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Research Article

Effect of Rosa Mosqueta Husk Extract (*Rosa rubiginosa*) on Thermooxidation of Grape Seed Oil

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There is a growing interest in lipid behavior with nutritional contribution. In this sense, it is necessary to determine the behavior of the grape seed oil during a thermooxidation process at 180°C. The induction period (OSI), together with the formation of polar compounds (CP) by HPSEC and the retention of alpha-tocopherol (AT) by HPLC, was the main parameter studied during this deterioration process. The behavior of 4 systems of oils, natural oil (a), refined oil (b), and refined oil with addition of rosa mosqueta husk extract (SGO + C) and alpha-tocopherol (SGO + AT), was compared. The results indicate that the system (a) shows a high retention of the AT content during heating. On the contrary, both systems (SGO + C and SGO + AT) presented a discrete but significant CP inhibition in relation to the values presented in purified grape seed oil (SGO). When comparing the thermooxidative behavior of the SGO + C and SGO + AT systems, it indicates better results for the first system, attributable to the combination of carotenes and AT present in C.

1. Introduction

Rosa mosqueta husks are a byproduct from the production of rosa mosqueta seed oil. Rosa mosqueta is a plant from the Rosaceae family, which has been classified as a minor fruit, native to Central Europe, Poland, Balkans, Hungary, Russia, and the Caucazo and has been presented as a potential source of protective compounds during heating of vegetable oils.

In Chile, the presence of three species has been found: *Rosa rubiginosa*, *Rosa moschata*, and *Rosa canina* [1]. The major use of the fruit of rosa mosqueta is the production of oil for cosmetic purposes, generating major byproducts the husk (mature, dehydrated, shredded, and seedless receptacle) and the ground (byproduct of the dehydration of the fruit and ground husk, with remains of seeds and dried pistils) [2]. The main bioactive constituents of the fruit of *Rosa canina* species in the descending order are the carotenoid pigments lycopene, β-carotene, and cryptoxanthin [3]. This is important nutritional information because some of the carotenoids are considered as precursors of vitamin A.

One of the reasons why the study of the effect of natural extracts on lipid matrices is being an important factor is because they improve nutritional and/or technological aspects for consumers and food industry. In the case of polyunsaturated fats, the protective effect is especially important since it has been shown that during the process of thermooxidation of vegetable oils, the degradation of polyunsaturated fatty acids occurs first because of their higher number of double bonds susceptible to suffer deterioration, subsequently the monounsaturated fatty acids and finally the saturated fatty acids [4].

Grape seed oil is a relatively new product in the market that comes from the vineyard industry. An important economic aspect of this product is based on its wide use in

the cosmetics industry due to its high content of polyunsaturated fatty acids (linoleic acid, 66–75%), wide range of tocols (α-tocopherol, 14–229 μg/g), and presence of other lipophilic constituents, such as vitamin E and phytosterols. On the contrary, grape seed oil also has hydrophilic constituents such as flavonoids, carotenoids, phenolic acids, tannins, and other compounds with nutritional interest [5]. Grape seed oil has been linked to beneficial health effects such as anti-inflammatory, cardioprotective, antimicrobial, and anticancer properties and may interact with cellular and molecular pathways [6]. Despite the various positive effects, the high content of polyunsaturated fatty acids makes it susceptible to oxidation as previously described. This oil has been recommended for human consumption without risk and especially for patients with atherosclerosis [7–9].

Among the different tocopherols present in vegetable oils, special emphasis has been given to the structure of alpha-tocopherol, which reaches its maximum activity at relatively low levels of concentration [10, 11]. It is known that the protective effect of tocols as alpha-tocopherols *in vitro* not only can depend on their chemical and absolute reactivities towards hydroperoxides and other free radicals but also can participate in parallel reactions with other chemical species; therefore, it is not clear if in the presence of carotenoid pigments, they could act as prooxidants or synergists [10]. In the oxidation of carotenoids, the most important individual factor is the presence of oxygen, so in the absence of air, carotenoids can tolerate relatively high temperatures. In addition, it is known that β-carotene in the presence of natural tocopherols present in vegetable oils acts synergistically in the prevention of fat oxidation [12–14].

According to the reviewed literature, scarce scientific evidence has been published regarding a deepening in the thermooxidative behavior of a polyunsaturated fat in the presence of a natural extract of rosa mosqueta residues.

The objective of this work was to evaluate the effect of rosa mosqueta husk extract on the thermooxidative deterioration process of a polyunsaturated vegetable oil, for which grape seed oil was used as a study matrix with and without extraction of its endogenous antioxidants.

2. Materials and Methods

2.1. Plant Material. Rosa mosqueta (*Rosa rubiginosa*) husk was provided by the company Triosa S.A. (Santiago, Chile), from which an extract (C) with hexane was obtained as an extraction solvent.

The natural oil of grape seed (GO) was prepared by cold pressing Chilean grape seeds (*Vitis vinifera*) provided by the wine company Viña San Pedro (Curico, Chile).

2.2. Preparation of Rosa Mosqueta Husk Extract (C). Extract C was obtained by presenting 13 kg of rosa mosqueta husk (*Rosa rubiginosa*) to extraction with hexane, followed by removal of the solvent by means of a rotary evaporator at 35°C and then being made up with hexane to a final volume of 2 L as mother solution. To determine the concentration of the compounds present in the extract, 1 ml of the solution was evaporated with nitrogen gas and diluted with 10 ml of HPLC-grade acetone, which was first filtered (in pore size filter 20 μm) and then injected in the HPLC equipment with the diode array detection (DAD) system.

2.3. Treatment of GO. The elimination of the content of endogenous tocols of GO was carried out by adsorption chromatography, using a glass column packed with activated aluminum oxide, according to the methodology proposed by Yoshida et al. [15]. In this way, a crude oil of purified grape seed oil (SGO) was obtained without the presence of its endogenous tocols, which was confirmed by HPLC analysis with a fluorescence detector (FD).

2.4. Preparation of Samples for the Thermooxidation Test. An amount of 200 ml of the stock solution was taken, which was concentrated to a final volume of 20 ml, which was subsequently dissolved in the purified grape seed oil. Hexane was removed from the oil by bubbling nitrogen gas. In this way, the systems prepared for the thermooxidation test were the following:

(a) Natural oil of grape seed (GO)

(b) Grape seed oil without its endogenous tocols (SGO)

(c) SGO (380 g) added with rosa mosqueta husk extract (SGO + C) with a concentration of 470 mg/kg of carotenes and 379 mg/kg of AT

(d) SGO with added 379 mg/kg of α-tocopherol (SGO + AT)

As a comparison in the thermooxidation process, systems "a" and "b" were used to know the thermooxidative behavior of grape seed oil with and without its protective components. The system "c" was used to determine the protective efficiency of extract C on the SGO. The system "d" was used to evaluate the protective action of alpha-tocopherol (AT) in SGO and compare it with the protective action of extract C. In the latter case, AT was added in a concentration similar to that quantified in extract C.

2.5. Thermooxidation Test and Sampling Period. A total of 10 g of systems a, b, c, and d was added to open glass tubes and heated to 180 + 1°C in the heating system of the Rancimat equipment (Metrohm Ltda, Herisau, Switzerland) for 12 hours. The samples were collected every 30 minutes during the first three hours and later at 8 and 12 hours to determine the concentration of tocols and the formation of polar compounds. Each sample was evaluated at least in triplicate. In addition, in each sample, fatty acid profile analysis was evaluated, oxidative stability according to induction period (IP) was determined by the Rancimat method, percentage of polar compounds (PC) was determined, and quantification of their species was done. In addition, variations in the content of AT and carotenes during the thermooxidation period were compared.

3. Chemical Analysis

3.1. Fatty Acid Composition. Fatty acids were determined in the oils by gas chromatography FID detection (Hewlett-Packard, Palo Alto, CA, USA), previous preparation of the fatty acid methyl ester derivatives. It used a capillary column BPX-70 (50 m length; 0.25 μm film thickness), and the carrier gas was hydrogen. The initial oven temperature was 160°C, and a temperature gradient from 180 to 230°C at 2°C·min^{-1} was applied. The sample size was 1 μL. Standard fatty acid methyl ester (FAME) was purchased from Merck (Merck, Darmstadt, Germany) [16]. The identification of the fatty acids was done by comparing their retention times with those of standard FAME.

3.2. Analysis of Tocopherols and Tocotrienols. The detection and quantification were performed by high-performance liquid chromatography (HPLC) with fluorescence detection, according to AOCS methodology [17]. We used a Supersphere Si LiChroCART 60 column (25 cm × 4 mm id, particle size 5 μm, Merck), and the mobile phase was propan-2-ol in hexane (0.5 : 99.5 v/v) at a flow rate of 1 ml/min. A pump was used for HPLC, with Rheodyne 7725i, an injector with a loop of 20 μm, a fluorescence spectrophotometer, and an integrator model D-2500. The peaks were detected at an excitation wavelength of 290 nm and an emission wavelength of 330 nm. The tocols were identified and externally quantified using tocopherol and tocotrienol standards acquired from Calbiochem.

3.3. Analysis of Carotenoid Pigments. The extraction of pigments from oils was carried out according to the method proposed by Henry et al. [18]. The analysis was determined by HPLC with a diode array detector (HPLC-DAD). The HPLC system consisted of a Merck-Hitachi L-6200 pump in addition to a Waters 996 DAD detector, coupled to a computer with the Millennium 32ss software, and a Waters symmetry column (C18, particle size of 5 lm, 4.6 mm id 25 cm; Waters, Milford, MA). The isocratic mobile phase was methanol : acetonitrile : ethyl acetate (20 : 65 : 15 v/v) at a flow rate of 1 ml/min. The carotenoids were detected at 450 nm.

3.4. Analysis of Polar Compounds. The quantification and distribution of polar compound species were determined by a combination of adsorption column chromatography and high-performance size exclusion chromatography (HPSEC) [19]. Specifically, samples of thermooxidized oils were added on a column of silica gel, followed by elution with an apolar fraction (mixture of petroleum ether and ethyl ether, 87/13) and another polar fraction (ethyl ether, 100%). The fraction of polar compounds is dissolved in tetrahydrofuran and analyzed by HPSEC. In the latter analysis, a Hitachi L-6200 Merck HPLC pump, a sample loop of 20 μl, a Merck RI-71 refractive index detector, and a Hitachi Merck D-2500 integrator were used. The separation was performed on two columns of 500 and 100 Å (PLGEL, 30 cm × 0.8 cm id, 5 μm; Hewlett-Packard) connected in series. The mobile phase was tetrahydrofuran with a flow rate of 1 ml/min.

3.5. Oxidative Stability. The induction period (PI) in minutes was determined using the Rancimat equipment at 100°C, according to the official AOCS method [17].

3.6. Statistical Analysis. The data of the different chemical analyses were subjected to the ANOVA method to explore the differences resulting from the effects of the presence of rosa mosqueta extract and the presence of AT on thermooxidation of the different samples of grape seed oil. The comparison of means was made using the least square difference (LSD) method. The differences between samples were considered significant for a confidence interval at the 95% level ($p < 0.05$) in all cases. These statistics were carried out using Statgraphics Plus, version 7.0 (Manugistics Inc., Statistical Graphic Corporation, Rockville, MD).

4. Results and Discussion

4.1. Lipid Composition. In Table 1, the composition of fatty acids and tocopherols in GO is shown, which is characterized for being highly polyunsaturated due to its high linoleic acid content (70.7%) and a lower monounsaturated content represented mainly by oleic acid (16.6%) and a low amount of saturates composed mainly of palmitic acid (6.8%) and stearic acid (3.9%). These results are consistent with the fatty acid profile of grape seed oils obtained by traditional extraction methods [7, 20, 21] and other sophisticated methods, as the extraction with supercritical CO_2 [22]. On the contrary, it was observed that the purification process of GO with activated aluminum oxide was managed to extract its endogenous tocols generating the SGO, which presented a minimum variation in the original fatty acid composition. The type of fatty acids of GO and SGO makes them very vulnerable to oxidation due to their high degree of polyunsaturation, which is reflected in the ratio of polyunsaturated fatty acids/saturated fatty acids (P/S) greater than 6 for both systems oils. The composition of tocols of GO was characterized by having high content of alpha-tocotrienol (AT3) and gamma-tocotrienol (GT3), with 336.8 and 397.5 mg/kg, respectively, and, at the same time, small amount of the alpha-tocopherol isomers (AT3) and gamma-tocopherol (GT3), with 60.1 and 26.1 mg/kg, respectively. On the contrary, it is seen in Table 1 that the treatment applied to GO to produce SGO achieved that the level of polar compounds decreased from 3.1 to 1.1%, attributable to a major preference and/or affinity of the stationary phase for the oil degradation compounds during the cleanup stage.

4.2. Composition of C. In Table 2, the composition of carotenoid pigments present in extract C is shown. HPLC analysis of the extract determined the presence of rubixanthin, β-carotene, and lycopene in the decreasing order, respectively, in addition to a high α-tocopherol content. Similar results in total carotenes and the distribution of the

Table 1: Fatty acids, tocols' composition, and CP of GO and SGO.

Fatty acid (methyl ester %)		GO	SGO
Myiristic	(C14 : 0)	Trace	Trace
Palmitic	(C16 : 0)	6.8 ± 0.0	6.7 ± 0.1
Palmitoleic	(C16 : 1)	0.1 ± 0.0	0.1 ± 0.0
Heptadecanoic	(C17 : 0)	0.1 ± 0.0	0.1 ± 0.0
Estearic	(C18 : 0)	3.9 ± 0.1	3.9 ± 0.1
Oleic	(C18 : 1w9)	16.6 ± 0.3	16.4 ± 0.4
Octadecaenoic	(C18 : 1w7)	0.8 ± 0.1	0.80 ± 0.2
Linoleic	(C18 : 2w6)	70.7 ± 0.1	71.0 ± 0.2
Octadecadienoic	(C18 : 2)	Trace	Trace
Linolenic	(C18 : 3w3)	0.4 ± 0.1	0.4 ± 0.0
Arachidonic	(C20 : 0)	0.2 ± 0.0	0.2 ± 0.0
Eicosenoic	(C20 : 1)	0.2 ± 0.0	0.2 + 0.01
Behenic	(C22 : 0)	Trace	Trace
Tetracosanoic	(C24 : 0)	Trace	Trace
Others	—	0.2 ± 0.0	0.1 ± 0.0
SAT	—	11.0	11.0
MUFAs	—	17.7	17.5
PUFAs	—	71.1	71.4
Tocols (mg/kg)			
AT	—	60.1 ± 0.1	N.D
AT3	—	336.8 ± 0.2	N.D
GT	—	26.1 ± 0.3	N.D
GT3	—	397.5 ± 1.2	N.D
Total	—	820.5	N.D
CP (%)			
TGD	—	1.7 ± 0.2	0.8 ± 0.1
oxTGM	—	0.9 ± 0.1	0.3 ± 0.0
TGP	—	0.5 ± 0.0	—
Total	—	3.1	1.1

SAT: saturated acid; MUFAs: monounsaturated acids; PUFAs: polyunsaturated acids; GO: grape seed oil; SGO: antioxidant-stripped grape seed oil; AT: alpha-tocopherol; CP: polar compounds %. TGD: triglyceride dimers; oxTGM: monomers of oxidized triglycerides; TGP: triglyceride polymers; ND: no determinate. The values are presented as an average of three determinations ± standard deviation.

Table 2: Concentration (mg/l) of carotenoid pigments and alpha-tocopherol determined in rosa mosqueta extract.

Component	(mg/L)
Rubixanthin	588.2 ± 15.7
Lycopene	104.1 ± 6.6
β-carotene	256.1 ± 13.2
α-tocopherol	720.1 ± 2.6

The values are presented as an average of three determinations ± standard deviation.

main carotenes have been published by other authors, both for the fruit and the rosa mosqueta husk [23, 24], confirming that this product as a good source of carotenoid pigments can be used as an antioxidant and a source of vitamin A, both in the food industry and in the cosmetics industry.

4.3. Study of Thermal Oxidation of Systems a, b, c, and d. In Table 3, the values of the oxidative stability index (OSI) obtained in the Rancimat equipment at 100°C, expressed as the induction period (PI 100°C) of the GO, SGO, SGO + C, and SGO + AT systems, are shown. However, although the values found in the thermooxidation test were relatively low for all the systems studied, there were significant differences ($p < 0.05$) for the PI results. Thus, the PI values had the following decreasing order GO > SGO + C > SGO + AT > SGO. The application of chromatography of adsorption to the GO system to form SGO, effectively produced a decrease in stability by 61% (PI = 3.2 h), was derived from the loss of the protective components to thermooxidation. This protection has also previously been well documented in other vegetable oils under conditions of thermal deterioration, where it has been demonstrated that the loss of tocopherols is very rapid in less unsaturated oils; in addition, it has been demonstrated that the deterioration of a fatty matter determined by the formation of polymer compounds and polar compounds is more dependent on the presence of its protective components than the degree of unsaturation [25, 26].

Table 3: Oxidative stability (100°C) of GO and SGO added with AT and C.

Aceite	PI (h)
GO	8.2 ± 0.1a
SGO	3.2 ± 0.6b
SGO + C	6.2 ± 0.2c
SGO + AT	4.2 + 0.2d

GO: grape seed oil; SGO: antioxidant-stripped grape seed oil; AT: alpha-tocopherol; C: rosa mosqueta extract; PI: period of induction. The values are presented as an average of three determinations ± standard deviation. Different letters for PI mean significant differences between samples ($p < 0.05$).

In SGO + C, an increase of the PI value was obtained in around 100% (from 3.2 to 6.2 h) with respect to SGO, approaching 75% of the stability of GO, which shows a protective action due to the components present in extract C (carotenoids and alpha-tocopherol quantified in this study) obtained from rosa mosqueta husk. This effect could be attributed to a protective and complementary action of AT and carotenoids present in C. Evidencing this behavior is important since the protective action of the carotenes has been studied mostly at low temperatures, in addition to the fact that there is a lack of information with respect to its relationship with oils of different degrees of unsaturation. Kim et al. [27] observed that the inhibition of the formation of conjugated dienes and consumption of oxygen obtained using extracts of red pepper carotenoid pigments (Korean pepper powder) on linoleic acid depends largely on the process of initial drying of the fruit of pepper, more than storage temperatures (0 and 20°C) [27]. On the contrary, Goulson and Warthesen observed that the addition of β-carotene improves the stability of mostly monounsaturated vegetable oils submitted to thermal deterioration conditions [12].

In the case of SGO + AT, it presented an increase in PI of 31% with respect to SGO. In spite of the fact that the improvement in the value of PI in relation to SGO was positive and significant ($p < 0.05$), as expected, it had a lesser effect than that produced by the addition of extract C in SGO, attributable to the complementary effect of the

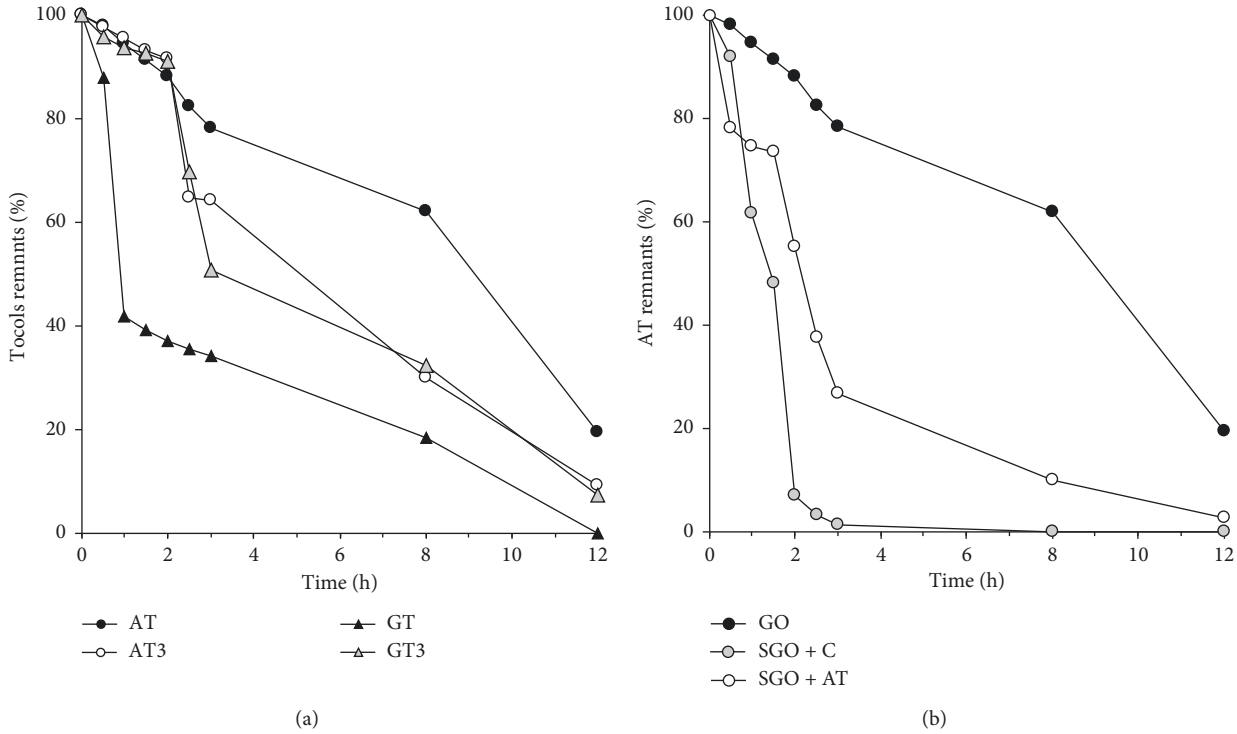

Figure 1: Remnant tocols (%) during the thermooxidation at 180°C of GO (a) and SGO (b) added with AT and C extract. GO: grape seed oil; SGO: antioxidant-stripped grape seed oil; AT: alpha-tocopherol; GT: gama-tocotrienol; C: rosa mosqueta extract.

component present in extract C [25]. However, it is clear that the addition of C and AT is not able to equalize the protective effect of the components of GO; this is because not only carotenes and tocols exert protective effects but also similar effects are attributed to compounds such as polyphenols, sterols, and among others, components naturally present in vegetable oils [28].

4.4. Stability of Endogenous Tocols in GO. In Figure 1(a), the percentage remanence of the endogenous tocols of GO is presented; α-tocopherol (AT), α-tocotrienol (AT3), γ-tocopherol (GT), and γ-tocotrienol (GT3) were heated for 12 h at 180°C. The results indicate that the total tocols of GO decay to 50% after 3 h of heating and then after 8 h decay to 30%. These results are agreeing with the loss of tocols observed in heating processes at 180°C of vegetable oils with a high content of mono- and polyunsaturated fatty acids [28]. In addition, it has been observed that tocopherols and tocotrienols degrade more rapidly in monounsaturated oils than in polyunsaturated oils, and also an antipolymerisation effect of tocopherols at high temperature depends on the degree of unsaturation affecting to a greater extent the less unsaturated substrate [25, 29]. In GO, individual tocols followed different resistance to degradation, AT > GT3 and AT3 > GT. GT was degraded early in a large proportion in relation to the rest of tocols, and after 1 h of heating, only 40% of its initial content remained. On the contrary, AT at 8 h of heating still remained above 60% of its initial concentration (60.1 mg/kg).

The tocotrienols AT3 and GT3 showed a similar behavior between them and an intermediate behavior between AT and GT. After 8 hours of heating, the residual content of both tocotrienols decreased to 30% with respect to the initial one (336.8 and 397.5 mg/kg, respectively). At 12 h of heating, only AT remained at 20% of its initial concentration.

4.5. Stability of AT in SGO. In Figure 1(b), the percentage retentivity of AT present in the GO, SGO + C, and SGO + AT systems is presented during the thermooxidative study. It was observed that the content of AT in the SGO + C system remained below GO and SGO + AT during most of the thermooxidative study, beginning with a strong decay (>90%) at 2 h of heating. The higher consumption of AT in the SGO + C system could be attributed to secondary reactions with the degradation products of carotenoid compounds or other undetermined components of extract C. On the contrary, the content of AT in the GO system is maintained throughout the process of thermooxidation still remaining with a percentage remanence around 20% at 12 h of heating. This behavior is evidently associated with the high content of total tocols (820 mg/kg) of GO, among other protective components present in unrefined vegetable oils mentioned above, which could act collaboratively in the deterioration process. The content of AT in the SGO + AT system is maintained lower than that in the GO system and superior to the SGO + C system between 2 h and 8 h of heating. The behavior is attributed to the higher concentration of TA in the SGO + AT sample. In this sense, it

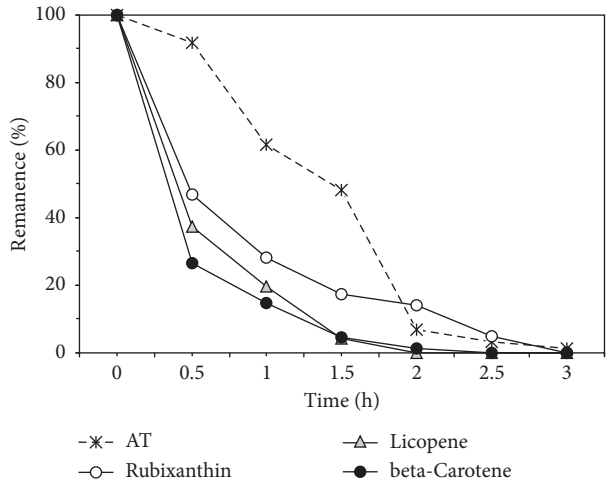

Figure 2: Remanence (%) of the components of rosa mosqueta extract added to SGO during thermooxidation at 180°C. SGO: antioxidant-stripped grape seed oil; AT; alpha-tocopherol.

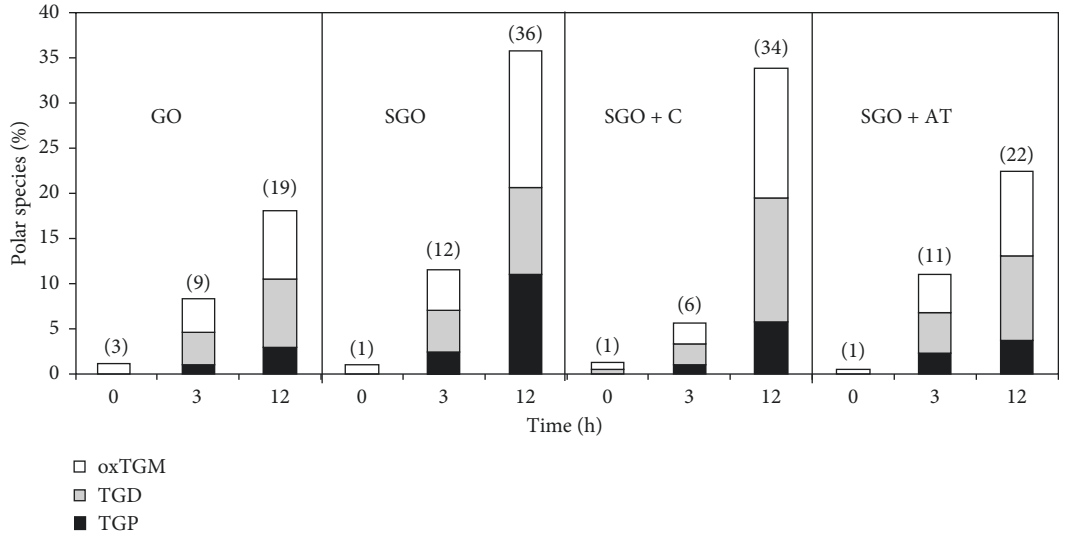

Figure 3: Evolution of polar species (%) during thermooxidation at 180°C of GO, SGO, and SGO added with AT and C extract. TGD: triglyceride dimers; oxTGM: monomers of oxidized triglycerides; TGP: triglyceride polymers; ( ): total polar compounds %; GO: grape seed oil; SGO: antioxidant-stripped grape seed oil; C: rosa mosqueta extract; AT: alpha-tocopherol.

has been documented that, in purified polyunsaturated marine oils, the AT action at low concentrations (100 ppm) is much higher than GT. However, this effect is reversed at high concentrations of AT (1000 ppm) [30].

In Figure 2, a similar behavior is observed between the curves of the different carotenoid pigments. After 1.5 h of heating, it can be seen that rubixanthin, β-carotene, and lycopene have a degradation rate higher than 80%. On the contrary, AT at the same time has a lower loss, around 50%.

Despite the strong decay of AT in the SGO + C system in conjunction with a large decrease in the different carotenoid pigments, compared to the SGO + AT system, the induction period (Table 3) is significantly longer in the SGO + Csystem. This phenomenon could be attributed to the collaborative action of bioactive species protective of oxidation present in the extract and not detected and quantified in this study, where some of these species could be polyphenols, sterols, terpenes, etc., from the plant tissue.

4.6. Evolution of Polar Compounds. Figure 3 shows the evolution of the polar compounds (CP) of the systems under study at 3 h and 12 h. It is appreciated that the SGO + C system shows a slow CP production at the beginning of the deterioration (3 h). On the contrary, although the SGO + AT system has an inhibition of production of initial polar compounds (3 h) lower than SGO + C, the final degradation is much lower (12 h). Coinciding with the discussed, in relation to the IP values, the SGO + C and SGO + AT systems achieve greater CP developments than the GO system at 12 h of heating and lower CP developments than the SGO system. This last

behavior clearly attributable to the elimination of protective components through the cleanup step with activated aluminum oxide. These results indicate that both the components present in the extract C, as well as in AT, produced in SGO a moderate protective effect to the thermooxidation. However, it is less significant to the effect produced by the presence of natural protective components present in GO.

As a comparison of the thermooxidative behavior of each system studied with the protective components, linear adjustments were made in the GO, SGO + AT, and SGO + C systems.

The correlations of linear adjustment were between the content of α-tocopherol (%) versus TPC content (%) from the beginning of the heating up to a period of 12 h. It is clear that as the presence (%) of AT decreases in the different systems studied, the amount of TPC increases, reflected by the negative value of the slope of the obtained equations (GO, $y = -0.19x + 23.16$, $r^2 = 0.99$; SGO + AT, $y = -0.20x + 19.84$, $r^2 = 0.89$; SGO + C, $y = -0.19x + 20.25$, $r^2 = 0.39$). According to the correlations obtained, it is shown that the strongest correlation is obtained for the GO system and then the SGO + AT system and finally SGO + C, with values for the coefficient of determination (r^2) of 0.99, 0.89, and 0.39, respectively.

5. Conclusions

The application of a cleanup step with aluminum oxide directly affects the protection of polyunsaturated oils against thermooxidation processes. The extraction with solvents can be a useful tool for the extraction of extracts rich in carotenoids and α-tocopherol in waste vegetable products.

In this study, it has been proven that the use of extracts of rosa mosqueta rich in carotenoid pigments and α-tocopherols can exert a significant protective effect of thermooxidation of a polyunsaturated vegetable matrix, whereas in this case, grape seed oil lacks its tocols. Therefore, this extract could be used in the stabilization and/or development of healthy foods, ingredients, and nutraceuticals rich in essential fatty acids.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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