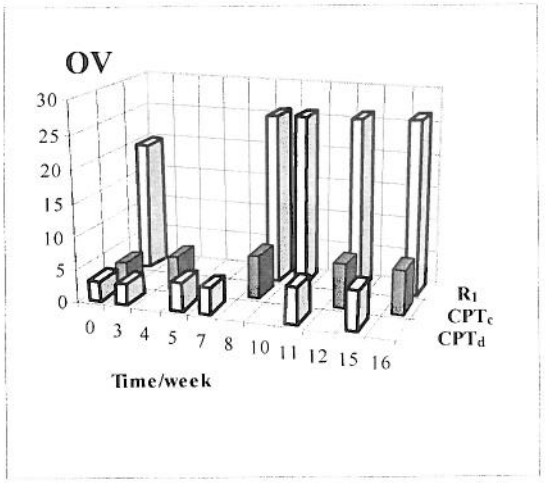

Fig. 4. Oxidative value (OV) of cold pressed and refined sunflower oil stored at room temperature (samples description indicated in Table 1)
Slika 4. Oksidacijska vrijednost (OV) hladno prešanog i rafiniranog suncokretovog ulja tijekom skladištenja pri sobnoj temperaturi (opis uzoraka vidi u tablici 1)

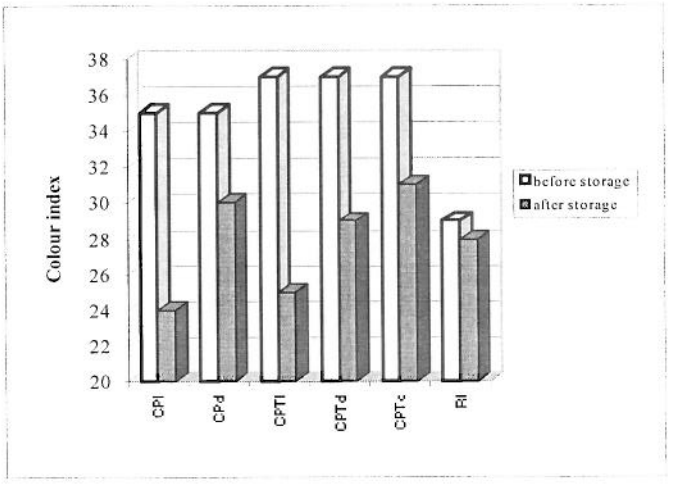

Fig. 5. Colour index of the cold pressed and refined sunflower oil before and after storage at room temperature (samples description indicated in Table 1)
Slika 5. Indeks boje hladno prešanog i rafiniranog suncokretovog ulja prije i nakon skladištenja pri sobnoj temperaturi (opis uzoraka vidi u tablici 1)

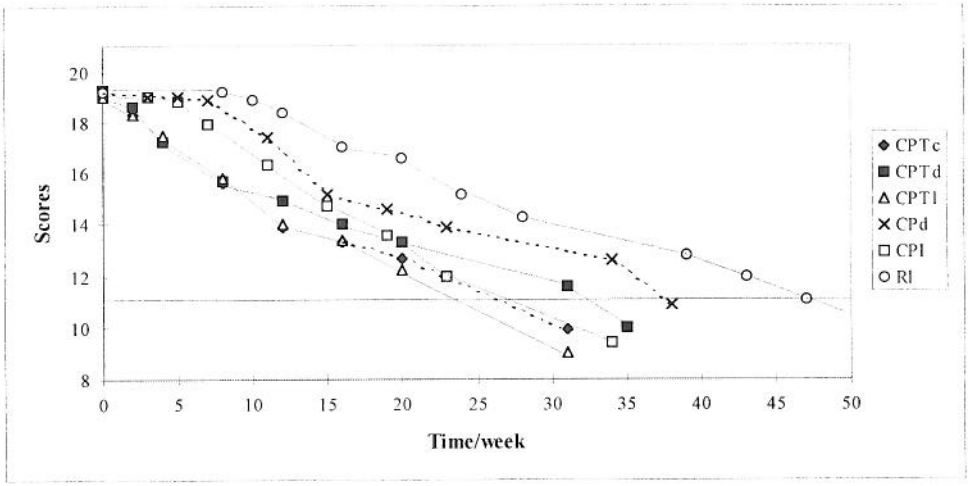

Fig.6. Organoleptic evaluation of unrefined and refined sunflower oil stored at room temperature (samples description indicated in Table 1)
Slika 6. Organoleptička procjena nerafiniranog i rafiniranog suncokretovog ulja tijekom skladištenja pri sobnoj temperaturi (opis uzoraka vidi u tablici 1)

the lowest change of only 0.36 %, thus having only the tocopherols from the initial raw material.

The highest change of colour index (down to 69 %), (Fig. 5) occured in the oil samples exposed to light, whereas the lowest change (8 %) was detected in the samples of cold pressed oils stored in dark places. The colour index of R_I, which had already been reduced during the process of oil decoloration, did not change dramatically during the storage period and was lower than the colour index of cold pressed oils, which is in agreement with the findings reported *(3)*.

The organoleptic properties (Fig. 6) of the tested cold pressed and refined oils showed that the stability, and thus the shelf life of the tested oil samples was shorter than declared (for cold pressed oils 9 months, for refined oil 12 months). The samples R_I got scores lower than 11.2 after 46.5 weeks, the samples CP_d after 37 weeks, the samples CPT_d after 32 weeks, the samples CP_I and CPT_c after 26 weeks, and the samples CPT_I after 24 weeks of storage. The presented results of organoleptic evaluation indicated that tocopherol added to cold pressed sunflower oil did not affect prolongation of the time during which the oil usually has a satisfactory quality so that further adding of tocopherol is not necessary. This is especially true in the case of new trends in modern technology, where the rule is to have all the components, including tocopherols, coming from the original raw material *(1)*.

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