DIFFERENCES IN SENSORY AND CHEMICAL PARAMETERS OF COLD PRESSED, REFINED AND DOUBLE REFINED SUNFLOWER OIL

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Abstract

The study evaluated the sensory and physicochemical characteristics of cold-pressed sunflower oil (CPSO), refined sunflower oil (RSO), and double-refined sunflower oil (DRSO). The aim of this study was to assess and compare the quality of cold-pressed, refined, and double-refined sunflower oil through sensory and physicochemical analyses. Sensory analysis indicated that CPSO received the highest overall quality score (18.69 points), being appreciated for its pleasant taste and aroma similar to sunflower seeds, while DRSO obtained the lowest sensory score. Physicochemical determinations showed variations among the oil types in terms of moisture, free acidity, saponification, iodine, and peroxide values. Refining reduced moisture content, acidity and peroxide value, improving oxidative stability and shelf life, while density remained relatively constant.

Key words: *oil, sensory analysis, quality indices, self life*

INTRODUCTION

Cold-pressed sunflower oils (CPSO) represent an important category of unrefined edible oils obtained through environmentally friendly "green" technologies, characterized by preserved native bioactive compounds and distinct sensory attributes derived from the seeds. Unlike conventionally produced sunflower oil refined (RSO) and double refined (DRSO), which typically undergoes refining after extraction, CPSO retains its natural composition, including essential fatty acids, tocopherols, vitamin E, and selenium, contributing to its nutritional and functional value [1, 2] The quality, composition, and yield of CPSO depend largely on seed quality, pre-treatment, and pressing conditions, while the residual press cake constitutes a valuable by-product.

Refining of sunflower oil is primarily aimed at improving its suitability for human consumption by removing undesirable components such as free fatty acids (FFA), phospholipids, pigments, volatile compounds, and contaminants including pesticides and solvents. This process involves several stages such as degumming, neutralization, bleaching, winterization, and deodorization, each targeting specific impurities [3, 4]. Degumming removes phospholipids responsible for dark coloration and off-flavours, either through water hydration or acid treatment [5, 6], achieving significant reductions in phospholipids content [7]. Neutralization (deacidification) eliminates FFA via alkaline treatment, forming soaps that are subsequently removed [8]. Winterization (dewaxing) removes long-chain waxes and saturated triglycerides through cooling and filtration, with minimal impact on minor bioactive compounds such as tocopherols [7, 9]. Finally, deodorization eliminates volatile compounds and oxidation products, improving sensory quality and stability while aiming to preserve most minor constituents [10, 11].

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Despite its effectiveness, refining can lead to the loss or degradation of valuable minor components, thereby reducing the nutritional quality of the oil [12]. In contrast, CPSO maintains these compounds in their native form, resulting in characteristic sensory properties such as nutty, woody, or slightly bitter notes, largely influenced by volatile terpenic compounds (e.g., α-pinene) and alcohols like 3-methyl-1-butanol [13-15]. However, the absence of refining also makes CPSO more variable in quality and stability [1, 9].

The quality and oxidative stability of vegetable oils are strongly influenced by minor constituents such as phospholipids, waxes, tocopherols, trace metals, and free fatty acids, which may exhibit pro- or antioxidant effects [16-18]. Oil degradation begins shortly after extraction, leading to primary oxidation (peroxide formation), increased acidity, colour changes, and off-flavours. Therefore, quality parameters such as peroxide value, acid value, and iodine value are critical indicators of oil stability and identity [19-21].

The objective of this research was to assess the quality of cold-pressed, refined, and double-refined sunflower oil by sensory and physicochemical assessments.

To attain the objectives, the primary sensory features (overall aspect, colour, smell and taste) were assessed, and the following parameters were quantified: water content, relative density, free acidity, saponification index, iodine index, and peroxide index.

MATERIAL AND METHOD

Oil samples were obtained directly from a vegetable oil plant from the region.

CPSO was obtained by pressing with a auger screw press, the obtained broken was supplementary pressed with a mechanical screw press to release the remaining oil. The process of cleaning the oil from rough impurities was carried out by passing it through a sieve; the resulting oil was transferred to a preliminary decantation tank and then introduced into another tank for filtration using a vertical plate filter. After that the oil is sent to the second filtration in a plate and frame filter press.

RSO was obtained by heating crude oil to elevated temperatures (210-270°C during deodorization) to remove volatile compounds, oxidation products, and undesirable flavours. This processing significantly improves oil clarity, extends shelf life, and produces oil suitable for diverse culinary applications including frying operations.

DRSO represents the most extensively processed category, involving sequential refining cycles and specialized winterization steps. Winterization specifically targets wax removal through cooling and filtration, which requires 99.20% of waxes to be eliminated according to industrial standards. This additional processing step creates oil with exceptional clarity, stability, and shelf life, though it results in minimal retention of many natural bioactive compounds. The multiple refining cycles produce oil with the lowest oxidative activity but also the lowest nutritional value in terms of minor bioactive components.

The sensory evaluation of sunflower oil samples was conducted by a group of fifteen semi trained assessors utilizing a 5-point scale as proposed by Banu et al. [22]. Each assessor got three coded samples, each representing a distinct assortment of sunflower oil. The data were analysed using a 20-point scale for overall quality assessment Banu et al. [23].

The insoluble contaminants in sunflower oils were assessed in accordance with SR EN ISO 663: 2017 [23]. The determination of humidity was conducted in accordance with the SR EN ISO 662:2016 [24] standard, which specifies the techniques for humidity determination. The density of oil was ascertained in accordance with ISO 6883:2017 [25]. The iodine value was determined in line with SR EN ISO

3691: 2019 [26]. The acidity value denotes the quantity of KOH in milligrams required to neutralize free fatty acids in one gram of fat. The method entails neutralizing the free acidity of a defined quantity of fat utilizing an alcoholic solution of KOH with a specified titre and factor, in the presence of phenolphthalein, in line with the SR EN ISO 660:2020 [27] standard.

To determine the saponification value, a specified quantity of fat (oil) is combined with an excess of 0.5n potassium hydroxide (in alcohol) and subsequently heated. Upon completion of saponification, the residual quantity of potassium hydroxide is assessed using acid titration to ascertain the excess amount. The quantity of KOH employed in fat neutralization and saponification can be determined by deducting the surplus amount [28, 29]. The peroxide value was assessed using the SR EN ISO 3960:2017 [30] standard. The product undergoes titration in a combination of acetic acid and chloroform, utilizing a potassium iodide solution.

RESULTS

Upon completion of the sensorial analysis of the examined sunflower oil assortments (Figure 1) and further data processing, the weighted mean score for all assessed sensorial attributes and the overall quality score were determined (Figure 2).

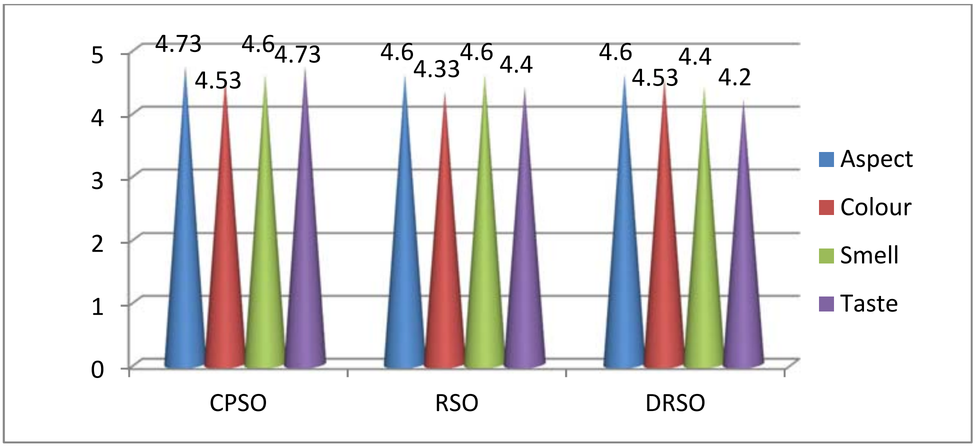

Figure 1 Sensory analysis of sunflower oil assortments

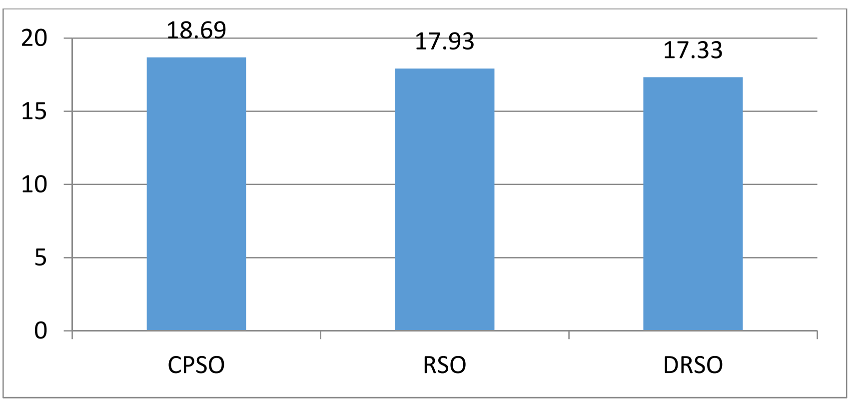

Figure 2 Quality rating scale

The physicochemical analyses conducted included the following determinations: density and moisture content, free acidity content, saponification iodine and peroxide value, which are presented in table 1.

Table 1 Physicochemical analysis of oil samples

Specification	CPSO	RSO	DRSO
Density (g/cm^3)	0.923±0.012	0.92±0.005	0.92±0.005
Moisture (%)	0.48±0.007	0.24±0.008	0.05±0.007
Free acidity value (mg KOH/g)	1.43±0.81	0.44±0.3	0.24±0.4
Saponification value (mg KOH/g)	190.22±0.66	187.81±1.09	186.66±2.42
Iodine values ($g\ I_2/100g$)	128±046	127.4±0.52	125.4±051
Peroxide value ($meq\ O_2/100g$)	7.61±0.72	5.60±0.72	0.12±0.21

Similarly to sensory analysis, the results indicate differences between the three types of oil.

DISCUSSIONS

Concerning the results of the sensory analyses, differences were observed among the three types of sunflower oil.

CPSO was rated by the examiners as being of high quality, obtaining a total average score of 18.69 points. The maximum score was given to the overall appearance feature and taste, both with an average of 4.73±0.46 points. In the case of the sensory evaluation of RSO, we deduce that it has corresponding specific qualities, with the sensory features of overall appearance and smell receiving the maximum score of 4.6±0.51 points. The sensory attributes of colour and smell were less appreciated, receiving scores of 4.3±0.49 and 4.4±0.51 points, respectively. For DRSO, a lower score was obtained compared to the other varieties, with the lowest value being assigned to taste at 4.2±0.41 points, and the highest score being assigned to appearance and colour at 4.6±0.51 points.

Following the sensory analysis, it is clearly noted that the assessors appreciated the CPSO more than the other two assortments, because it has the advantage of delicate taste and smell, similar to sunflower seeds.

The analysed products were sensorial classified into quality levels based on the total average score accumulated and the weighting factors of each sensory attribute. As seen in Figure 2, CPSO recorded the highest average score of 18.69 points, placing it in the “very good” quality level. RSO and DRSO obtained a total average score of 17.89 and 17.33 points, respectively, thus receiving the "good" qualification.

Similar sensorial results were observed in a study by Nakonechna et al. [13], were different cold-pressed sunflower oil were positively assess in comparison with conventional obtained oils.

Regarding chemical analyses, we can observe differences between the three types of sunflower oil.

Density denotes the ratio of the mass of a certain volume of a substance to the mass of an equivalent volume of water at the same temperature, and is an essential characteristic of fluids [31, 32].

The density of sunflower oil remains relatively stable throughout the various phases of refining 0.92 g/cm^3 at 20°C. Similar results were presented by Neagu et al. [33] and Pal et al. [34], but Jankuloska and Pavlovska [21], showed a diminish of density throughout refining process from 0.925 to 0.921 g/cm^3.

The moisture level of oils is a critical quality criterion, as water affects both the refining and processing of edible oils and the stability of oils during storage.

In case on humidity content, the results indicated that the refinement degree of CPSO reduced the moisture content from 0.48 to 0.05%. Similarly, Shah et al. [35], obtained closed values (0.46–0.04%) and Jankuloska and Pavlovska [21] (0.6-0%), while Pal et al. [34] stated that starting from crude pressed oil to refined one the moisture level was 0.

As a result of the determinations carried out, we obtained the following values regarding the free acidity: for cold-pressed unrefined oil, the value was 1.43, for refined oil it was 0.44, and for double-refined oil, the value was 0.24.

Prior research by other autors corroborates these findings. Tasan et al., [36] obtained values ranging from 0.86 to 1.05, while Bendini et al. [14] for crude sunflower oil mentioned values from 0.11 to 2.75 and for conventional oil between 0.11 and 0.2. Jankulovska and Pavlovska [21] indicates a decrease of acidity value during rafination from 2.26 to 0.15 while Pal et al. [34], in similar research regarding the degree of oil refinement, obtained values ranging from 1.10 for CPSO and 0.13 for DSO. Pavlovska et al. [2] note values for CPSO for free acidity of 0.52 and 0.13 for refined ones, and Nakonechna et al. [13] reported for CPSO results of 1.02-1.15 and 0.12-0.31 for refined oil.

The determination of the peroxide value aims to evaluate the degree of oxidation of the oil and can provide important information regarding its quality, safety, and shelf life.

When sunflower oil is exposed to air, light, and heat, the fatty acids in the oil can undergo oxidation reactions, which can lead to the formation of peroxides. Peroxides can be harmful to human health and can affect the aroma of the oil.

Following analyses, the obtained results showed values of 5.61 for CPSO, 5.60 for refined oil, and 0.12 for double-refined oil. The peroxide values exhibited a similar pattern to that of the free acidity content. This signifies that degradation occurs throughout the extraction process, attributable not just to oxidation but also to hydrolysis.

Same pattern was also mentioned in other studies. Tasan et al. [36], obtained values ranging from 12.10 to 9.20 meq O_2/kg, while Bendini et al. [14], mentioned for crude sunflower oil mentioned values from 3.03 to 15.98 and for conventional oil between 2.76 and 22 meqO_2/kg. Pal et al. [34], obtained values of 22.5 for CPSO, 7.9 for refined oil and 0.13 meq O_2/kg for DRSO. Pavlovska et al. [2] note values for CPSO for peroxide value of 5.94 and 1.27 meq O_2/kg for refined ones, Shah et al. [35] observed a reduction from 3.2 to 0.9 mEqO_2/Kg and Nakonechna et al. [13] reported for CPSO results of 0.23-4.16 and 0.19-6.36 meqO_2/kg for refined oil.

The determination of the saponification index of sunflower oil aims to evaluate its quality and composition and provides a direct measure of the average molecular weight of the fatty acids.

In the case of CPSO was obtained an average value of 190.2 mg KOH/g, for RSO 187.8 while for DRSO the value was 186.6 mg KOH/g. A similar decrease for the saponification index were also stated by Neagu et al. [33] from 212.14 to 209.44 mg KOH/g and Shah et al. [35] from 178.5 to 177.2 mg KOH/g oil, while Jankuloska and Pavlovska [21] did not find any difference between raw and refined sunflower oil both with the same value of 190 mg KOH/g oil.

The iodine value (IV) is a very important analytical constant, being defined as the percentage of iodine absorbed by an oil sample, reflecting its unsaturation level or the existence of double bonds capable of reacting with iodine and used for the characterization of natural lipids. Similar it can be observed that the refining process reduced the iodine value from 128 g I_2/100g CPSO to 125.4 g I_2/100g for DRSO. Similar observations were made by Neagu et al. [33] and Shah et al. [35], while in contrary, Jankuloska and Pavlovska [21] and Pavlovska et al. [2] mentioned an increase of the iodine value during the refining process.

CONCLUSIONS

The results obtained in this study demonstrated that the degree of sunflower oil refining influences both sensory and physicochemical characteristics.

Cold-pressed sunflower oil (CPSO) showed the highest sensory acceptance due to its pleasant flavour and aroma, preserving the natural characteristics of sunflower seeds. In contrast, refined and double-refined oils presented improved clarity, stability, and lower oxidation indices, but lower sensory appreciation.

The refining process led to a gradual reduction in moisture content, free acidity, peroxide, saponification and iodine values, indicating improved oxidative stability and extended shelf life.

Although refining improves technological and storage properties, it also reduces, the concentration of natural bioactive compounds responsible for the nutritional and sensory quality of the oil. Therefore, cold-pressed sunflower oil may be considered a more suitable option for consumers seeking products with superior sensory attributes and higher nutritional value, while refined oils are more suitable for applications requiring enhanced stability and longer preservation.

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