WARSAW UNIVERSITY OF LIFE SCIENCES –SGGW

INSTITUTE OF FOOD SCIENCES

Evaluation of polyphenol content and lipoxygenase activity in selected oil cakes in terms of their valorization

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OIL PLANTS

Hemp
Cannabis sativa

- is an annual plant indigenous to eastern Asia, its seeds are used for manufacturing of hemp oil
- cold-pressed oil is produced from selected seeds of registered varieties of edible hemp, which do not contain THC. It is characterized by a high content of vitamins K and E and unsaturated fatty acids.

Rapeseed
(Brassica napus)

- one of the most important oilseed plants in Poland
- is a bright yellow flowering plant cultivated primarily for its oil-rich seed, which naturally contains appreciable amounts of erucic acid
- used to manufacture vegetable oil and margarine

Safflower
(Carthamus tinctorius)

- a species of annual plant from the asteraceae family. It comes from the Middle East and India.
- historically used as a substitute for saffron
- the plant was considered the source of the best vegetable dye - carthamine, also known as Spanish red

Flax
(Linum usitatissimum)

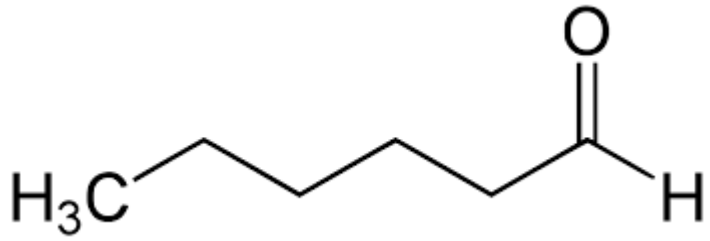
- fibrous and oil rich plant
- its seeds contain up to 35% of oil, which is used to manufacture edible, and industrial oil

Camellia
(Camellia)

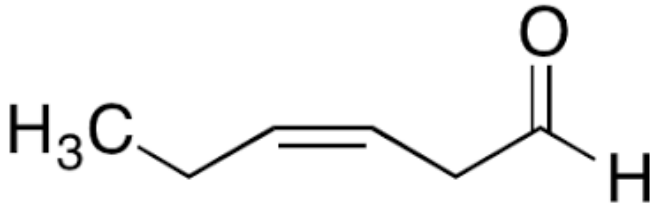
- the oldest oleaginous plant cultivated in Poland
- It's oil contains up to 90% of polyunsaturated fatty acids
- traditionally used in Japan for hair care

GREEN NOTE AROMA COMPOUNDS

Green note aroma compounds affect the green character of food products and the impression of freshness. They are popularly used in the food industry to reconstitute the fresh green odor of fruits and vegetables lost during processing. They are associated with the aromas of green apples, melons, cucumbers, and freshly cut grass. C_6-C_9 carbon aldehydes and their corresponding alcohols such as hexanal, 3-*cis*-hexenal, 2-*trans*-hexenal,3-*cis*-nonenal, 2-*trans*-nonenal, and (3-*cis*, 6-*cis*) and (2-*trans*, 6-*cis*) nonadienal are important components of green aroma notes. One of the most popular green-note molecules is hexanal, characterized by a grease, grass, or leafy fresh odor.



hexenal



Z-3-hexenal

Lipoxygenase (LOX, EC. 1.13.11.12.)

- family of (non-heme) iron-containing enzymes
- can be found in many organisms, very common in plants
- catalyzes the dioxygenation of polyunsaturated fatty acids in lipids containing a cis,cis-1,4- pentadiene
- the most important enzyme of the green note pathway

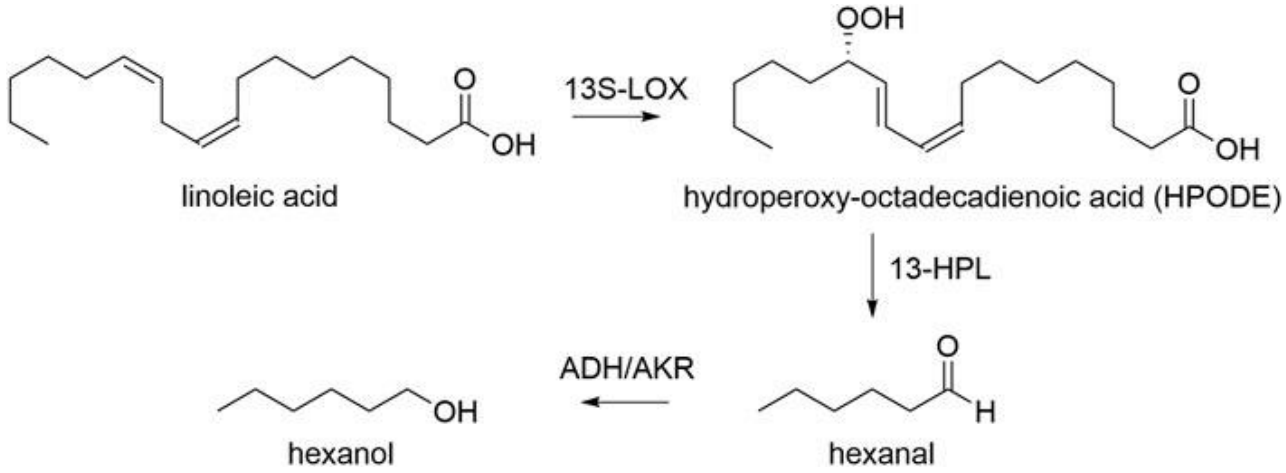
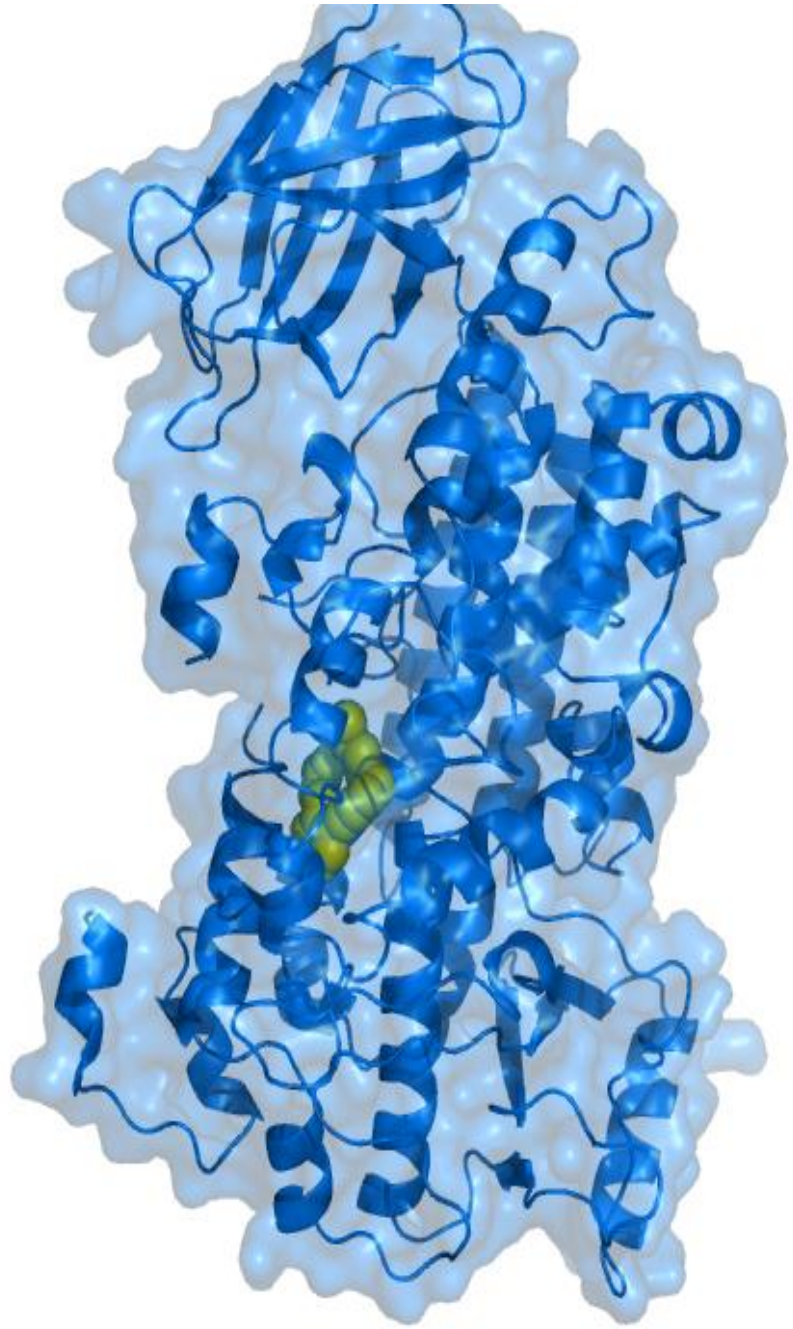


Fig. 1. Lipoxygenase pathway for the metabolism of α-linolenic acid.



Rabbit 15-lipoxygenase (blue) with inhibitor (yellow) bound in the active site

The aim of this study was to evaluate selected oil cakes (linseed, rapeseed, hemp, safflower and camelina) in terms of their potential use as a source of lipids in the biosynthesis of green note aroma compounds by *Yarrowia lipolytica* yeast. The composition of fatty acids in individual oil cakes was verified to determine which of them is the richest source of linoleic acid. In addition, the activity of lipoxygenase in the oil cake extracts was also determined to know to what extent the yeast enzymatic apparatus can be enhanced with the activity of enzymes derived from the oil cake.

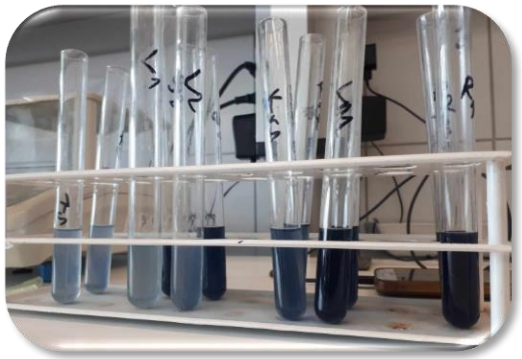
Materials and methods

Composition of fatty acids

Soxhlet extraction

Gas chromatography

Lipoxygenase and phenolic compounds extraction



Enzymatic assay

Spectrophotometry measurement

Results

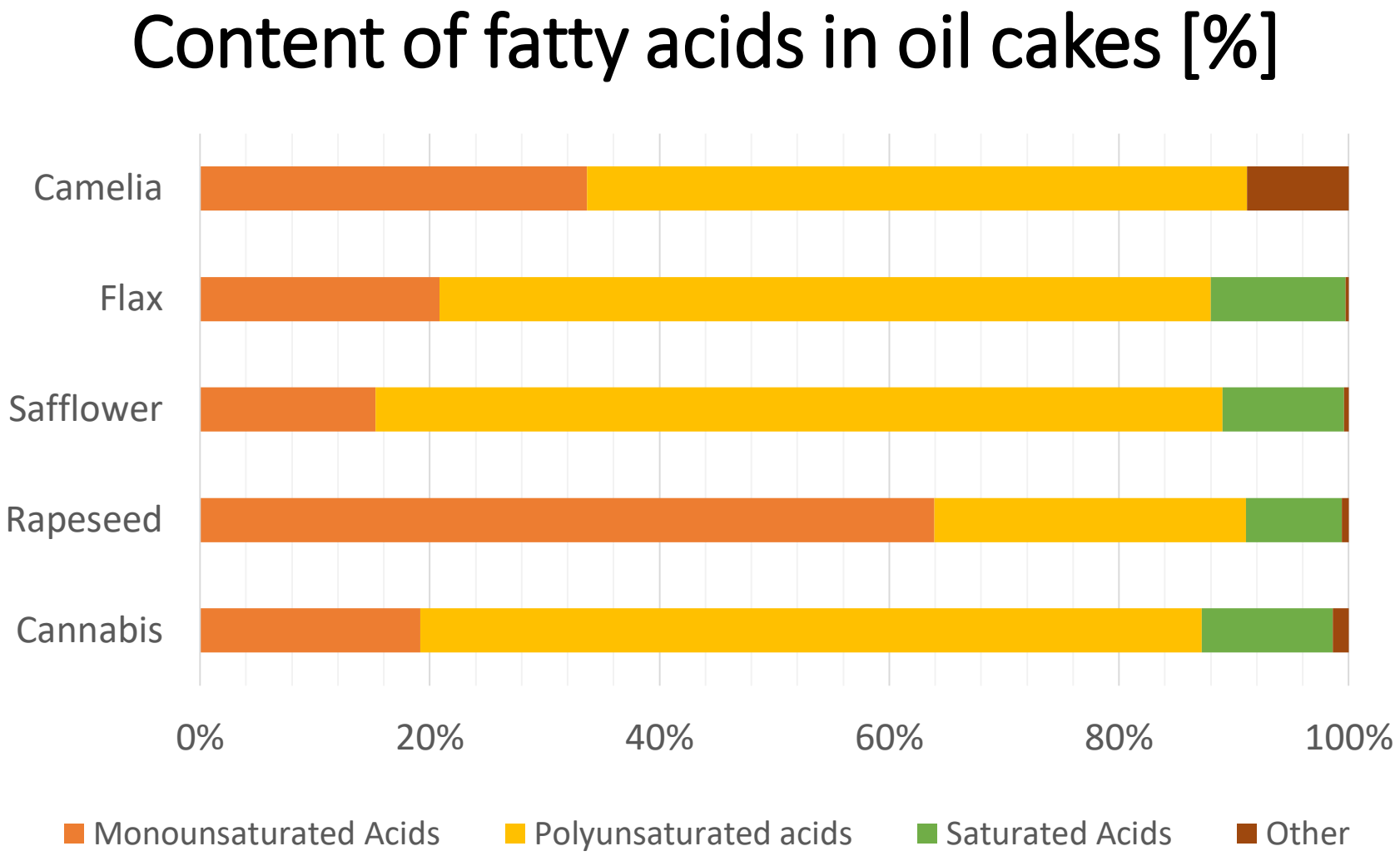


Figure 2. Percentage of monounsaturated, polyunsaturated and saturated acids in the lipid fraction extracted from oil cakes.

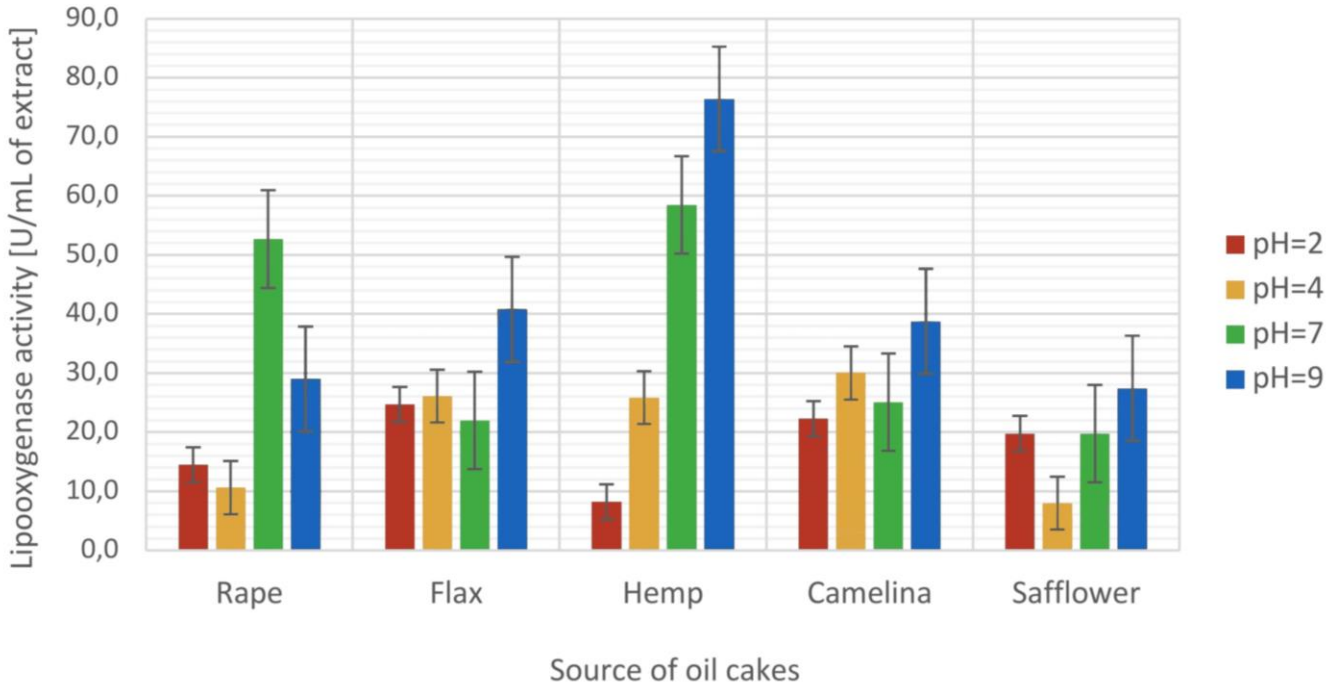


Figure 3. Lipoxygenase activity in the extracts of selected oil cakes.

Table 1. Total phenolic content in selected oil cakes.

	Source of oil cakes				
	Rape	Flax	Hemp	Camelina	Safflower
Total phenolic content [mg GAE/mL of extract from oil cakes]	$0.104^{a} \pm 0.025$	$0.198^{c} \pm 0.076$	$0.116^{a} \pm 0.005$	$0.137^{b} \pm 0.014$	$0.130^{b} \pm 0.010$

* The values with a different letter (a-c) are significantly different ($\alpha = 0.05$).

Conclusions

- The fatty acid composition of the lipid fraction extracted from the oil cakes indicates a high content of polyunsaturated acids, which are a substrate of bioconversion
- Hemp cakes are characterized by the highest content of linoleic and linolenic acid, and the extract obtained from them shows high lipooxygenase activity with a low concentration of phenolic compounds
- High oxidative activity combined with the catalytic activity of microorganisms may give promising results in the context of efficient biosynthesis of green fragrance compounds
- The cakes obtained by pressing oil from oilseeds can be a valuable raw material in microbiological cultures
- The use of oilcake as a carbon source in medium for the cultivation of microorganisms with their lipooxygenase activity is part of the current trend of waste valorization and environmental protection