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Lipid and volatile profiles of Finnish oat cultivars: Effect of storage on the volatile formation

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Introduction and Aim

Oats have the highest lipid content among grains. They have a high content of unsaturated fatty acids and lipid-degrading enzymes, which impact volatile profiles of oat. The formation of undesirable volatiles affects sensory quality.

Therefore, the **aim of this study** was to investigate lipid profiles of different Finnish oat batches and study their relationship to formation of volatiles during storage.

Materials and Methods

- **Twenty oat flours** (n=20) of known pure cultivars from **2019** were studied
- Oat lipids were extracted from **milled heat-treated oat flake flour** (Jokinen et al. 2021) by **four-stage lipid extraction**: double extraction with MTBE-methanol (10:3, v/v), extraction with hexane, and extraction with methanol
- Extracted oat samples were fractionated into **neutral** and **polar** lipids by solid-phase chromatography
- Unfractionated and fractionated lipid extracts were methylated by an **acid-catalyzed** method and analyzed by **gas chromatograph** with a flame ionization detector
- Volatile compounds of oat flours were analyzed by **solid-phase micro-extraction** followed by gas chromatography-mass spectrometry method
- Oat flour samples were **stored** in paper bags at 22 °C for up to **nine months**

Results

Extractable oil amount of oat samples varied between **5.9-8.9 g per 100 g of flour** (DW). **Palmitic** (16%), **oleic** (36%), and **linoleic acid** (39%) were the most abundant fatty acids. **Neutral lipids** accounted for **78.7±2.5%,** and **polar lipids** for **21.3±2.5%** of lipid mass. Neutral lipids had more oleic acid, less linoleic acid, and palmitic acid than polar lipids (**Table 1**).

Table 1: Content of main fatty acids (expressed as percentage of total fatty acids)

Mean value of	C16:0, palmitic acid %	C18:1(n-9), oleic acid %	C18:2(n-6), linoleic acid %
unfract. lipid extract (n = 20)	15.8 ± 0.7	35.7 ± 2.6	39.0 ± 2.1
neutral fraction (n = 20)	15.2 ± 0.7	37.9 ± 2.3	38.0 ± 2.0
polar fraction (n = 20)	19.2 ± 0.7	20.6 ± 2.7	44.0 ± 1.9

The fresh samples had a low volatile content. The content and quality increased throughout the storage trial, indicating **lipid oxidation occurred (Figure 1)**. Main lipid-derived volatiles detected from oat flour samples were **2-butanone**, **2-heptanone, heptanal**, **3-octen-2-one, nonanal**, **2-octenal, pentanal, hexanal, and octanal.**

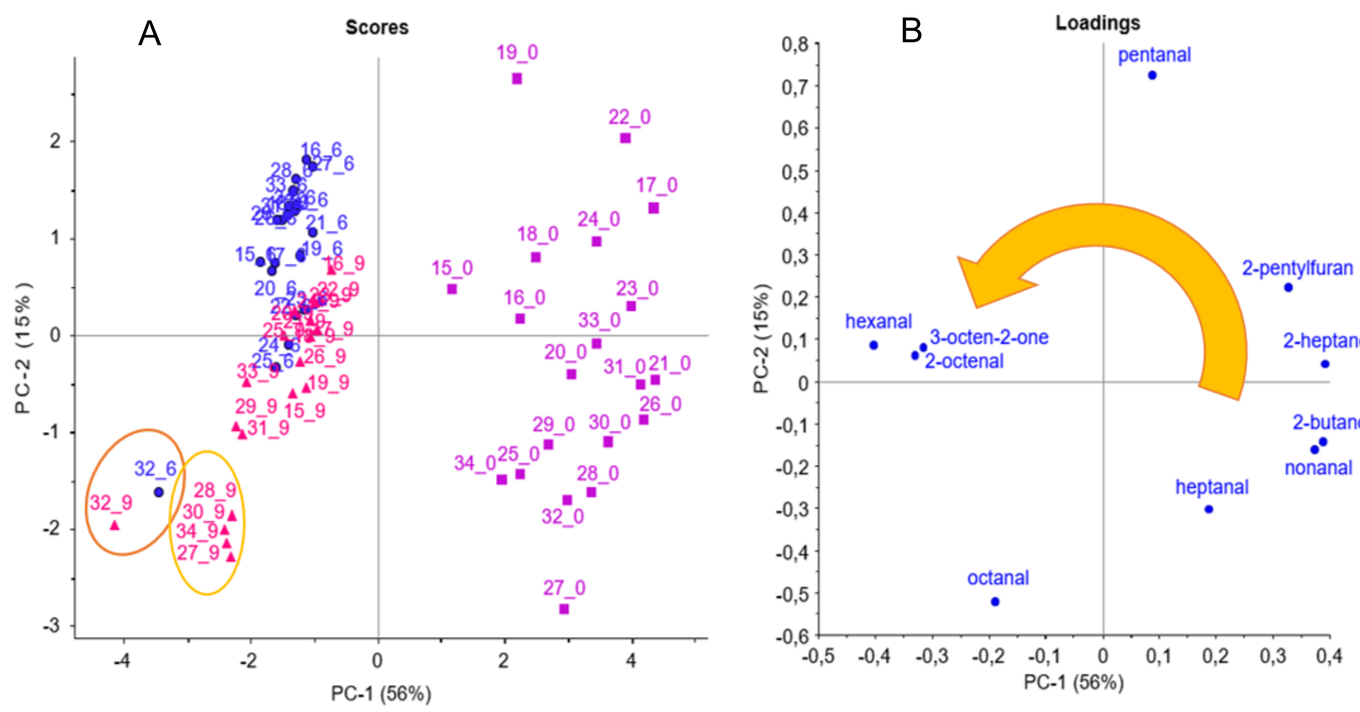

Figure 1. Principal component analysis (**PCA**) of **volatile lipid oxidation indicators** (n = 3). (**A**) PCA scores plot showing different oat cultivars during **storage trial** (violet ▪ = 0 months, blue • = 6 months and pink ▲ = 9 months). The samples numbers (15-34) are according to Jokinen et. al 2021. (**B**) PCA loading plot showing selected volatile variables. The arrow indicates the main direction of oxidation.

Conclusions

- Polar fraction contained **higher quantities of palmitic and linoleic acid** than the neutral fraction, while the neutral fraction had higher **oleic acid**
- **Lipid-derived volatiles** did **not correlate** to either **oil amounts** or **linoleic acid** content
- At **0 months**, there was **more variability in the volatile profile** between the oat batches representing different cultivars than at 6 and 9 months (**Figure 1**)
- During the storage, the sample became **more equal** and **formed two groups according to time** (6 and 9 months), except for a few exceptions (**Figure 1**)
- The level of volatile oxidation indicators in **sample 32** was already high at 6 months of storage, also **samples 27, 28, 30 and 34** showed high levels at 9 months of storage (**Figure 1**) and **are considered to be the most oxidized**

References

Jokinen, I., Pihlava, J-M., Puganen, A., Sontag-Strohm, T., Linderborg, K. M., Holopainen-Mantila, U., Hietaniemi, V., Nordlund, E. (2021). Quality factors of industrially produced oat flours in relation to the composition of the native grains. *Foods*, *10*, 1552

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