OXIDATIVE STABILITY OF FORTIFIED SESAME OIL WITH SPICES

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Abstract
In the context of an increasingly heightened concern for health and healthy eating, vegetable oils play an important role in modern diets. In this regard, cold-pressed oil is an excellent source of lipids and bioactive compounds, which have beneficial health potential. Sesame (*Sesamum indicum* L.) is cultivated in several countries and plays an important role in human nutrition. The plant's seeds are used both as a spice and a source of oil. Sesame oil is a common ingredient in Asian cuisine, used to add flavour to a variety of dishes but never used as a cooking oil. Sesame oil is characterized by a strong and dominant aroma. Similarly, the spices add aroma and flavor to food. The aim of the study was to monitor the oxidative stability of four sesame oil samples fortified with some spices: garlic (*Allium sativum),* basil (*Ocimum basilicum*), cumin *(Cuminum cyminum*) and cinnamon (*Cinnamomum zeylanicum*) during storage for 9 month in room conditions.

Introduction

The process of foods fortification has been a fundamental aspect of global nutrition policy, with the objective of reducing the problem of nutrient deficiencies on a worldwide scale. The most commonly fortified foods are: cereals and bakery products, milk and dairy products, fats and oils, tea and other beverages, infant formulas and accessory food items [12].
Sesame oil obtained from sesame (*Sesamum indicum* L) seeds and is a high-quality edible oil that is traditionally used in Asian cuisine, renowned for its distinctive flavour and aroma [5]. It is recommended that its use in food be in small quantities [9]. The chemical composition of sesame indicates that the seed constitutes an important source of oil (44–58%), protein (18–25%), carbohydrate (13.5%) and ash (5%). In general, it seems that room temperature preserves the nutritional value of sesame due to the increase in omega-6 and vitamin content, and can be the optimal storage conditions for sesame for use in food industry [1, 7]. Spices are known to be the fundamental components of flavour in foods. Spices have many functions in foods: the enhancement of flavour in food products (condiment) and the preservation of food items [10]. Spices have their aromatic properties distributed in different organs of plants, so: in roots (ginger and turmeric), bulbs (garlic and onion), twigs or bark of trees (cinnamon), leaves (basil, rosemary, marjoram, oregano, mint), flowers (lavender, clove and orange), fruits (peppers, star anise and tamarind), seeds and grains (coriander, cumin, fennel, nutmeg, and sesame), etc [6]. Has been demonstrated to offer significant nutritional benefits, contributing to a good human health [10]. The factors that affect the oxidation of vegetable oils are numerous and include temperature, production-related processes, heating techniques, light, fatty acid composition of the oil, antioxidants compounds, oxygen concentration, thermal oxidizable compounds and transition metal ions [4].

Experimental

The oil samples and the dry spices were acquired from local supermarkets from Timisoara (Romania). The dry spices were introduced in four dark bottle and covered with cold - pressed sesame oil, in a ratio of 1:10 at room temperature (20°C) during 21 days and were stirred periodically during maceration. After this time, the macerates were filtered, analyzed and stored in the refrigerator until consumption. The primary and secondary oxidation products – the peroxide value and the p-anisidine value – were periodically determined every three months during 9 months. The oil samples have been kept away from light in dark colored bottles. Oxidative stability was made on non-oxidized sesame oil samples (initial point) for sesame oil (C) and four fortified sesame oil samples with spices: garlic (FSeO1), basil (FSeO2), cumin (FSeO3) and cinnamon (FSeO4) after storage at room temperature condition.

Physico-chemical analysis

The peroxide value (PV) was determined according to standard iodometric methods for the edible oil and the results were expressed in milliequivalents O_2/kg (mEq O_2/kg). According to AOCS [3], *the p-anisidine value (p-AV)* standard method is based on the reactiveness of the aldehyde carbonyl bond on the p-anisidine amine group and the formation of a Schiff base that absorbs at 350 nm. Thus, 2 g (w) of fortified sesame oil sample were dissolved in 25 mL isooctane and the absorbance (A1) were measured at 350 nm. A blank was prepared with isooctane. An aliquot (5 mL) of this solution, respectively 5 mL of isooctane (as blank) was transferred to each of two test tubes of 10 mL and was added, to each, 1 mL anisidine solution (0.25% g/v glacial acetic acid). The absorbance (A2) has been read, after 10 minutes, also at the same wavelength, against isooctane containing p-anisidine. p-AV was calculated to the formula (1):

$$\text{p-AV} = 25 \times \frac{1.2 \times A_2 - A_1}{w} \qquad (1)$$

In order to estimate the oxidative deterioration of lipids was used *TOTOX value (total oxidation value)* and was calculated according to the formula (2) [11]:

$$\text{TOTOX value} = 2PV + \text{p-AV} \qquad (2)$$

All determinations were carried out in triplicates. All reagents and solvents used in this study were of analytical reagent grade.

Results and discussion

The oxidative stability of oils is one of the most important indicators of shelf life [8]. Sesame oil is characterized by a low oxidation rate, due to its low content of unsaturated fatty acids. These acids react readily with oxygen to form peroxides [9]. The oxidative stability of fortified sesame oil is determined by the monitoring of chemical quality indicators. The oxidation degree of sesame oil samples, both without and with the fortified of spices, is presented for comparison in Table 1.

Table 1. Oxidation degree of fortified sesame oil samples

Sample	PV (mEq O_2/kg)				p-AV				TOTOX			
	Time (months)				Time (months)				Time (months)			
	0	3	6	9	0	3	6	9	0	3	6	9
C	1.49	1.49	1.49	1.54	1.64	1.87	1.86	2.09	4.62	4.85	4.84	5.16
FSeO1	2.76	2.77	2.80	2.77	1.78	1.78	1.80	1.80	7.30	7.32	7.40	7.34
FSeO2	3.28	3.28	3.30	3.36	1.88	1.88	1.92	1.96	8.44	8.44	8.52	8.68
FSeO3	2.38	2.38	2.39	2.38	1.59	1.59	1.64	1.61	6.35	6.35	6.42	6.37
FSeO4	2.54	2.56	2.64	2.60	1.74	1.76	1.80	1.86	6.82	6.84	7.08	7.06

The initial peroxide value range of the fortified oils was found to be relatively low, ranging from 1.49 to 3.28 meq/kg, thereby indicating a high degree of stability against oxidation. The PV increases slightly from one month to the next. After 9 months, the PV values decreased for samples FSeO1 and FSeO3 - corresponding to the garlic and cinnamon fortified oils. This decline occurred concurrently with the appearance of secondary oxidation compounds [10]. According by AOCS [3] standard methods, PV of fresh oils should be less than 10 mEq O_2/kg oil, while the PV above 30 mEq O_2/kg indicate a rancid oil.
The p-anisidine value was used to assess the secondary oxidation of the oil or fat, which is mainly due to aldehydes and ketones; represent an indicator of oxidative rancidity in oils and fatty foods. The p-anisidine value for sesame oil samples ranged from 1.64 to 2.09. There were no significant differences in the p-anisidine value between the flavored sesame oil samples. Since the sesame oil samples obtained in this study have p-anisidine values less than 1, it means that the oils are of good quality. The control sample was found to have the highest value, indicating that the addition of spices has an inhibitory effect on the secondary oxidation products. It has been demonstrated that an oil's TOTOX value is an important indicator of its quality. The lower the TOTOX value, the better the quality of the oil [2].

Conclusion
It is evident that the all spices utilized in the study ensure the oxidative stability of the fortified oil samples. Among these, sesame oil samples containing garlic and cinnamon demonstrated the most significant resistance to oxidation. Chemical analysis of spices fortified cold-pressed sesame oils did not show a clear pattern related to changes during storage. However, the most significant changes were observed after 6 months of conditions specified in this study.

References

[1] N. Abdiani, M. Kolahi, M. Javaheriyan, M, Sabaeian, J. Agric. Food Res. (2024) 10111.

[2] H.A. Abou-Gharbia, A.A.Y Shehata, F. Shahidi, Food Res. Int. 33 (2000) 331–340.

[3]AOCS, Method Cd 18-90 p-Anisidine value, Official Methods of Analysis of the American Oil Chemists Society, 1997, reapproved 2017.

[4] B. Bekdeşer, S.E. Çelik, M.Bener, F. Dondurmacıoğlu, E. Yıldırım, E.N. Yavuz, R. Apak, Food Chem. 434 (2024) 137426.

[5] C. Chi-Fai, C. Jhih-Ying, W. Chung-Li, ACS Food Sci Technol. 1 (2021) 1222-1227.

[6] L. Diniz do Nascimento, A.A. Barbosa de Moraes, K. Santana da Costa, J.M. Pereira Galúcio, P.S. Taube, C.M. Leal Costa, J.N. Cruz, E.H. de Aguiar Andrade, L.J. Guerreiro de Faria, Biomolecules 10 (2020) 988.

[7] M. Elleuch, S.Besbes, O. Roiseux, C. Blecker, H. Attia, Food Chem. 103 (2007) 641-650.

[8] A.M. Marina, Y.B. Che Man, S.A.H. Nazimah, I.Amin, J. Am. Oil Chem Soc. 86 (2009) 301-307.

[9] T. Moslavac, S. Jokic, D. Šubarić, M. Ostojčić, S. Tomas, M. Kovač, S. Budžaki, Kemija u industriji. (2023) 10.15255/KUI.2022.082.

[10] M. Nadeem, R. Asad, Pak. J. Food Sci. 22 (2012) 101-107.

[11] A. Rohman, Y.B. Che Man, A. Ismail, P. Hashim, Int. Food Res. J. 18 (2011) 303-310.

[12] https://en.wikipedia.org/wiki/Food_fortification