Thermophilic starters, milk composition and technological parameters affect the volatile compounds of hard cooked cheeses

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Introduction

The composition of thermophilic starters influences the composition of volatile compounds of hard cooked cheeses, maybe through their effect on the chemical composition and bacterial dynamics in cheese from the early stages of cheesemaking (*Buchin et al, 2017, Eur. Food Res. Technol., 243:1943–1955*). A modulation of this effect by milk composition or technological parameters was investigated.

Material and methods

Cheese-making: 24 model Swiss-type cheeses (10 kgs) **by crossing 3 factors,** all the other processing conditions similar, the same mesophilic strains added, 150 days of ripening

Starter combination (S) 2 levels		Milk composition (M) 3 levels protein content		Process (T) 3 levels cooking temperature
(1) StH1D1 (2) StH2D2	x	(29) 29 g/l (32) 32 g/l (35) 35 g/l	x	(53) 53°C (55) 55°C (57) 57°C

Analyses:

- **Gross composition** of cheeses at 1 and 150 days,
- **Microbiological composition, proteolysis patterns and volatile compounds** of cheeses at 1, 30, 75 and 150 days
- **Statistics:** ANOVA (effect of factors and interactions) and PCA

St: S. *thermophilus*, 1 strain, 5.10^5 cfu/mL H1-H2: *L. helveticus*, 2 strains, 10^6 cfu/mL
D1-D2: *L. delbrueckii*, 2 strains, 10^6 cfu/mL

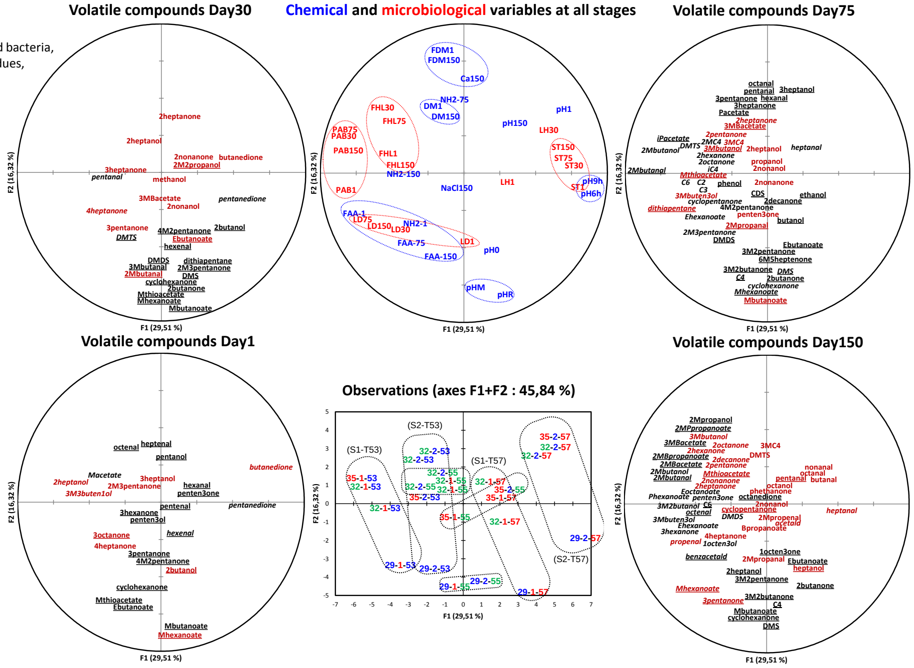
Results

Principal Component Analysis (PCA) made from data significantly affected by the factors under study

Chemical and microbiological composition:
ST=S. thermophilus, LH=L. helveticus, LD=L. delbrueckii,
FHL=facultatively heterofermentative lactobacilli, PAB=propionic acid bacteria,
DM=dry matter, FDM=fat/DM, FAA=free aminoacids, NH2=NH2 residues,
pH0, pHR, pHM, =pH in initial milk, at renneting, at moulding,
pH6h, pH9h=pH at 6h and 9h pressing,
1-30-75-150=days of ripening

Volatile compounds Day30 — Chemical and microbiological variables at all stages — Volatile compounds Day75

Volatile compounds Day1 — Observations (axes F1+F2 : 45,84 %) — Volatile compounds Day150



Volatile compounds:
Affected by **starter**, **milk**, ***temperature,***
M=methyl, E=ethyl, P=propyl, B=butyl, i=iso, C2, C3, C4, C6 =acetic, propionic, butyric, caproic acids, DMS=dimethylsulfide, DMDS=dimethyldisulfide, DMTS=dimethyltrisulfide,

Analysis of variance (ANOVA): Number of volatile compounds affected at each ripening stage

Effect	Day1	Day30	Day75	Day150
S	9	13	16	29
1>	7	5	1	8
2>	2	8	14	20
M	18	17	29	26
29>	7	14	13	15
29<	1	0	7	7
35>	0	0	5	3
35<	10	5	13	3
32>	5	1	6	4
32<	3	4	1	5
T	7	4	26	31
53>	0	3	20	25
53<	2	1	2	2
57>	0	0	1	2
57<	4	1	13	18
M*S	2	1	2	6
M*T	0	4	2	6
S*T	11	5	9	19

- **Chemical and microbiological composition: Milk** effect on gross composition and growth of FHL, PAB and LD; **Starters** effect on growth of all microbiota, mostly LD and LH, acidification and proteolysis; ***High temperature*** beneficial for *ST and LH* but detrimental for other microbiota.
- **At unmoulding:** Major **milk** effect for volatile composition. **M29** favorable for aldehydes, alcohols and ketones (markers of fat oxidation) and esters (markers of lipolysis); **Starters S1** favorable for the same alcohols and ketones; ***High temperature*** favorable for *2,3-butanedione* and *2,3-pentanedione* (produced by ST).
- **At 30 days: Milk M29** favorable for sulfur compounds and branched aldehydes (degradation of AA) and again the same esters; **Starters** effect again on ketones and alcohols; ***Temperature*** effect negligible.
- **At 75 days:** Increasing effect of ***temperature***. ***Low temperature*** favorable for *volatile fatty acids* and *sulfur compounds* (enhanced PAB and FHL growth); **Milk** effect more or less the same; **Starter S2** higher than S1 for secondary alcohols and methyl ketones (fatty origin) and branched alcohols and esters and sulfur compounds (AA origin).
- **At the end of ripening: *Low temperature*** favorable for many *ketones* (from fat), *branched or sulfur compounds* (from AA), *esters*; **Starters S2** favorable for mainly aldehydes, primary alcohols and methylketones (from fat); **Milk** effect the same as previously,

Conclusion

During ripening, milk effect remained major whereas starter and temperature effects increased until the same level for the 3 factors

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