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Analyses of the oxidative stability of deep-frying oils

Introduction

The quality of edible oils gains more and more in importance. The project presented compares the oxidative stability of conventional **sunflower oil (SF)** with **high-oleic sunflower oil (HOSF)**. HOSF became more interesting for frying applications over the past years.

Material and methods

Oil samples with and without spiked antioxidants (50 mg/kg and 500 mg/kg mixed tocopherols, respectively) were stored at 80°C for 9 days.

The following analyses were performed:

- Measurement of free fatty acids and peroxide value according to §64 LFGB-methods L1300.5 and L1300.6
- Measurement of p-anisidine value with the FOODLAB*fat* device (cdR srl, Florence/Italy)
- Measurement of the antioxidative capacity by TEAC-assay according to Re et al. (1999)
- Measurement of alpha- and delta-tocopherol content by HPLC according to the §64 LFGB-method; eluent was hexane/2-propanol (99/1 v/v)
- Measurement of volatile compounds by headspace-SPME-GC/MS with the following conditions [Jelen et al.(2000)]:

SPME-parameters	
SPME-phase	CAP/DVB/PDMS
enrichment time	90 minutes
enrichment temperature	25°C
desorption time	5 minutes
desorption temperature	260°C

Results

Free fatty acids and peroxide value: Both parameters showed no differences between the oils.

p-Anisidine value: HOSF with added mixed tocopherols showed significant lower values in comparison to SF.

TEAC-assay: Both oils displayed similar results. Addition of mixed tocopherols showed an increasing antioxidative capacity.

Tocopherol content: In the early stage of the accelerated storage test HOSF and SF showed similar contents of alpha-tocopherol. Delta-tocopherol could only be found in supplemented oils. After storage alpha-tocopherol could be detected only in HOSF.

Volatile compounds: 10 major volatile lipid oxidation compounds were selected by their quantitative appearance and their low odour threshold. In both oils hexanal was the only major volatile compound that could be detected in the untreated oils. (E)-2-heptenal was found in considerably higher amounts in SF compared to HOSF. In SF the amount of (E)-2-heptenal decreased with increased tocopherol content. Octanal and nonanal could be found in significant larger amounts in HOSF.

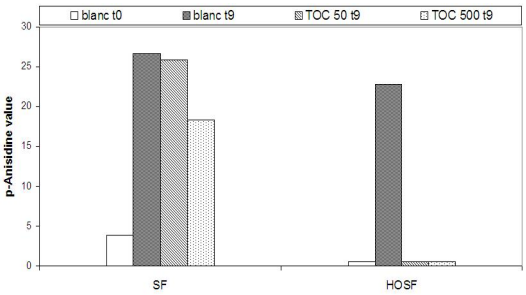

Fig.1: p-Anisidine value of the sunflower oils

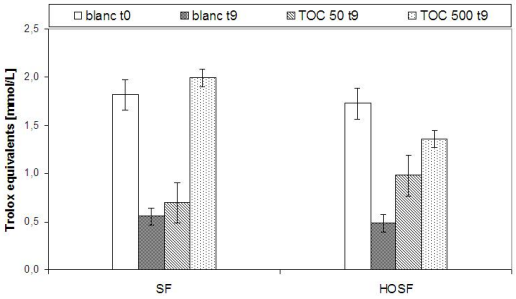

Fig.2: Antioxidative capacity of the sunflower oils (trolox equivalents, TEAC-assay)

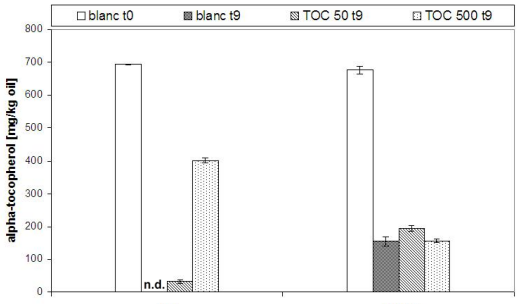

Fig.3: alpha-tocopherol content in sunflower oils; n.d.: not detectable (<5,61 mg/kg oil)

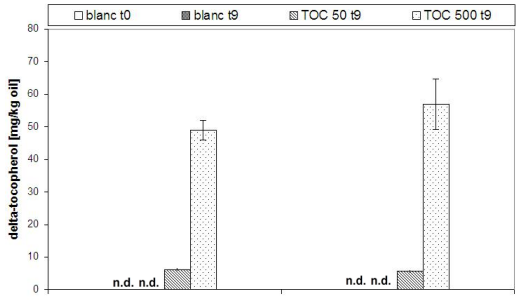

Fig.4: delta-tocopherol content in sunflower oils; n.d.: not detectable (<7,67 mg/kg oil)

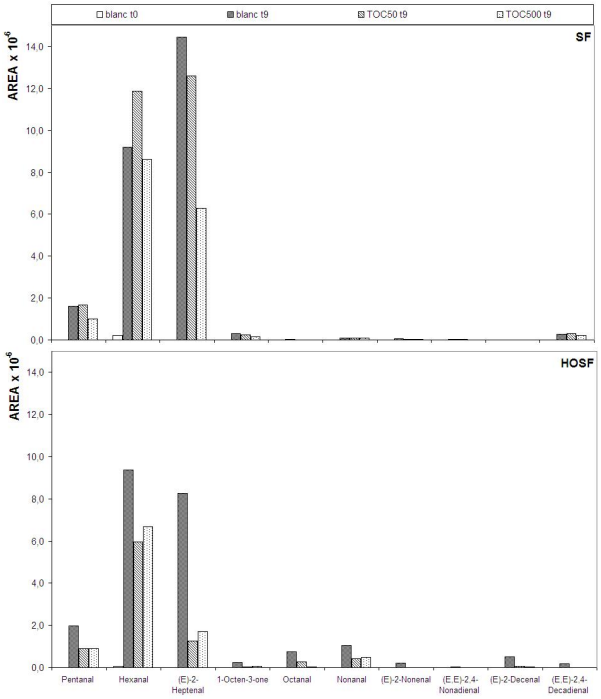

Fig.5: Major volatile compounds in SF oil (above) and HOSF (below)

Tab.1: Volatile compounds in SF oil and HOSF oil (HS-SPME-GC/MS analysis)

Substances		retention index	Substances		retention index	Substances		retention index	Substances		retention index
Alcohol				(Z)-2-Octenal	1049		(E)-2-Hexene	622		Dihydro-2(3H)-furanone	913
	Ethanol	450		(E)-2-Octenal	1060		1-Heptene	690		Dihydro-5-methyl-2(3H)-furanone	955
	1-Butanol	657		Nonanal	1109		(E)-2-Heptene	706		2-Pentylfuran	992
	1-Penten-3-ol	678		(E,E)-2,4-Octadienal	1117		(E)-3-Heptene	711		Dihydro-5-ethyl-2(3H)-furanone	1055
	1-Pentanol	759		(E)-2-Nonenal	1177		1-Octene	789		Dihydro-5-propyl-2(3H)-furanone	1171
	1-Hexanol	871		Decanal	1221		(Z)-2-Octene	807	**Ketone**		
	1-Heptanol	972		(E,E)-2,4-Nonadienal	1230		(E)-2-Octene	815		Acetone	500
	1-Octen-3-ol	981		(Z)-2-Decenal	1262	**Carboxylic Acid**				2-Pentanone	686
	1-Octanol	1073		(E)-2-Decenal	1273		Acetic acid	602		4-Hydroxy-4-methyl-2-pentanone	843
Aldehyde				(E,Z)-2,4-Decadienal	1298		Propanoic acid	691		2-Heptanone	892
	2-Propenal	486		(E,E)-2,4-Decadienal	1324		Butanoic acid	784		1-Octen-3-one	980
	Propanal	500		(E)-2-Undecenal	1372		Pentanoic acid	895		3-Octanone	988
	(E)-2-Butenal	646	**Alkane**				Hexanoic acid	1002		(E)-3-Octen-2-one	1041
	Pentanal	698		Pentane	500		Heptanoic acid	1081		2-Nonanone	1094
	(E)-2-Pentenal	747		Hexane	600		Octanoic acid	1188		(E)-3-Nonen-2-one	1156
	Hexanal	800		Heptane	700		Nonanoic acid	1277		2-Decanone	1207
	(E)-2-Hexenal	854		Octane	800	**Aromate**			**Nitrile**		
	Heptanal	901		Nonane	900		Toluene	758		3-Butenenitrile	654
	(E)-2-Heptenal	957		Decane	1000	**Ester**			**Sulfurous Substance**		
	(Z,E)-2,4-Heptadienal	997	**Alkene**				Ethyl acetate	614		Carbon disulfide	537
	Octanal	1003		1-Hexene	596	**Furan**			**Terpene**		
	(E,E)-2,4-Heptadienal	1011		(Z)-2-Hexene	607		2-Ethylfuran	702		Limonene	1029

Literature:
Jeleń HH et al.; *Journal of Agriculture and Food Chemistry* 48(6):2360-2367 (2000)
Re R et al.; *Free Radical Biology and Medicine* 26(9/10):1231–1237 (1999)

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