THERMAL STABILITY OF TRIACYLGLYCEROLS IN EDIBLE OILS & TRIOLEIN MODEL SYSTEMS IN THE PRESENCE OF β-CAROTENE

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Abstract

Triacylglycerols are the main components of the edible oils. The nutritional value of edible oils increases with increase of the presence of unsaturation in the fatty acid composition of the triacylglycerols. However, thermal oxidation influences significantly the fatty acids profile and its quality during cooking and hence the triacylglycerols chemistry. The presence of the natural antioxidants makes the oil resistant to oxidation. The addition of chain breaking antioxidants like β-carotene can increase the thermal oxidative stability and nutritional level. β-Carotene (50-300µg/g) was added to the edible oils like sunflower, rapeseed, corn oils and triolein model systems of relatively similar triacylglycerol composition. The samples were oxidized in Rancimat at 110^{o}C and 20 L/h of air for 14 hours. The samples were analyzed using reversed phase HPLC-ELSD & HPLC-MS using isopropanol-methanol as eluent. Results suggest that upon increasing the β-carotene content the thermal stability of most of the triacylglycerols in edible oils increases or remain constant, while TAGs are more stable in the triolein model system. Thus, β-carotene plays a potential role during thermal oxidation, in protecting the useful ingredients i.e. triacylglycerols from further oxidation.

Key words

β-Carotene, rapeseed oil, sunflower oil, corn oil, triolein, triacylglycerols oxidation.

INTRODUCTION

β-Carotene is one of the most essential oil soluble pigments, acts as antioxidant and provitamin A. It plays a significant role in human health by acting as antioxidant, protecting cells and tissues from the damaging effects of free radicals and singlet oxygen and is a potential anti-carcinogen. It is usually used as additive and colorant in food products like margarine, buttery oils, bakery shortening, fried potatoes, popcorn oil. β-Carotene is present in nearly all vegetable oils, including corn, soybean, rapeseed, linseed, olive, sunflower, and soybean oils [1]. β-Carotene has been shown to protect lipids from free radical auto-oxidation by reacting with peroxyl radicals, thus inhibiting propagation and promoting termination of the oxidation chain reaction. Lee & Min [2] studied the effects of 0, 5, 10, and 20 ppm of β-carotene on the oxidation of soybean oil/methylene chloride model system containing 4 ppm chlorophyll in light (4000 lux). They found that β-carotene reduced the oxidation of soybean oil at all concentrations and especially at 20 ppm. However, Steensen & Min [3] found that during auto-oxidation of soybean oil held in the dark, thermal β-carotene degradation products act as pro-oxidants, while thermally degraded lycopene showed antioxidant activity in similar soybean oil systems. In addition, they found that β-carotene and lycopene degradation products exposed to singlet oxygen oxidation under light neither increase nor decrease the oxidative stability of their respective soybean oil samples.

The β-carotene importance in food industry as colorant and a source of vitamin A, the thermal induced degradation and the resulting loss of color and properties like protecting fatty acids and triacylglycerols oxidation, during processing is thus of great concern to the food chemist and food manufacturers. We studied the effect of different concentration of β-carotene on the oxidation of different triacylglycerols in edible oils and triolein model system.

MATERIALS AND METHODS

Edible oils were purchased from the commercial market at Graz Austria, while model triacylglycerols mixture were from Sigma Aldrich (Germany). All other chemicals and reagents were of ACS grade from Sigma Aldrich USA. All-*E*-β-carotene was dissolved in acetone and added to the three tested oils in order to obtain concentrations in the range of 50-300µg/g. The β-carotene fortified TAGs and edible oils were oxidized in the Rancimat at 110^{o}C and 20 L/h of air for 14 hours. β-Carotene was measured using HPTLC method [4]. The TAGs samples (20mg±0.5mg) were dissolved in 2mL of acetone and HPLC solvent and directly injected in to the HPLC. HPLC system model Agilent HP 1100 coupled to ESI-MS (Agilent, Waldbronn, Germany) was used. The analytes were eluted using an isocratic solvent system consists of 18% isopropanol in methanol (0.1% acetic acid) with ammonium acetate (0.05%). The ESI-MS spectra were obtained at *m/z* range of 200 to 1000.

RESULTS AND DISCUSSION

The thermal degradation of β-carotene in the oils was measured at 110°C every hour for five hours. We know from the previous studies that the lower amount of β-carotene showed antioxidant effects in oils [5]. Therefore this study was aimed to observe the inter-relationship of the effect of 300µg/g of β-carotene on the thermal stability of edible oils, and the degradation of β-carotene. All-*E*-β-carotene was found degraded faster in sunflower oils and rapeseed oils, while it is quite stable in the case of model system and corn oil. Results indicate that β-carotene was more stable in triolein model system than edible oils. One of the main possible reason was the absence of pro-oxidants in model system.

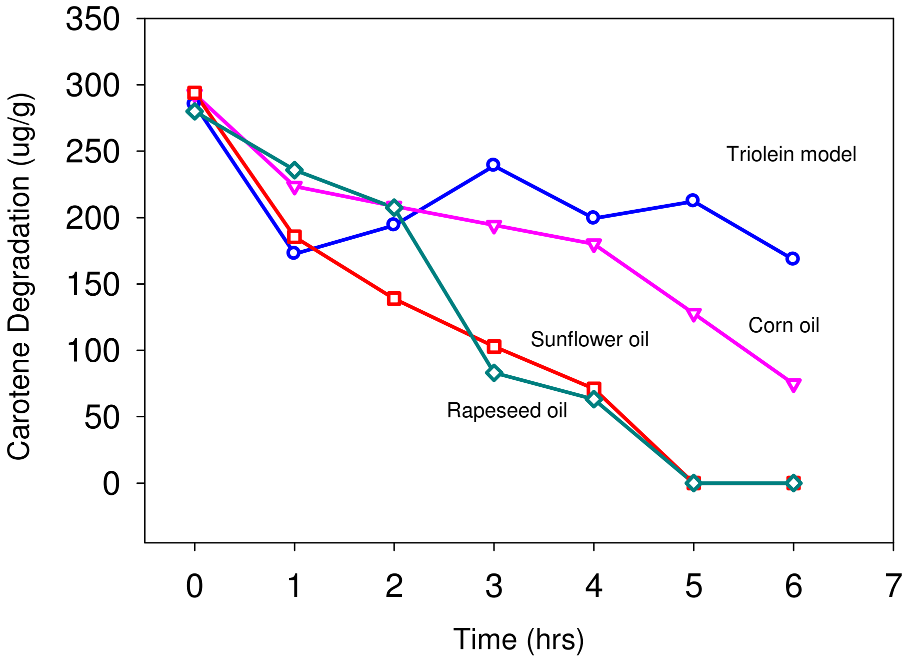

Figure 1. Degradation of β-Carotene in edible oils and triolein model system.

Triacylglycerols were identified using electro spray ionization mass spectrometry. Identification was based on mass spectrum from literature and authentic standards. Results indicate that triolein model system is more stable than edible oils again the thermal degradation. Triacylglycerols like LLL, OLL, OLO in corn oil and sunflower oil, while in rapeseed oil (LnLLn, LnOLn, OLLn and OLL) were the major oxidizable triacylglycerols more than others. Triolein was found a stable triacylglycerol in all cases.

Table 1. Change in the concentrations (peak area) of triacylglycerols of Corn, Sunflower and Rapeseed oils.

Sample	Ret. Time	TAG/DAG	Peak Area (ELSD)							
			Control	00	50	100	150	200	250	300
Corn oil	5.4	DAGs	189.0	1965.0	1842.2	1803.2	2036.7	2815.9	1974.2	1844.0
	11.0	LLL	41.1	25.02	26.8	31.2	36.7	445.1	36.1	35.7
	13.3	OLL	2414.5	518.2	597.3	584.1	580.8	814.7	588.7	849.8
	15.9	PLP	4857.3	1733.0	1928.4	1919.4	1886.3	2580.1	1925.6	2480.5
	16.6	OLO	2868.3	1488.8	1614.5	1641.9	1669.7	2254.0	1636.6	1977.1
	19.3	OOO	555.9	416.7	471.5	481.0	517.3	683.8	468.2	522.6
	20.0	SLO/SOL	115.4	34.4	52.9	68.9	61.8	90.9	75.6	79.4
	24.5	SOO	49.83	26.1	26.1	30.0	32.8	35.5	75.6	31.5
Sunflower oil	3.6	DAGs	182.0	3113.5	3544.0	3683.6	3421.9	3364.5	3704.5	3098.1
	9.4	LLL	3482.1	426.6	356.5	238.9	253.6	296.1	422.6	399.2
	11.06	OLL	5345.4	1209.8	1057.9	764.2	798.6	899.8	1207.4	1126.8
	13.2	PLP	1925.0	723.8	662.9	563.78	568.9	620.2	767.4	718.5
	15.8	OLO	463.6	99.3	109.4	79.8	84.0	88.3	110.3	103.4
	19.01	POO/OOO	450.0	305.0	313.7	306.1	298.0	314.7	354.8	337.1
	19.98	SOL/SLO	216.8	95.0	102.6	86.2	93.7	82.8	101.9	90.4
	24.1	SOO	34.8	28.6	30.8	38.5	37.8	34.3	40.3	36.9
Rapeseed oil	5.4	DAGs	189.0	1965.0	1842.2	1803.2	2036.7	2815.9	1974.2	1844.0
	11.0	LLL	41.1	25.02	26.8	31.2	36.7	445.1	36.1	35.7
	13.3	OLL	2414.5	518.2	597.3	584.1	580.8	814.7	588.7	849.8
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