Sterol-Rich Sunflower Press Oil

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Plant sterols or phytosterols (PS) are compounds with proven health benefits. Their richest natural sources are vegetable oils, followed by nuts and legumes. Extracted from plants, free PS are widely used in fortified foods and dietary supplements. In most cases, free PS are extracted using organic solvents that are harmful to human health as well as to the environment. The food industry is currently facing the challenge of obtaining foods enriched with bioactive compounds while applying minimal processing. In this context, the production of PS-enriched seeds may be a good option to increase PS in our diet simply through the intake of vegetable oils.

PS-enriched food | phytosterols | sunflower oil | refined oil | physical refining | chemical refining

1. Overview

New phytosterol (PS)-enriched sunflower seeds, which are higher in campesterol and Δ7-stigmastenol, have recently been developed. Crude oils obtained from these new sunflower seeds in 2015 and 2017 were used in this study. Oils extracted only by press (PO) and with subsequent solvent extraction (SO) were characterized. Physical refining (PhR) was used to obtain edible PO by minimal processing and to keep the PS levels as high as possible. Oils obtained by chemical processing were also studied for comparative purposes. Different bleaching treatments were examined to reduce the contents of phospholipids in the PO to levels required for PhR (<10 mg kg^{-1}). Phosphorous levels in PO from 2015 (9–12 mg kg^{-1}) were reduced to optimal levels by bleaching with 0.1% Trisyl and 1% Tonsil 278 FF. Contrarily, treatments with Trisyl and Tonsil (278 FF or 114 FF) were not sufficient to reduce the higher levels in PO from 2017 (15–36 mg/kg^{-1}), thereby they were subjected to chemical refining (ChR). The PhR applied to PO from 2015 did not lead to substantial changes in the composition and total content of PS. In contrast, losses of up to approximately 30% of total PS were found owing to ChR, although the oils preserved their unique PS profiles.

2. Plant Sterols

Plant sterols or phytosterols (PS) are compounds with proven health benefits [1][2]. Their richest natural sources are vegetable oils, followed by nuts and legumes [1]. Extracted from plants, free PS are widely used in fortified foods and dietary supplements. In most cases, free PS are extracted using organic solvents that are harmful to human health as well as to the environment [3]. The food industry is currently facing the challenge of obtaining foods enriched with bioactive compounds while applying minimal processing [4][5]. In this context, the production of PS-enriched seeds may be a good option to increase PS in our diet simply through the intake of vegetable oils [6][7][8][9][10].

The industrial production of sunflower seeds and sunflower oils is of great relevance worldwide [11]. In Europe, sunflower oil is the second most produced oleaginous seed oil and accounts for approximately 30% of the whole oil production [12]. Numerous studies on the production and characterization of edible sunflower oils with modified fatty acid compositions have been reported [13][14]. In addition, the development of oils containing modified tocopherols has been the goal of extensive research [15][16]. However, studies related to sunflower oils from seeds enriched in PS are limited [9][10]. In this respect, there are inherent difficulties in obtaining PS-enriched oils as the content of PS in seeds increases rapidly during the first seed growing stages, when the oil content in the seed is still low, and then the increase rate of PS becomes much slower as compared to that of the oil [9][10]. The PS composition can be also changed [17] and this could be of great interest in order to adapt sunflower oils to specific nutritional demands. Recently, new lines of PS-enriched seeds with increased levels of campesterol and Δ7-stigmastenol, respectively, have been developed [9][10].

At the industrial level, sunflower oil production consists of extraction by press (around 70–80% of the total oil is extracted) followed by solvent extraction (hexane) of the remaining oil. Both the press oil (PO) and solvent oil (SO) are blended to produce what is known as crude oil, which must then be refined for edible purposes [13].

Oils obtained by pressing are highly demanded [18][19]. The fact that POs are obtained without the use of organic solvents raises the question of whether it is worth commercializing them separately in sunflower oil production to obtain added-value environmentally friendly oils. However, the composition of minor components differs between POs and SOs [20][21][22]. Specifically, total PS contents in oils from PS-enriched seeds have been reported to range from 2839 to 5284 mg kg^{-1} for POs and from 4849 to 9249 mg kg^{-1} for SOs [23]. Most importantly, it would be not possible to commercialize POs as unrefined or virgin oils due to their high content in phosphorus (P) and metals, beyond the levels allowed by regulations [24]. While chemical refining (ChR) is imperative in SOs because of its high levels of P, the application of a physical refining (PhR) process to POs when the acidity is low could be an alternative in order to preserve PS, which are otherwise significantly lost during chemical neutralization [25][26][27][28][29][30][31][32][33].

PhR basically consists of a bleaching step followed by neutralizing deodorization in which the free fatty acids are removed by steam distillation at low pressures (2–6 mbar) and high temperatures (180–270 °C). Compared to ChR, PhR reduces the loss of neutral oil and allows for the recovery of free fatty acids with minimal production of pollutants [34][35]. The reduction of phospholipids to levels below 10 mg kg^{-1} oil is crucial for PhR because phospholipids promote browning during deodorization [34][35][36].

The removal of low contents of P and metal traces can be achieved by applying specific bleaching treatments [37][38][39]. Bleaching is considered an adsorption purification process by which, along with pigments, a wide range of undesirable components are removed prior to deodorization, including oxidation products, trace metals and other contaminants [37][40]. A treatment with amorphous silica has been reported as a dry degumming process, presenting reductions of P higher than 85% and, thus, avoiding wet-degumming [38][41]. Similar reductions have also been observed for iron [41][42][43]. In this respect, bleaching using combinations of earths and silica could be employed to remove the low levels of P found in POs from new PS-enriched sunflower seeds [23], as well as trace metals to meet the levels allowed in the regulation [24].

3. Conclusions

The P levels present in the PO obtained from the new PS-enriched sunflower seeds can vary from one season to another and their reduction by bleaching to optimal levels for PhR may result as insufficient. If this is the case, the PO of the new seeds should be refined by ChR, consisted of degumming, neutralization, bleaching and deodorization. By applying optimal PhR conditions, the PO of the new cultivars can preserve their naturally occurring levels of PS and tocopherol.

The PO and SO of the new PS-enriched sunflower seeds can lose up to 30% of total PS as a consequence of ChR but keep the PS profile that differentiates them from common sunflower oils. Even when losses of PS are expected after ChR, the levels found in the refined oils, i.e., 3285–4547 mg kg^{-1} in the PO and 4602–6616 mg kg^{-1} in the SO, can be considered high compared to the established ranges by the food codex (CODEX 210-1999) for crude oils (2400–5000 mg kg^{-1}).

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