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BLENDING OF ROASTED AND UNROASTED SESAME SEEDS OILS WITH SUNFLOWER AND OLIVE OILS FOR IMPROVING THEIR ANTIOXIDATION POTENCY

Hassanein, Minar M. M.
National Research Centre, Fats and Oils Dept., Dokki, Cairo, Egypt

ABSTRACT

Oils extracted from sesame seeds (roasted and unroasted), sunflower seeds as well as virgin olive oil (cold press) were evaluated for their oil contents, unsaponifiable percentage, iodine and saponifiction values. GLC analysis of fatty acids composition and sterols components were evaluated. In addition, lignans and tocopherols were identified by TLC. The extracted oils from roasted and unroasted sesame seeds were characterized by higher percentages of unsaponifiables (1.9 and 1.6% respectively) compared to sunflower oil (0.3%).Total sterols of roasted and unroasted sesame seeds (450.0 and 440.0 mg/100g of oil) were higher than sunflower and olive oils (370.0 and 260.0 mg/100g of oil respectively). Oils extracted from sesame seeds (roasted at 180ºC for 30 min) and unroasted seeds were blended with sunflower and olive oils at two levels (5 and 10 %) for raising the antioxidation potency of these oil blends. The mixed oils were subjected to accelerated oxidation through heating in electric oven at 63ºC for different periods (2, 4, 6, 8, 10, 12 and 14 days). Peroxide values (PV, primary oxidation products) were followed during course of heating. From plotted curves (PV versus time) the induction period (IP) was calculated by determining the break point of the plotted curves (intersection point of the extraplotted parts of the curve). It was found that sesame oil contained powerful antioxidants (lignans), as determined by TLC, and when mixed with individual sunflower and olive oils generally, the antioxidative stability of oil mixtures was increased. Generally, the oil extracted from roasted sesame seeds was considered much more antioxidative than unroasted sesame seeds.

Keywords: Roasted and unroasted sesame seeds, lignans, tocopherol, induction period, synergism, natural antioxidants.

E-mail minarmahmoud@yahoo.com

INTRODUCTION

The use of natural antioxidants in food is recently receiving special attention of the world-wide trend to avoid or minimize the use of synthetic food additives. Sesame is one of the world's important oil seed crops. Not only is it a source of edible oil, the seed itself provides a nutritious food for humans. Nowadays consumers are more demanding and conscious about their rights and the benefits of food nutrients should provide to human health. One excellent characteristic of sesame oil is its resistance to oxidative deterioration. Its remarkable stability has been suggested to be due to the presence of the endogenous antioxidants, sesaminol and sesamol together with tocopherol (Kamal-ELdin and Appelqvist, 1994a and Hemalatha and Ghafoorunissa, 2004). Sesaminol {2- (3, 4-methylenedioxy-6-hydroxy phenyl)-6)3, 4-methylenedoioxy phenyl)-cis-3, 7-dioxabicyclo-[3, 3, 0] octane} is produced from sesamolin, a minor component of sesame oil, by intermolecular transformation during the industrial bleaching process of

unroasted sesame oil. Sesamol (3, 4-methylene-dioxy phenol) is a potent phenolic antioxidant and is present in crude sesame oil in small amounts and also is liberated from sesamolin during acid clay bleaching, hydrogenation and the frying process (Kamal-ELdin and Appelqvist, 1994b. Tashiro *et al.,* 1990 and Fukuda *et al.,* 1986 a, b). Thus sesamolin, although not having any antioxidant properties it itself, is a precursor to these two phenolics antioxidants. In contrast, sesamin{2,6-bis-(3,4-methylenedioxy phenyl)-cis-3,7-dioxabicyclo-[3,3,0]octane}, another minor component of sesame oil, gives an epi-sesamine during the bleaching process, and it also has been reported to enhance the activities of pyrethrin insecticides synergistically (Tashiro *et al.,*1990).Structurally, it is a lignan, similar to sesamolin, but it does not have any potential as an antioxidant or antioxidant precursor. It is known that sesame is an ancient oilseed crop whose seeds contain 22-25% protein and 42-54% oil with superior oxidative stability compared with several other vegetable oils, both at storage temperature and during frying (Yoshida *et al.,* 2007). Sesame oil is not only a good source of edible oil, but it is also widely used in baked foods and confectionery products (Suja *et al.*, 2005). It is also considered as a food beneficial to health in oriental countries (Yoshida *et al.,* 2007). The fatty acids of sesame oil are palmitic (7-12%), stearic (3.5-6%), oleic (35-50%) and linoleic (35-50%) (Kamal-ELdin and Appelqvist, 1994b). Crude sesame oils extracted from natural seeds contain ca.45-68 mg% total tocopherols which are mainly (95-99.5%) gamma-tocopherol and the remaining is alpha- and delta isomers (Kamal-ELdin and Appelqvist, 1994b, Hemalatha and Ghafoorunissa, 2004 and Kamal-ELdin and Appelqvist, 1995). The oil is characterized by its content of a number of compounds from furofuran family, mainly sesamin and sesamolin. Sesamol and four other antioxidants are also present in sesame seeds on small amounts (Kikugawa *et al.,* 1983). Many scientific works have been undertaken to investigate the health-promoting effects of sesame (Kamal-ELdin and Appelqvist, 1995). Lignans and lignan glycosides present in sesame appear to be important functional components (Shyu and Hwang, 2002 and Ide *et al.,* 2003). The main sesame lignans are sesamin and sesamolin, which are found in sesame oil, but they possess no antioxidative activity ((Kamal-ELdin and Appelqvist, 1994a). Yoshida H. (2006) compared the quality characteristics of sesame oils (prepared from sesame seed roasted at 120-250ºC using a home electric oven) with an unroasted oil sample. It was found that only minor increases ($p<0.05$) in characteristics, such as acid value, peroxide value, anisidine value and thiobarbituric acid value, of sesame oils occurred in relation to increasing roasting temperature between 120-180ºC. When the roasting temperature was over 220ºC, fatty acid (FA) content of the oil was reduced; reflecting an increase in glycolipid content and triglyceride oxidation/polymerization but FA composition was unchanged. Fukuda *et al.,* (1986b) reported that the oil extracted from roasted sesame seeds at 180-200ºC was considered much more antioxidative than unroasted purified sesame oil.

This study aimed to the preparation of more-stable vegetable oils with a wide range of desired fatty acids composition by blending different

proportions (5 and 10% at 63ºC) of sesame seed oil (roasted and unroasted) with sunflower and olive oils. Stability tests, based on PV were done at 63 ºC to avoid the difficulties of high-temperature stability tests.

MATERIALS AND METHODS

Material

The main materials in this study were fresh seeds of sesame seed (*Sesamum indicum linn.*), sunflower (*Helianthus annuus*) and olive oil. Two oil seeds, namely, sesame and sunflower were purchased from Oil Seed Crop Department, Ministry of Agriculture, Giza (season 2009), while olive oil (cold press) was purchased from Siwa Oasis (Jet Master).Authentic samples: standard fatty acids methyl esters(C16-C24 saturated and unsaturated); standard tocopherols(α-,β-,γ-and δ-tocopherols) and sterols (campe, stigma, β-sito, isofuco,7-stigma,5,7 avena sterols) were purchased from Sigma Com.

Methods

Samples of sesame seeds were roasted at 180ºC for 30 min in an electric oven. Oil seed samples of roasted and unroasted sesame and sunflower (500g each) were ground and soaked in chloroform-methanol (2:1 v/v) with intermittent stirring to extract the oil and the extraction process was repeated two times. The combined extracts of each sample were collected, filtered, dried over anhydrous sodium sulphate and then evaporated under reduced pressure at 50ºC in a rotary evaporator . The samples were kept in stoppered dark glass vials in the refrigerator till used.

Oil content

The oil content of sesame and sunflower seeds was determined on dry basis according to Official and Tentative Methods of the AOCS (1980).

Iodine value

The unsaturation characters of the oils were measured by the iodine value (IV) determination according to the micro-method of Kaufmann (1958).

Saponification value

The saponification value (SV) was determined according to Official and Tentative Methods of the AOCS (1980).

Peroxide value

The Peroxide value (PV) was determined according to Official and Tentative Methods of the AOCS (1980).

Fatty acids pattern

The oil was converted into methyl esters via transesterification with 5 % hydrogen chloride gas in methanol (Chrestie, 1973). Transesterification reaction was monitored with the help of TLC using silica gel G plates and n-hexane : diethyl ether : acetic acid mixture (80 :20 :1,v/v/v) was used as a developing solvent Hewlett Packard-HP 5980-A gas chromatograph was employed for the analysis of the mixed methyl esters under the following operating conditions: column, DB-23 (0.32 mm x 30m);temperature

programming, 150-230ºC, 3ºC/min; injector, 230ºC; detector, FID at 240ºC; carrier gas, helium at flow rate of 1.3 ml/min and split ratio, 100:1.Calibration was made using standard fatty acid methyl esters and the results were recorded by an electronic integrator as peak area percent with the help of standard fatty acids.

Unsaponifiable fraction:

a- Identification of tocopherols, sterols and lignans by TLC

The unsaponifiable matter of each oil sample was previously prepared according to AOCS (1980). The unsaponifiable fractions were fractionated by preparative TLC. Two successive solvents mixtures, hexane/ diethyl ether/ acetic acid (80/20/1 and 70/30/1, v/v/v) were used as developing solvent systems. Standard tocopherol and sterol were also applied on the plates to help identifying the components and localize the lignans components. The spots were visualized with iodine vapor.

b- Whole sterols

Whole sterols were isolated from the prepared unsaponifiable fraction (AOCS ,1980) by preparative TLC on silica gel G plates (0.5 mm thickness) using chloroform/ diethyl ether/ acetic acid (95/4/1 by volume) as developing solvent. The sterol zone was located with the help of standard beta-sitosterol (R_f 0.16) applied alongside the sample prior to development .The sterol zone was scraped off the plate, thoroughly extracted with moistened diethyl ether. The solvent was distilled off and the isolated sterols were converted into trimethylsilyl derivatives (TMS) [E. Udo 1991] .Hewlett Packard-HP 5890-A gas chromatograph, was employed for analysis using the following operating conditions: column, DB-17 (0.32mmx 15m, 0.25µm coating) at 250ºC; detector, FID at 260ºC; carrier gas, helium (8.6ml/min) and split ratio, 35:1. An automatic integrator was coupled directly to the detector. TMS sterols mixture of standard (containing known percentages of sterols) was used for identification and quantification of the sterols in each oil sample. The area under each peak was measured by the automatic integrator.

Oven Accelerated Oxidation Test (PV)

The oil samples (individuals and mixtures) were placed in 12 pettri-dishes (15 cm diameter) as follows: 1-four pettri-dishes for original oils (two sesame seed oil roasted and unroasted, olive and sunflower oils).2- four pettri-dishes for sunflower oil with 5% roasted sesame seed oil, sunflower oil with 10 % roasted sesame seed oil, sunflower oil with 5% unroasted sesame seed oil and sunflower oil with 10% unroasted sesame seed oil. 3-four pettri-dishes for olive oil with 5% roasted sesame seed oil, olive oil with 10% roasted sesame seed oil, olive oil with 5% unroasted sesame seed oil and olive oil with 10% unroasted sesame seed oil. All the oil samples (12 pettri-dishes) were heated in an electric oven at 63ºC for 2, 4, 6, 8, 10, 12 and 14 days.

Induction period (IP) of oils mixed with sesame oil

The PV was followed by the plotted curves (PV against time) and the IP of the samples corresponding to the breakpoint of the plotted curve (intersection point of the extrapolated parts of the curve) was determined.

The IP expresses the time at which the primary oxidation (beginning of peroxide formation) of the samples has begun.

Statistical analysis

All experimental data are expressed as mean ± S.D. Significant differences among the groups were determined by one-way analysis of variance (ANOVA) using the SPSS statistical analysis program. Statistical significance was considered at $p \leq 0.05$. Statistical analysis of data was carried out according to Baily (1994).

RESULTS AND DISCUSSION

Chemical characteristics

Chemical characteristics of oils of roasted and unroasted sesame seeds as well as sunflower and olive oils are recorded in table 1. The saponification values (SV) of all oils were nearly similar. Concerning the iodine value (IV), representing the unsaturation character of an oil, it was found that olive oil had lower IV compared with other oils. Sunflower oil had IV higher than the two sesame oils (roasted and unroasted). In addition, the oil contents of the oils were 52.0, 42.0 and 33.6% for roasted, unroasted sesame and sunflower seeds respectively. It is worthy to mention that Hwang (2005) reported that sesame oil has IV and SV amounting to 104-120 and 186-195 respectively.

Table (1): Chemical properties of RSO, URSO, sunflower and olive oils

Oil Samples	Saponification value mg KOH/g oil	Iodine Value g of Iodine/100 g oil
RSO	189.30c ±0.185	111.08b ±0.202
URSO	190.63b ±0.177	108.83c ±0.229
Sunflower	166.08d ±0.239	127.83a ±0.284
Olive	193.35a ±0.242	86.48d ±0.124
LSD at α 0.01	0.916	0.939

Roasted sesame seed oil (RSO), unroasted sesame seed oil (URSO)

Fatty acid profiles

The fatty acid profiles (as methyl ester) of the four oil samples were determined by GLC and ANOVA for C 16:0, 18:0and 18:1 was recorded in Tables 2 and 3 respectively. Oleic acid (18:1) of RSO amounted 40.83%, while in URSO reached 43.55%, whereas in sunflower seed oil and olive oil oleic acid amounted to 33.35 and 72.33% respectively. In RSO and URSO, linoleic acid content was 45.85% and 43.7% respectively. It is worthy to

mention that the amount of oleic acid in URSO was nearly equal to that of linoleic acid. On the other side, sunflower and olive oils contained linoleic acid at a level of 54.60 and 12.53% respectively. Olive oil contained linolenic acid beside oleic and linoleic acids (0.26). Olive oil, contained higher amounts of oleic acid (72.33%). It is worthy to mention that the oil with the high oleic acid content will not oxidize rapidly than the oil with the high linoleic and linoleinc acids contents.

Table (2): Fatty acid profile of RSO, URSO, sunflower and olive oils

Oil Samples	Fatty acid composition %							
	16:0	**16:1**	**18:0**	**18:1**	**18:2**	**18:3**	**20:0**	**20:1**
RSO	8.95c ±0.171	1.38e ±0.175	4.85d ±0.144	40.83b ±0.149	45.85a ±0.144	--------	----	----
URSO	8.33b ±0.149	2.38d ±0.149	3.73c ±0.085	43.55a ±0.145	43.70a ±0.187	------	-----	-----
Sunflower	6.33c ±0.138	---	6.58c ±0.165	33.35b ±0.132	54.60a ±0.091	-----	0.16d ±0.024	0.36d ±0.023
Olive	12.15b ±0.176	0.38d ±0.034	3.43c ±0.155	72.33a ±o.125	12.53b ±o.125	0.26d ±o.125	0.40d ±0.41	0.27d ±0.023

Table (3): ANOVA for C 16:0, C 18:0, C 18:1 and C 18:2 in RSO, URSO, sunflower and olive oils

Oil Samples	Fatty acid composition				
	16:0	**18:0**	**18:1**	**18:2**	**Main effect of oils**
RSO	8.95 h ±0.176	4.85k ±0.14	40.83e ±0.15	45.85c ±0.14	25.12a ±0.275
URSO	8.33i ±0.15	3.73L ±0.09	43.55d ±0.14	43.70d ±0.19	24.83b ±4.87
Sunflower	6.33j ±0.14	6.58j ±0.17	33.35f ±0.13	54.60b ±0.09	25.21a ±5.22
Olive	12.15g ±0.18	3.43L ±0.15	72.33a ±0.12	12.53g ±0.13	25.11a ±7.1
Main effect of fatty acid	8.94c ±0.55	4.64d ±0.33	47.51a ±3.82	39.17b ±4.11	-

Roasted sesame seed oil (RSO), unroasted sesame seed oil (URSO)

Unsaponifiable fraction

a-Tocopherols and lignans

The unsaponifiable fraction of the oils as g / 100 g of oil were 1.9, 1.6, 0.3 and 1.8 % for RSO, URSO, sunflower and olive oils respectively. Published data of the unsaponifiable fraction of sesame seed oil (Kamal-ELdin *et al.,* 1991) revealed the presence of desmethylsterol, sesamin, sesamolin and gamma-tocopherol at R_f values of o.38, o.57, o.61 and 0.74 respectively. In comparison with these reported data, it was found that corresponding R_f values of sesame seed oil unsaponifiable fraction examined in this work were 0.37, 0.50, 0.60 and 0.63. Accordingly, it can be say that sesame oil contains more potent antioxidants such as sesamin, sesamolin and gamma-tocopherol.

b-Whole sterols

From the results of GLC analysis recorded in Table 4, it was noticed that β-sitosterol was predominating in RSO and URSO, sunflower and olive oils and constitutes 66.0, 61.8, 68.0 and 72.0% respectively, however 5-avenasterol appeared in reasonable amounts in both RSO and URSO. Concerning some minor constituents, namely, 7-stigma and 7-avenasterols constituted 3.0 and 0.5% in RSO and 3.1 and 1.0% in URSO. While in sunflower and olive oils, these two sterols amounted to 0.4, 0.0, 1.0 and 1.0 respectively. The contents of total sterols isolated by TLC from the unsaponifiable fractions calculated as mg/100g of oil were 450.0, 440.0, 470.0, and 260.0 respectively.

Table 4: GLC analysis of whole sterols pattern, as silyl derivatives, of the sesame seed oils in comparison with sunflower and olive oils

Oil Samples	Content mg/100g of oil	GLC of sterol components as wt (%)					
		Campe sterol	Δ^5- stigma sterol	β-sito sterol	Δ^5-avena sterol	Δ^7-stigma sterol	Δ^7-avena sterol
RSO	450.0L ±1.52	13.2k ±0.21	7.0a ±1.6	66.0b ±0.2	10.3c ±0.15	3.0c ±0.11	0.5j ±0.01
URSO	440.0k ±1.5	17.1b ±0.26	6.0d ±0.15	61.8d ±0.1	11.0a ±0.15	3.1k ±0.12	1.0c ±0.02
sunflower	370.0c ±1.0	16.5c ±0.20	11.5h ±0.11	68.0k ±0.2	3.6j ±0.1	0.4k ±0.15	0.0
olive	260.0c ±2.5	11.5a ±0.3	12.5d ±3.2	72.0j ±0.15	2.0c ±0.15	1.0b ±0.01	1.0d ±0.02

According to data in Table 5, there is no significant ($p<0.05$) concerning with the effect of oil samples treatments.

Table (5): ANOVA for campe-, 5-stigma-, and betasito-sterols in RSO, URSO, sunflower and olive oils

Oil Samples	sterol composition			
	Campe-sterol	Δ^5-stigma-sterol	β-sitosterol	Main effect of oils
RSO	13.2k ±0.21	7.0a ±1.6	66.0b ±0.2	28.73c ±0.67
URSO	17.1b ±0.26	6.0d ±0.15	61.8d ±0.1	28.3c ±0.17
Sunflower	16.5c ±0.20	11.5h ±0.11	68.0k ±0.2	32.0a ±0.17
Olive	11.5a ±0.3	12.5d ±3.2	72.0j ±0.15	32.0a ±0.12
Main effect of sterol	14.57c ±0.24	9.25d ±1.27	66.95a ±0.16	

Roasted sesame seed oil (RSO), unroasted sesame seed oil (URSO)

Oxidative stability of oils

The PV of the four oils was determined for 14 day (2, 4, 6, 8, 10, 12, and 14) at 63 ºC (Fig 1) referred that the oils showed rise of PV (induction period) at different periods. In sunflower the sudden rise of PV was at 6 days

of heating and reached 52.0, while in olive oil PV reached 30.0 at 8 days heating. In the two sesame oil samples (RSO and URSO) the slight rise of PV started at a level of 15.0 and 20.0 after 10 days. It can be stated that the PV of sesame oil after 10 days heating did not increase markedly at 12 and 14 days as is the case with sunflower oil. It can be noticed that two sesame oils samples, unlike other oils, exhibited higher oxidative stability. These can be attributed to the fact that sesame oil contained unique lignans and tocopherol antioxidants that acquired high stability oxidative than other oils.

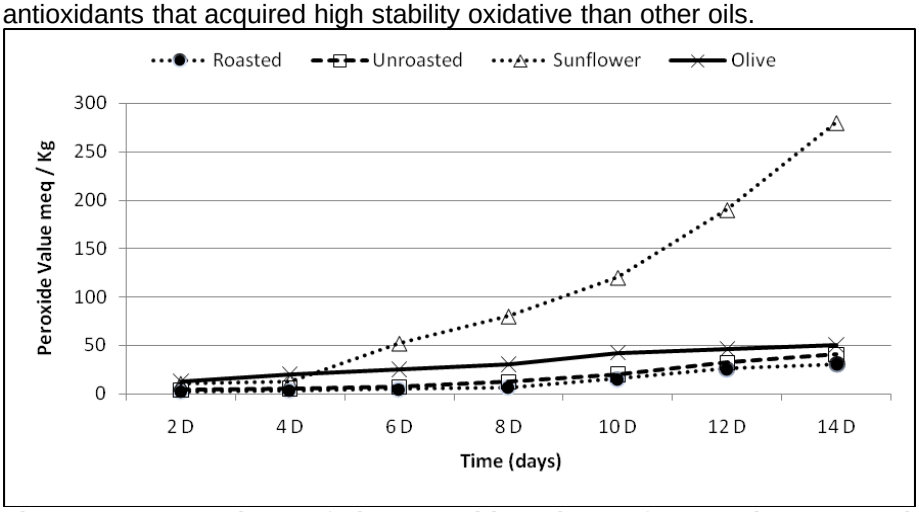

Figure 1: Comparison of the peroxide values of roasted, unroasted, sesame seed, seed, sunflower and olive oils

Mixing of sesame oil with sunflower gives the blend more oxidative stability than the sunflower control (no addition). Sunflower oil alone at 2 days heating gave PV of 10.5 while addition of 5 and 10% of RSO decreased the PV to 6.5 and 5.0 respectively. This indicates that blending of sunflower oil with sesame oil improved the oxidative stability (Fig 2a).Concerning blending of sunflower oil with URSO in two levels 5 and 10% (Fig 2b), the PV decreased from 10.5 (for control) to 8.5 and 7.0 respectively after 2 days heating.. This shows that the URSO was little efficient in decreasing the PV than the RSO. This can be due to the fact that the oil extracted from RSO was considered much more antioxidative than URSO (purified sesame oil) (Fukuda *et al.,* 1986b). It is noteworthy to mention that the IP of sunflower alone (control) was found to be 6 days and by mixing it with 5 and 10% RSO the IP was improved to 4 days while , mixing sunflower with 5 and 10% URSO, the IP was 6 days.

Figure 3 (a,b), show that the PV of olive oil (cold press) without addition (control) increased from 12.5 after 2 days heating to 20.0, 25.0, 30.0, 42.0, 45.0 and 50.0 after 4,6,8,10,12,and 14 day at 63ºC respectively. Concerning the PV of olive oil blended with 5 and 10% RSO, it was found that, it increased from 10.0 after 2 days to 12.0, 13.8, 16.0, 22.5, 28.0 and 32.0 for 5% and to 8.5 for 2 day to 10.0, 10.5, 14.0, 20.0, 22.0 and 25.0 for

10%. It can be concluded that the breakpoint (IP) of the extrapolated parts of the curve was 8 and 10 days for both 5 and 10 % RSO incorporated in olive oil. However, olive oil alone exhibited the breakpoint (IP) was shown at 8 days indicating that the RSO have antioxidative effect on olive oil. It is known that both olive and RSO showed higher antioxidation potency, however sesame oil is superior to olive with respect to the presence of lignans as well as gamma-tocopherol in sesame seed oil. Referring to the incorporation of URSO at two concentrations (5and 10%), it was found that olive oil alone gives IP of 8 days, however the olive oil incorporation with URSO gave similarly IP of 8 days. It can be concluded that the URSO as well as olive oil are equally efficient in maintain the stability to 8 days.

(a) (b)

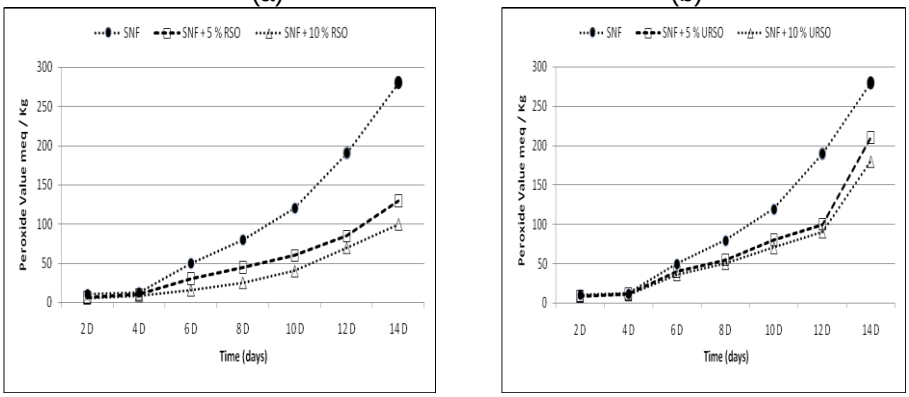

Figure 2: Comparison of the peroxide values of pure sunflower seed oil and of that mixed with5 and 10 % (a) roasted and (b) unroasted sesame seed oils

(a) (b)

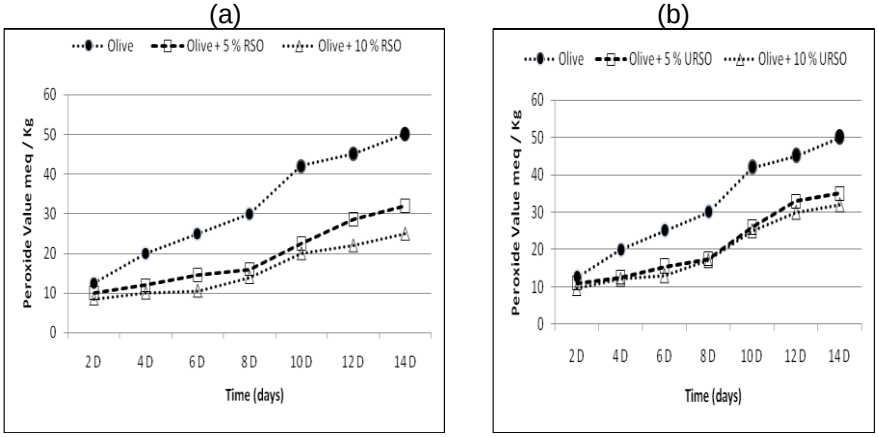

Figure 3: Comparison of the peroxide values of pure olive oil and of that mixed with5 and 10 % (a) roasted and (b) unroasted sesame seed oils

Conclusion

It can be generally concluded that:

1-This study may serve as a milestone towards the development of newer blended oils with improved stability characteristics.

2-Oil blends containing sesame oil could meet nutritional needs with improved stability for domestic cooking purposes.

3-A combination of a number of minor constituents such as tocopherols, sesamol and sterols in the sesame seed oils could have a synergistic role in increasing the antioxidation potency. Synergists generally provide a reservoir of hydrogen to regenerate the antioxidant is untenable since it has been shown that in the presence of phenolic antioxidants synergists are spared (Privette 1961).

4-Mixing different proportions of RSO and URSO with sunflower and olive oils consider a simple method to prepare more stable edible oils with a wide range of desired fatty acid composition.

5-Generally, it was found that sesame seed oil containing powerful antioxidant (lignans and tocopherols) increased the antioxidation potency of sunflower and olive oils via synergism and accordingly increased the stability of mixtures. Thus, sesame oil alone is considered as the best of stable oils.

6-Blending of RSO and URSO with sunflower and olive oils increase the antioxidant potential of these oils and therefore, one can say that blending of vegetable oils with sesame oil may be more effective than the addition of synthetic antioxidants.

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REFERENCES

A. O C. S. (1980). The Official and Tentative Methods of the American Oil Chemist's Society. 3 rd Ed. Published by American Oil Chemist's Society. USA.

Chresti, W.W. (1973).''Lipid Analysis'' Pergamon Press, Oxoford, p 89.

E Udo: Fats and Oils: The Complete Guide to Fats and Oils in Health and Nutrition, (Vancouver BC, Canada) Alive Books. 1991.

Baily N. T. (1994). Statistical methods in biology, 3rd ed., Cambridge University press, London.

Fukuda, Y.; Nagata, M.; Osawa, T. and Namiki, M. (1986a).''Contribution of lignin analogues to antioxidative activity of refined unroasted sesame seed oil.'' J. Am. Oil Chem. Soc., 63: 1027-1031.

Fukuda,Y.; Nagata, M.; Osawa, T. and Namiki, M. (1986b).''Chemical aspects of the antioxidative activity of roasted sesame seed oil and the effect of using the oil for frying. 'Agric. Biol. Chem. 50: 857-862.

Hemalatha, S. and Ghafoorunissa (2004).''Lignans and tocopherols in Indian sesame cultivars.''J. Am. Oil Chem. Soc., 81 (5), 467-470.

Hwang, L. S. (2005)."Edible oil and fat products: Edible oil (Sesame oil), Volume 2. In: Bailey`s Industrial Oil and Fat Products. Sixth Edition, Edited by Shahidi, F. John Wiley & Sons, Inc. New York.

Ide,T.; Kushiro, M. ;Takahashi, Y. ; Shinoohara, K. ;Fukuda, N. and Sirato-yasumoto, S. (2003)''Sesamin, a sesame lignin , as a potent erum lipid-lowering food component.'' JARQ Jpn. Agric Rss. Q 37: 151-158.

Kamal-ELdin, A. and Appelqvist, L. A. (1994a).''Variation in fatty acid composition of the different acyl lipids in seed oils from four sesamum species.'' J. Am.Oil Chem. Soc., 71 : 135-139.

Kamal-ELdin, A. and Appelqvist, L. A. (1994b).''Variation in the composition of sterols, tocopherols and lignans in seed oils from four sesamum spedies.'' J. Am.Oil Chem. Soc., 71(2), 149-156.

Kamal-ELdin, A. and Appelqvist, L. A.(1995).''The effects of extraction methods on sesame oil stability.'' J. Am. Oil Chem. Soc., 72 (8), 967-969.

Kamal-ELdin, A. , Yousif, G.and Appelqvist, L. A.(1991)."Thin layer chromatographic separations or seed oil unsaponifiables from four sesamum species." J. Am.Oil Chem. Soc., 68(11), 844-847.

Kikugawa, K.; Arai, M. and Kurechi, T. (1983).''Participation of sesamol in stability of sesame oil.'' J. Am.Oil Chem. Soc., 60: 1528-1533.

Kaufmann, H. P. (1958).''Analyse der fette und fetteprodukte.''571 Springer Verlag-Berlin.

Shyu, Y. S. and Hwang, L. S.(2002).''Antioxidative activity of the crude extract of lignin glucosides from unroasted Burma black sesame meal.''Food Res Inter 35:357-365.

Suja, K. P; Jayalekshmy, A. and Arumughan,C. (2005)''Antioxidant activity of sesame cake extract.''Food Chem 91:213-219.

Privette, O. S. (1961) ' Some observations on the course and mechanism of autoxidation and antioxidant action. In proceeding Flavor Chemistry Symposium-1961, Campbell Soup Company.pp147-163.

Tashiro,T.; Fukuda, Y.; Osawa, T. and Namiki, M. (1990)''Oil and minor components of sesame (sesamum indicum L.) strains.'' J. Am.Oil Chem. Soc., 67(8), 508-511.

Yoshida, H. (2006) 'Composition and quality characteristics of sesame seed (sesamum indicum) oil roasted at different temperature in an electric oven.'' J. Am.Oil Chem. Soc., 65(3), 967-969331-336.

Yoshida, H.;Tanaka, M.;Tomiyama, Y. and Mizushina, Y. (2007)''Antioxidant distributions and triacylglycerol molecular species of sesame seeds (sesamum indicum). J. Am.Oil Chem. Soc., 84:165-172.

مزج الزيوت المستخلصة من بذور السمسم (المحمص وغير المحمص) بزيوت كل من دوار الشمش والزيتون لرفع كفاءة مضادات الاكسدة لهذة الزيوت فى مخاليطها

مينار محمود محمد حسنين
المركز القومى للبحوث- قسم الزيوت والدهون- الدقى- القاهرة –مصر

اجريت هذة الدراسة على الزيوت المستخلصة من بذور السمسم المحمص وغير المحمص والتى تم خلطها مع زيت كل من دوار الشمس والزيتون بنسب ٥ و ١٠% لرفع كفاءة مضادات الاكسدة وثبات هذه الزيوت٠ وان و قد تم تسخين هذه المخاليط فى فرن كهربائى عند درجة حرارة ٦٣ ° م لمدة ١٤ يوم وقد تم دراسة التغير فى خواصها من حيث الرقم البيروكسيدى (PV) وبداية التاكسد (IP) اثناء فترات التسخين المختلفة لمدد كالتالى ٢ و ٤و ٦و ٨و ١٠و ١٢و ١٤ يوما وعند درجة حرارة٦٣ ° م٠ وقد امكن تحديد بداية التاكسد من منحنيات الرقم البيروكسيدى مع الوقت وهى عبارة عن نقطة انكسار المنحنى (Intersection Point)٠ وقد وجد ان زيت السمسم (المحمص وغير المحمص) يحتوى على مضادات اكسدة قوية تم التعرف عليها من خلال التحليل الكروموتوجرافي على الطبقات الرقيقة (TLC) ٠ وعند اضافة نوعى زيت السمسم بالنسب السابقة لكل من زيت دوار الشمس والزيتون على حدة وجد ان كفاءة وثبات هذه المخاليط قد زادت٠ وجدير بالذكر ان بذور السمسم المحمصة تزيد من كفاءة وثبات المخاليط السابق ذكرها بالمقارنة بالزيت المستخلص من البذور غير المحمصة – واستكمالا للصورة فقد تم تحليل زيوت كل من السمسم بنوعيه المحمص و غير المحمص و دوار الشمس و زيت الزيتون من حيث نسبة الزيت و نسبة المواد غير المتصبنة والرقم اليودى و رقم التصبن بالاضافة الى التعرف على مضادات الأكسدة مثل الليجنان و التوكوفيرول فى زيت السمسم المحمص و غيرالمحمص عن طريق التحليل بكروماتوجرافيا الطبقات الرقيقة ٠

قام بتحكيم البحث

أ.د / حسان بركات حامد داود	**كلية الزراعة – جامعة المنصورة**
أ.د / صافيناز محمد الشامى	**المركز القومى للبحوث**