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Factors influencing tocopherol content and composition in lentils

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ABSTRACT

Although various approaches can improve fruit and vegetable production and quality, there is little information on factors influencing tocopherol composition in lentils. Here, we examined whether and to what extent tocopherol content and composition in lentils may be influenced by cultivar, origin, cooking, and processing. The results showed wide variability in tocopherol content in lentils purchased in grocery stores in Spain, which was strongly influenced by the cultivar, origin, brand, and processing. Purchasing raw lentils in local markets and cooking them immediately prior to eating (preventing processing and storage in pots) was the best way to increase tocopherol content, more specifically that of γ-tocopherol. The highest γ- and α-tocopherol contents were found in 'Pardina' lentils, with values of 4.40 and 1.21 mg/100 g FW, respectively. In conclusion, choosing appropriate varieties and home-cooking of raw lentils (avoiding processed products) is the most appropriate way to obtain a significant daily tocopherol intake from lentils.

1. Introduction

Grain legumes come from plants in the Fabaceae family, whose dry seeds are commonly consumed by humans. Legume seeds, also known as pulses, are a widespread food worldwide, with particular importance in Mediterranean and Middle Eastern regions (Yadav et al., 2007). Being rich in protein, essential elements, dietary fiber, and vitamins, pulses are increasingly occupying an important place in human nutrition (Bessada, Barreira & Oliveira, 2019). Furthermore, the rising awareness of consumers about healthy food and the growing trend for plant-based food has led to the development of new legume-based products (FAO, 2020).

Among legumes, lentils (*Lens culinaris* Medik.) are one of the most important legumes found in human consumption, being an excellent dietary source of complex carbohydrates, proteins, fiber, minerals, vitamins, and other highly valued nutrients, contributing positively to human health (de Almeida Costa, da Silva Queiroz-Monici, Reis & de Oliveira, 2006; Boschin & Arnoldi, 2011; Marathe, Rajalakshmi, Jamdar, & Sharma, 2011). Legume consumption has been demonstrated to lower the glycemic index in diabetic people, protect against coronary heart diseases, be inversely associated with obesity and high levels of low-density lipoproteins (LDLs), and play an important role in maintaining the immune system response (Bazzano et al., 2001; Bramley et al., 2000; Rizkalla, Bellisle, & Slama, 2002; Schoeneck & Iggman, 2021; Villegas et al., 2008; Wang, Hatcher, Toews, & Gawalko, 2009). The development of these diseases has been associated with the oxidative and nitrosative stress from the overproduction of reactive oxygen or nitrogen species (ROS/RNS), respectively, which may attack various cellular and extracellular components and thus damage cells and tissues (Yu, Tsao, & Shahidi, 2012). Antioxidants can attenuate this oxidative stress via different modes of action, and some may act through a combination of several mechanisms such as scavenging ROS/RNS and preventing depletion of the endogenous antioxidant defense systems (Yu et al., 2012). Tocopherols are lipophilic compounds present in various fruits and vegetables, including legumes. As potent antioxidants, they play a crucial role in mitigating the stress-related effects mentioned above (Bramley et al., 2000; Jones & Rideout, 2006).

Lentils are mostly consumed after processing methods that include steaming, blanching, soaking, sprouting, and boiling. Cooking facilitates digestibility and nutrient absorption, and changes the organoleptic properties (Carmody & Wrangham, 2009; Güzel & Sayar, 2012). Although it facilitates food digestion and partially eliminates antinutritional factors (Gobbetti, De Angelis, Di Cagno, Polo, & Rizzello, 2020), cooking generally results in a loss of nutritional value in legumes. For instance, Barampama and Simard (1995) observed a decrease in minerals, vitamins, and some essential amino acids in cooked beans. Wyatt, Carballido, and Mendez (1998) also reported a reduction in

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tocopherol content after cooking lentils, chickpeas, and beans. Nevertheless, this variation in nutritional compounds depends on the type of food studied and the manipulation performed (Fabbri & Crosby, 2016), and evidence obtained thus far is very limited in the case of lentils of the Pardina and Castellana varieties, which are the most prevalent pulses found in European grocery stores.

Here, we aimed to evaluate whether tocopherol content and composition in lentils can be influenced by cultivar and origin, with an emphasis on canned and raw lentils purchased in grocery stores in Spain. Particular attention was given to what extent and how processing influences tocopherol intake from lentils in our diet. We examined the possible influence of cooking during food processing of lentils of the 'Pardina' and 'Castellana' varieties on the final tocopherol content.

2. Materials and methods

2.1. Experimental design, treatments, and varieties

Various factors influencing tocopherol content and composition in lentils were evaluated. In order to assess the impact of cultivar, origin, and processing on the tocopherol content and composition of lentils, several types of lentils were purchased from grocery stores situated in the vicinity of Barcelona (Catalonia, NE Spain). Dry and canned lentils from different commercial brands, varieties, and origins were selected. Three can or packets of each were analyzed, taking two subsamples from each can/packet (from different zones) to account for the intrinsic heterogeneity within the product. To assess the effect of cooking on the tocopherol content of dry lentils, the lentils were cooked according to the instructions provided by each commercial brand. Once the water had reached boiling point, the different subsamples were separated from each other using individual cotton bags of 6 × 8 cm and cooked without a prior soaking period. Once cooked, the lentils were rinsed with cold water and left to cool. The dry lentils and the cooked lentil samples were frozen in liquid nitrogen and stored in the freezer at −80 °C until subsequent tocopherol analyses. To investigate whether the commercial processing of lentils might affect their tocopherol content, samples of canned lentils were also analyzed; these were preserved in aquafaba, the liquid remaining from the cooking of legumes to which additives are typically added to prevent lentil darkening. Two subsamples from each can were frozen in liquid nitrogen before and after rinsing the lentils, i.e., with and without aquafaba. The samples were frozen in liquid nitrogen and stored at −80 °C until further analysis.

2.2. Tocopherol

For tocopherol analysis, 100 mg of each sample was used for extraction in 400 μL 100% cold methanol (MeOH) containing 10 mg/100 mL butyl-hydroxytoluene (BHT). This was vortexed and then ultrasonicated for 30 min (Bransonic Ultrasonic Bath 2800, Emerson Industrial, Danbury, CT, United States) and centrifuged for 10 min at 15,980 *g* and 4 °C (PrismR, Labnet International Inc.) to obtain the supernatant, which was recovered and transferred to a new tube. The remaining pellet underwent two new re-extractions to recover all tocopherol. The final extract (1.2 mL) was filtered using a single-use hydrophobic 0.45 μm PTFE filter prior to high-performance liquid chromatography (HPLC) analysis. Tocopherols and tocotrienols were separated in an HPLC system equipped with a Waters 600 control pump, a Jasco FP-1520 fluorescence detector, and a Waters 717 plus autosampler. Tocopherol compounds (α-, β-, δ- and γ-tocopherols, and α-, β-, δ- and γ-tocotrienols) were separated using an Inertsil 100A column (5 μm, 30 μm × 250 μm, GL Sciences Inc., Tokyo, Japan). The mobile phase used was a mixture of *n*-hexane and *p*-dioxane (95.5: 4.5 v/v) with a flow rate of 0.7 mL min^{-1} and an injection volume of 10 μL. The solvent was filtered with a 0.22 μm PVDF filter using a vacuum filtration system. Detection was performed at an excitation of 295 nm and fluorescence emission at 330 nm. The different compounds detected were identified and quantified by comparison with authentic tocopherol and tocotrienol standards obtained from Sigma-Aldrich (Steinheim, Germany).

2.3. Statistical analyses

Means, medians, and standard errors (SE) were calculated using Excel (16.61.1 version). Statistical analyses were performed by one or two-way ANOVAs and the Tukey's test was used as a post-hoc test. Prior to conducting a Shapiro-Wilk test, the data was transformed with logarithms with base 10 to ensure normality. Statistical differences in tocopherol content between canned and freshly-boiled lentils were analyzed following the Student's *t*-test. In all cases, differences between treatments were considered significant when $P < 0.05$. All statistical tests were performed with RStudio and all graphs were drawn with SigmaPlot 14.0 software (Systat Software, Germany).

3. Results and discussion

3.1. Freshly-cooked vs. canned lentils

Overall, the results indicated that canned lentils had a lower tocopherol content, and more specifically γ-tocopherol content, compared to lentils purchased raw from local markets and boiled for the recommended time (Fig. 1). Considering all varieties taken together, the mean, median and standard error of γ-tocopherol content were 2376, 2328 and 50 μg/100 g fresh matter for canned lentils and 2810, 2819 and 94 μg/100 g fresh matter for freshly-boiled lentils, respectively. Differences in γ-tocopherol between canned and freshly-boiled were quantitatively relevant (an 18% increase in freshly-boiled lentils relative to canned ones). In contrast, differences in α-tocopherol between canned and freshly-boiled lentils were not significant ($P = 0.390$, Student's *t*-test), at least partly due to the greater variability between varieties, with a mean, median and standard error of 636, 593 and 32 μg/100 g fresh matter for canned lentils and 701, 604 and 66 μg/100 g fresh matter for freshly-boiled lentils, respectively. This has significant implications for understanding that the more food is processed, the more negatively this influences tocopherol intake from lentils in our diet, an aspect that was clearly seen in our study, more specifically for γ-tocopherol. The considerable variability in the data can be attributed to the origins and brands of lentils obtained from grocery stores, reflecting differences in production and industrial processing (Dekker & Verkerk, 2003; Tahir, Vandenberg, & Chibbar, 2011; Tziouvalekas et al., 2022). There was also considerable variability in our study in the number of replicates for each variety (associated with their limited availability in grocery stores situated in the vicinity of Barcelona). Despite this, as shown in Table 1 and Table 2 for each brand and type of lentil separately, the general trend between freshly-boiled and canned lentils was clear. While the contents of α- and γ-tocopherol in canned lentils never exceeded 1 and 3 mg/100 g FW respectively (Table 2), higher amounts were found in freshly-cooked lentils that had been purchased raw (Table 1). The industrial canning process involves multiple steps such as blanching, thermal processing, and sterilization (Schoeninger, Coelho, & Bassinello., 2017), which can alter the nutritional content of lentils and, as shown here, specifically that of tocopherol. This consequence of canning for other nutrients has been described previously by Margier et al. (2018), who demonstrated a deterioration in the composition and content of other nutrients and bioactive compounds in canned legumes.

3.2. Effect of boiling on tocopherol content

The comparison of raw and freshly-cooked lentils revealed an impact of boiling on the α- and γ-tocopherol contents that was largely dependent on the variety studied (Fig. 2a). Boiling reduced the γ-tocopherol content in Castellana and Pardina lentils by 55% and 32%, respectively. However, differences between raw and boiled lentils were not

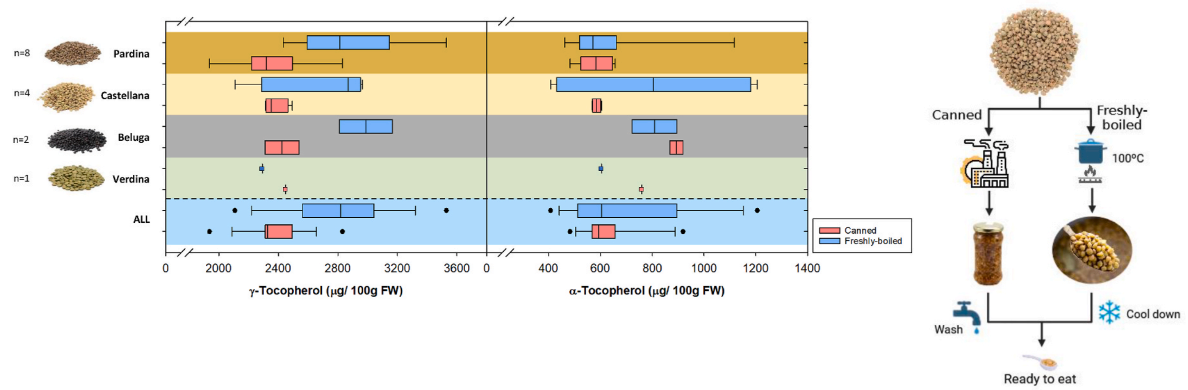


Fig. 1. γ- and α-tocopherol contents in canned and freshly-boiled lentils from different cultivars purchased in various grocery stores from Spain. Data, which are expressed as μg/100 g fresh weight (FW), show the median and range of the different brands/origins measured for each cultivar (with eight, four and two brands/origins for the Pardina, Castellana, Beluga and Verdina varieties, respectively). For each brand/origin within each variety, the mean of three samples (including two technical replicates per sample) were included in the analyses.

Table 1
Tocopherol content in raw and cooked lentils from different cultivars purchased in various grocery stores from Spain (region is additionally indicated in Spanish lentils). Brand and origin of lentils is shown (the region is additionally indicated in Spanish lentils). Data, which are expressed as mg/100 g fresh weight (FW), show mean and SE of n = 3 (including two technical replicates per sample). ND = not detected. An asterisk indicates significant differences between raw and cooked lentils within the same cultivar (ANOVA, *P* < 0,05).

Lentil grain (mg/100g FW)								
				α-Tocopherol	γ-Tocopherol			
Lentil cultivar	Brand	Origin	Organic	Raw	Cooked	Raw	Cooked	Cooking Process (min)
Beluga	La Cochura	Canada	No	0,30 ± 0,10	0,72 ± 0,11*	3,61 ± 0,44	2,81 ± 0,06	35
Beluga	Casa Ruiz	Spain (Castilla y León)	No	0,31 ± 0,06	0,90 ± 0,03*	3,22 ± 0,32	3,17 ± 0,16	30
Castellana	Casa Ruiz	Spain (Castilla y León)	Yes	0,25 ± 0,03	0,50 ± 0,06*	4,78 ± 0,14	2,96 ± 0,08*	50
Castellana	Vegas Bañezas	Spain (Castilla la Mancha)	No	0,65 ± 0,08	1,11 ± 0,13*	4,64 ± 0,22	2,82 ± 0,03*	25
Castellana	Corte Inglés	Spain (Castilla la Mancha)	No	0,12 ± 0,02	0,41 ± 0,02*	3,16 ± 0,21	2,11 ± 0,03*	90
Castellana	De Nuestra Tierra	Spain (Castilla y León)	No	0,48 ± 0,07	1,21 ± 0,06*	4,40 ± 0,08	2,92 ± 0,05*	25
Verdina	Veritas	France	Yes	0,17 ± 0,05	0,60 ± 0,07*	2,99 ± 0,62	2,29 ± 0,07	35
Pardina	Hort Del Silenci	Spain (Catalonia)	Yes	0,17 ± 0,01	0,61 ± 0,04*	4,20 ± 0,20	3,53 ± 0,15	35
Pardina	Hacendado	USA	No	0,47 ± 0,03	1,12 ± 0,05*	5,35 ± 0,20	3,04 ± 0,17*	80
Pardina	El Cutivador	Canada	No	0,24 ± 0,01	0,68 ± 0,02*	5,03 ± 0,10	3,18 ± 0,12*	62
Pardina	Eroski Basic	Spain (Castilla y León)	No	0,24 ± 0,03	0,51 ± 0,01*	5,01 ± 0,13	2,83 ± 0,08*	62
Pardina	Campo Largo	Spain (Murcia)	No	0,19 ± 0,01	0,54 ± 0,02*	4,69 ± 0,04	2,56 ± 0,01*	100
Pardina	Ametller Origen	Spain (Castilla y León)	No	0,25 ± 0,03	0,57 ± 0,02*	4,67 ± 0,33	2,69 ± 0,15*	105
Pardina	De Nuestra Tierra	Spain (Castilla y León)	No	0,20 ± 0,03	0,57 ± 0,01*	4,38 ± 0,28	2,80 ± 0,10*	105
Pardina	La Cochura	USA	No	0,16 ± 0,01	0,46 ± 0,04*	3,63 ± 0,21	2,43 ± 0,05*	35
Red	La Cochura	Canada	No	ND	0,41 ± 0,01*	1,18 ± 0,24	3,05 ± 0,14*	35

Table 2
Tocopherol content in ready-for-consumption cooked lentils sold in various grocery stores from Spain (cultivar, brand and origin of the lentils are shown). Data, which are expressed as mg/100 g fresh weight (FW), show the mean and SE of n = 3 lentil pots (two technical replicates per pot were measured). An asterisk indicates significant differences between lentils with or without aquafaba from the same cultivar (ANOVA, p < 0,05).

Canned lentils (mg/100g FW)							
				α-Tocopherol		γ-Tocopherol	
Lentil cultivar	Brand	Origin	Organic	With aquafaba	Without aquafaba	With aquafaba	Without aquafaba
Beluga	Ametller Origen	Spain (Catalonia)	No	0,77 ± 0,06	0,92 ± 0,04	2,24 ± 0,07	2,54 ± 0,14
Beluga	Pedro Luís	Spain (Navarra)	No	0,64 ± 0,03	0,87 ± 0,04*	1,93 ± 0,05	2,31 ± 0,04*
Castellana	Ametller Origen	Spain (Catalonia)	Yes	0,41 ± 0,00	0,59 ± 0,02*	1,86 ± 0,01	2,49 ± 0,14*
Castellana	El Cultivador	Spain (La Rioja)	No	0,42 ± 0,03	0,58 ± 0,07	1,84 ± 0,12	2,33 ± 0,03
Castellana	GutBio	Spain (La Rioja)	Yes	0,45 ± 0,01	0,60 ± 0,03*	1,80 ± 0,03	2,38 ± 0,09*
Castellana	Luengo	France	Yes	0,38 ± 0,03	0,57 ± 0,01*	1,64 ± 0,13	2,31 ± 0,06*
Pardina	Ferrer	Spain (Catalonia)	No	0,48 ± 0,03	0,66 ± 0,01*	2,06 ± 0,07	2,52 ± 0,01*
Pardina	De Nuestra Tierra	Spain (Castilla y León)	No	0,40 ± 0,02	0,59 ± 0,00*	1,98 ± 0,12	2,83 ± 0,04*
Pardina	Don Pedro	Spain (Cádiz)	No	0,38 ± 0,02	0,54 ± 0,06	1,87 ± 0,07	2,32 ± 0,14*
Pardina	Hacendado	Spain (Castilla y León)	No	0,47 ± 0,01	0,64 ± 0,02*	1,76 ± 0,02	2,19 ± 0,05*
Pardina	Luengo	Spain (Castilla y León)	No	0,36 ± 0,01	0,52 ± 0,01*	1,71 ± 0,07	2,31 ± 0,04*
Pardina	Ametller Origen	Spain (Catalonia)	No	0,43 ± 0,01	0,65 ± 0,03*	1,71 ± 0,05	2,40 ± 0,06*
Pardina	Estany	Spain (Catalonia)	No	0,38 ± 0,02	0,48 ± 0,06	1,55 ± 0,13	2,32 ± 0,03
Pardina	Aranca	Spain (Catalonia)	No	0,33 ± 0,01	0,57 ± 0,02*	1,39 ± 0,05	1,94 ± 0,09*
Verdina	JAE	France	No	0,56 ± 0,01	0,76 ± 0,02*	1,88 ± 0,02	2,45 ± 0,02*

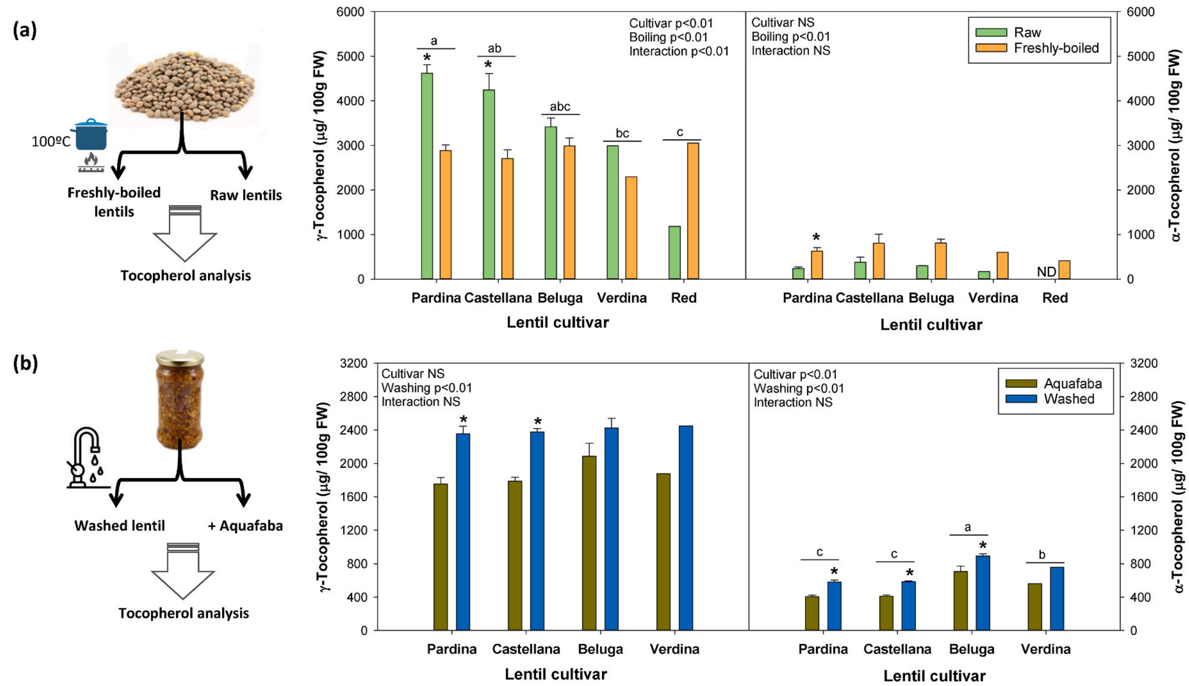


Fig. 2. γ- and α-tocopherol contents in (**a**) raw and freshly-boiled lentils, and (**b**) canned lentils with and without aquafaba, from different cultivars purchased in various grocery stores from Spain. Data, which are expressed as μg/100 g fresh weight (FW), show the mean and standard error of a different number of brands/origins for each cultivar (with eight, four, two and one brands/origins for the Pardina, Castellana, Beluga, Verdina and Red varieties, respectively). For each brand/origin within each variety, the mean of three samples (including two technical replicates per sample) were included in the analyses. An asterisk indicates significant differences between processing within the same cultivar (ANOVA, $P < 0,05$). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

significant for Beluga and Verdina lentils, and boiling increased the content of γ-tocopherol in red lentils (Fig. 2a, see also Table 1). The α-tocopherol content, which was always much lower than that of γ-tocopherol, generally increased in all studied varieties with boiling (Fig. 2a, Table 1).

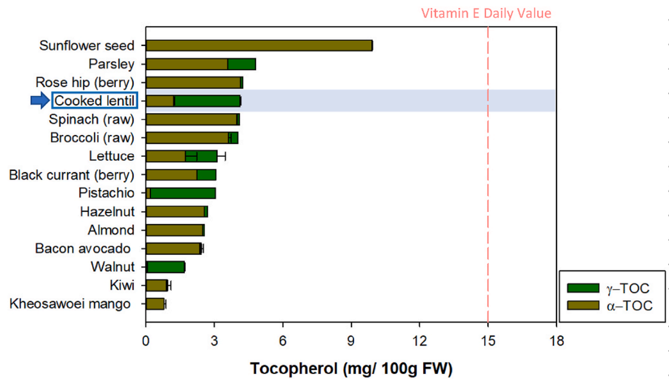
Raw lentils contained much higher amounts of γ-tocopherol compared to cooked and canned lentils (Tables 1 and 2). Furthermore, α-tocopherol was always present at much lower concentrations than γ-tocopherol, thus changes in tocopherols due to processing were always more apparent and quantitatively relevant in the content of γ-tocopherol. Although in our study the content of α-tocopherol generally increased in response to cooking, the process of freshly boiling lentils under controlled conditions, resembling home cooking and avoiding further processing, largely reduced the γ-tocopherol content in lentils (Table 1). Since lentils cannot be consumed raw, purchasing lentils from local markets and cooking them is a highly effective way to ensure the highest possible tocopherol content. Kim et al. (2023) reported a reduction in tocopherols content after soaking and boiling legumes, which led to a transfer of tocopherol from the seeds to the cooking liquid and thus a significant loss of tocopherol from the final product consumed. In our study, lentils were not soaked before boiling, which might explain the differential behavior of tocopherols in our study, particularly that of α-tocopherol (the contents of this tocopherol homologue slightly increased in all varieties studied, Table 1). Previous studies have suggested the possibility of enzymatic degradation of tocopherols in plants (Hakansson & Jagerstad, 1990; Hardy, Gallegos, & Gaunt, 1991), and thus it is likely that soaking before cooking (particularly if soaking lasts for long periods) might reduce the tocopherol content, particularly that of α-tocopherol (the most active form), an aspect that warrants further investigation.

3.3. Effect of aquafaba removal on tocopherol content

Canned lentils exhibited the same pattern of tocopherol content, with γ-tocopherol being the most abundant homologue across all varieties (Fig. 2b). The content of γ-tocopherol ranged from 1.39 to 2.24 mg/100 g FW when including aquafaba in the sample, and from 1.94 to 2.83 mg/100 g FW without aquafaba (Table 2). Aquafaba, the liquid remaining after cooking legumes, typically with added additives, has recently gained interest among vegans and the food industry due to its high stability and low fat and starch content. However, it is a diluted solution that contains minimal amounts of water-soluble proteins, soluble sugars, phenolic compounds, saponins, and other low molecular weight compounds (Tachie, Nwachukwu, & Aryee, 2023). This dilution reduces the tocopherol content when consuming the equivalent amount in a dish (e.g., 100 g). The highest amounts of γ-tocopherol were found in 'Pardina' lentils from Nuestra Tierra (Castilla y León) without aquafaba and in Beluga lentils from Ametller Origen (Catalonia) with aquafaba. The latter also contained the highest amounts of α-tocopherol, although these were relatively low (0.77 and 0.92 mg/100 g FW with and without aquafaba, respectively).

3.4. Lentils' contribution to tocopherol intake

Among the different lentil varieties tested in our study, the highest γ- and α-tocopherol contents in freshly-cooked lentils were found in 'Pardina' lentils, albeit from different origins (Catalonia and USA), with values of 3.53 and 1.12 mg/100 g FW, respectively (Table 1), indicating that this variety was the richest in tocopherol. Comparison of the content of tocopherol in this variety with other foods classically considered rich in tocopherol (Fig. 3) revealed that lentils contain a remarkable amount of tocopherols, more specifically γ-tocopherol. The role of tocopherol has been extensively studied in humans and other mammals and its antioxidant and radical scavenging mechanisms have been described in detail (Azzi, Ricciarelli, & Zingg, 2002; Schneider, 2005). Although α-tocopherol transfer protein (α-TTP) mediates the selective transport of α-tocopherol in its RRR- or 2R-forms into nascent very low-density lipoproteins and is responsible for its secretion from the



Fruits/ vegetables	Reference
Rose hip (Berry)	Piironen, Syvaoja, Varo, Salminen, & Koivistoinen, 1986
Black currant (Berry)	Piironen, Syvaoja, Varo, Salminen, & Koivistoinen, 1986
Parsley	Piironen, Syvaoja, Varo, Salminen, & Koivistoinen, 1986
Spinach (raw)	Knecht, Sandfuchs, Kulling, & Bunzel, 2015
Broccoli (raw)	Knecht, Sandfuchs, Kulling, & Bunzel, 2015
Walnut	Wojdyło, Turkiewicz, Tkacz, Nowicka, & Bobak, 2022
Pistachio	Wojdyło, Turkiewicz, Tkacz, Nowicka, & Bobak, 2022
Hazelnut	Wojdyło, Turkiewicz, Tkacz, Nowicka, & Bobak, 2022
Almond	Wojdyło, Turkiewicz, Tkacz, Nowicka, & Bobak, 2022
Kiwi	D'evoli et al., 2015
Kheosawoei mango	Franke, Murphy, Lacey, & Custer, 2007
Lettuce	Cruz et al., 2014
Sunflower seed	Del Moral, Fernández-Martínez, Pérez-Vich, & Velasco, 2013
Bacon avocado	Vincent, Mesa, & Munné-Bosch, 2020
Cooked lentil	This study

Fig. 3. γ- and α-tocopherol contents in the richest tocopherol foods, including lentils. Data, which are expressed as mg/100 g fresh weight (FW), have been taken from the cited literature. The recommended daily vitamin E intake is marked with a dashed red line. Note that cooked lentils are particularly rich in γ-tocopherol with levels comparable to pistachios, but with even higher contents of α-tocopherol. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

liver into the blood to maintain plasma α-tocopherol concentrations, all forms of dietary tocopherol are absorbed and transported via chylomicrons through lymph into the circulation in mammals, thus exerting positive effects on human health (Arita et al., 1995; Lim & Traber, 2007). Furthermore, recent studies have shown specific beneficial effects of γ-tocopherol on human health (Amarowicz & Pegg, 2008; Devaraj, Leonard, Traber, & Jialal, 2008; Jiang, Christen, Shigenaga, & Ames, 2001). Therefore, the high amounts of α- and γ-tocopherol provided by lentils should be considered as an additional positive effect of this food in our diet, aside from providing vegetable protein and high amounts of minerals such as Fe, Zn and other micronutrients (Amarowicz & Pegg, 2008). The 'Pardina', 'Castellana' and 'Beluga' cultivars appear to provide the highest amounts of γ- and α-tocopherols in cooked lentils. This implies that selecting the cultivar and origin of legumes is important when attempting to increase the tocopherol content in our diet. The tocopherol content in our diet can be further enhanced by purchasing lentils in local markets and cooking them optimally. Additionally, cooked 'Pardina' lentils contained considerable amounts of the active vitamin E form (α-tocopherol) and a higher total tocopherol content (considering γ- and α-tocopherol) than food generally considered to be very rich in vitamin E, such as avocados (Vincent, Mesa, & Munne-Bosch, 2020) and pistachios (Wojdyło, Turkiewicz, Tkacz, Nowicka, & Bobak, 2022) (Fig. 3). Therefore, if the cultivar and cooking process is chosen carefully, legumes such as lentils can provide a very significant amount of dietary vitamin E intake (up to 25% of the recommended dietary allowance with only 100 g).

4. Conclusions

In conclusion, choosing appropriate varieties and freshly-cooking raw lentils (avoiding processed products) seem to be the best way to obtain a meaningful tocopherol intake from lentils. Indeed, a dish of lentils, particularly if using Pardina lentils and cooking them at home, can make a significant contribution to meeting our daily recommended intake of vitamin E. Additional dietary sources of tocopherol, especially those rich in α-tocopherol (e.g., sunflower seeds, green vegetables, and nuts), will still however be required, since lentils are particularly rich in γ-tocopherol.

CRediT authorship contribution statement

Laia Jené: Methodology, Software, Data curation, Investigation, Writing – original draft. **Sergi Munné-Bosch:** Conceptualization, Investigation, Validation, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

All the authors declare that they have no conflict of interest.

Data availability

Data will be made available on request.

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