5th NIZO Dairy Conference – Prospects for Flavour Formation and Perception
Papendal (NL), June 13-15, 2007

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department
of Economic Affairs DEA
Agroscope Liebefeld-Posieux
Research Station ALP

Comparison of aroma compounds of mild and traditional acidic yogurts using SPME-GC-O-MS

Photo: www.swissmilk.ch

H. Schlichtherle-Cerny* and D. Oberholzer

Agroscope Liebefeld-Posieux Research Station ALP, CH-3003 Berne, Switzerland,
E-mail: hedwig.schlichtherle-cerny@alp.admin.ch

Introduction

Yogurt is probably the best known and most widely consumed fermented milk [1]. Some important flavor compounds are already present in milk, others are formed or increased during fermentation. Only few studies, however, combined sensory with analytical techniques to identify the aroma-active compounds of yogurt [2-4]. Interestingly, the aroma intensities of traditional acidic and mild yogurts are more influenced by the acidity (pH) rather than by the acetaldehyde, 2,3-butanedione and 2,3-pentanedione levels, character impact compounds of yogurt [4].

The objective of this study was to characterize and to compare the volatile aroma compounds present in mild and in traditional acidic yogurts produced using different cultures containing *Lactobacillus delbrueckii* ssp. *bulgaricus* (*Lb. bulgaricus*) and *Streptococcus* (*St.*) *thermophilus thermophilus* strains.

Materials and methods

- Pasteurized milk containing 3 % of skimmed milk powder was incubated with either the slow acidifying culture J550 (sample EH1) to pH 4.5, the traditional acidic culture B1 (samples EH2 and EH3) to pH 4.6 and 4.7, respectively, or a commercial reference culture for traditional acidic yogurt (Yo-Mix™ 621, Danisco, Denmark, sample EH4) to pH 4.6. Culture J550 contained 3 strains of *Lb. bulgaricus* and of *St. thermophilus*, the exact composition of the other cultures was not defined.
- Solid-phase microextraction (SPME) combined with gas chromatography-mass spectrometry and olfactometry (GC-O-MS) was used to analyze the volatile compounds on a polar SolGelWax column (30 m × 0.25 mm × 0.25 µm). Identification was based on identical retention indices, odors and mass spectra with the ones of authentic reference compounds.
- The perceived aroma notes were described by four trained panelists.

Results

Table 1. Aroma compounds detected in all four yogurt samples by SPME-GC-O-MS

Compound	Odor	EH1 pH 4.5	EH2 pH 4.6	EH3 pH 4.7	EH4 pH 4.6
Acetaldehyde	Fruity, acidic, fresh	✓	✓	✓	✓
Acetone	Chocolate, flowery	✓	Unknown	✓	✓
2,3-Butanedione	Butter, cream	✓	✓	✓	✓
2,3-Pentanedione	Butter, cream	✓	✓	✓	✓
Methional	Cooked potatoes	✓	✓	✓	✓
Acetic acid	Pungent, acidic	✓	✓	✓	✓
Butanoic acid	Rancid, sweaty	✓	✓	✓	✓
Unknown	Fatty, cake, baked	✓	✓	✓	Cheesy
Unknown	Bouillon, meaty	✓	Rancid	✓	✓

Table 2. Differences in aroma compounds detected in the four yogurt samples by SPME-GC-O-MS

Compound	Odor	EH1 pH 4.5	EH2 pH 4.6	EH3 pH 4.7	EH4 pH 4.6
Ethyl acetate	Fatty, pungent	-	✓	Pineapple	Solvent
Acetoin	Butter, pungent	-	✓	✓	-
2-Heptanone	Chocolate, fatty	✓	-	-	✓
1-Octen-3-one	Mushroom, metallic	✓	-	-	-
Dimethyl trisulfide	Garlic, sulfury	✓	-	*Fruity?*	-
1-Octen-3-ol	Mushroom	-	-	-	✓
Butyrolactone	Fatty	Unknown	✓	✓	-
3-Methylbutanoic acid	Fatty, soapy	-	✓	-	✓
Octanoic acid	Rancid, sweaty	✓	-	-	✓

GC-O-MS (figure 1) revealed known key aroma compounds [2-4] in all four yogurt samples, such as acetaldehyde, 2,3-butanedione and 2,3-pentanedione, as well as methional. Acetone was recognized as chocolate-like and flowery in three samples EH 1, EH 3 and EH 4, and detected as unknown in EH 2 (table 1). Two unkown compounds were described as fatty, baked and cake-like in EH 1-3, but as cheesy in EH 4. A bouillon-like meaty smelling unknown compound was perceived as rancid in EH 2.
Table 2 lists differences between the four yogurt samples. The mushroom-like 1-octen-3-one was only found in EH 1, EH 4 revealed the corresponding alcohol 1-octen-3-ol. The sulfury, garlic-like smelling dimethyl trisulfide was detected in EH 1, a fruity odor was perceived at the same retention index in EH 3. Acetoin was detected only in EH 2 an 3, while the fatty odor of 3-methylbutanoic acid was perceived only in EH 2 and EH 4. Octanoic acid was perceived exclusively in EH 1 and EH 4.

Figure 1. GC-Olfactometry

The total ion current GC-MS signals shown in figure 2 revealed the highest intensity of 2,3-butanedione in EH 1, and of 2,3-pentanedione in EH 4. The acetaldehyde signal was most intense in EH 2, and acetic acid was higher in EH 2 and EH 4 compared to EH 1 and EH 3. The mild yogurt EH 1 revealed less lactic acid (data not shown), although it had been incubated to a lower pH than the traditional acidic yogurts EH 2-4.
Volatiles such as hexanal, benzaldehyde, 1-pentanol and 2-butanone were detected by GC-MS, however not by GC-O. Complementary extraction techniques and quantification of key aroma compounds are necessary to select appropriate cultures for desired aroma profiles.

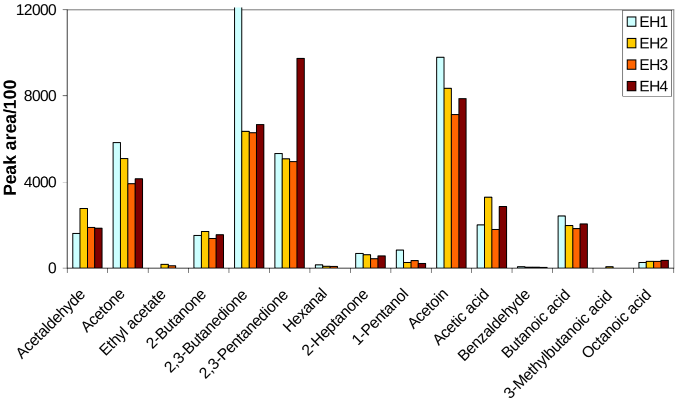

Figure 2. Differences in peak areas of selected volatile compounds in four yogurt samples by SPME-GC-MS

Summary and conclusions

- SPME-GC-O-MS proved useful for the analysis of aroma active compounds in yogurt and for the differentiation of mild and traditional acidic yogurts.
- Known key aroma compounds such as acetaldehyde, 2,3-butanedione, 2,3-pentanedione, methional as well as acetic, butanoic and octanoic acid were found among others in the studied samples. Pronounced differences were observed for 1-octen-3-one, dimethyl trisulfide, 1-octen-3-ol, acetoin and lactic acid.
- In order to select cultures for desired aroma profiles, further studies such as quantification of the key aroma compounds in addition to complementary extraction techniques are necessary.

References

Marshall, V.M. (1982) *Perfumer and Flavorist* 7:27-33
Ott, A., Fay, L.B., Chaintreau, A. (1997) *Journal of Agricultural and Food Chemistry* 45: 850-858
Ott, A., Germond, J.E., Baumgartner, M., Chaintreau, A. (1999) *Journal of Agricultural and Food Chemistry* 47: 2379-2385
Ott, A., Hugi, A., Baumgartner, M., Chaintreau, A. (2000) *Journal of Agricultural and Food Chemistry* 48: 441-450
Imhof, R. and Bosset J.O. (1994) *Lebensmittel-Wissenschaft und Technologie* 27: 265-269