CONTRIBUTION OF AUTOCHTHONOUS LACTIC ACID BACTERIA TO THE TYPICAL FLAVOUR OF RAW GOAT MILK CHEESES

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Introduction

The microbiota of raw goat milk includes different genera of lactic acid bacteria (LAB), mainly "wild" strains of lactococci, lactobacilli and enterococci. It plays an important role in the development of the sensory and textural characteristics of raw milk cheeses and it may also provide beneficial effects for consumers' health.

Autochthonous LAB isolated from raw milk or raw milk cheeses are frequently associated with more complex volatile profiles and higher scores for some sensory attributes than LAB strains found in commercial starters. Metabolic routes usually not present in commercial strains lead to the production of different flavour compounds in cheese by wild LAB strains, which may be separately used or combined for cooperative metabolism.

Objective

To gain a better understanding of the contribution of autochthonous LAB strains isolated from raw goat milk cheeses to their flavour characteristics.

Materials and methods

The ability of 298 LAB strains (belonging to 8 genera and 24 species) to generate volatile compounds when grown as goat milk cultures was evaluated by sensory analysis: 10 panelists evaluated 14 odour characteristics.

Thereafter, the volatile compounds produced by 56 selected strains individually used for the manufacture of lactic curds from pasteurized goat milk (incubation at 30°C for 24 h) were extracted by headspace solid phase microextraction (HS-SPME) and analyzed by gas chromatography–mass spectrometry (GC–MS), to elucidate their contribution to the odour and aroma of raw goat milk cheeses. Three commercial starters (MA11, MA16 and H13) were also included as reference.

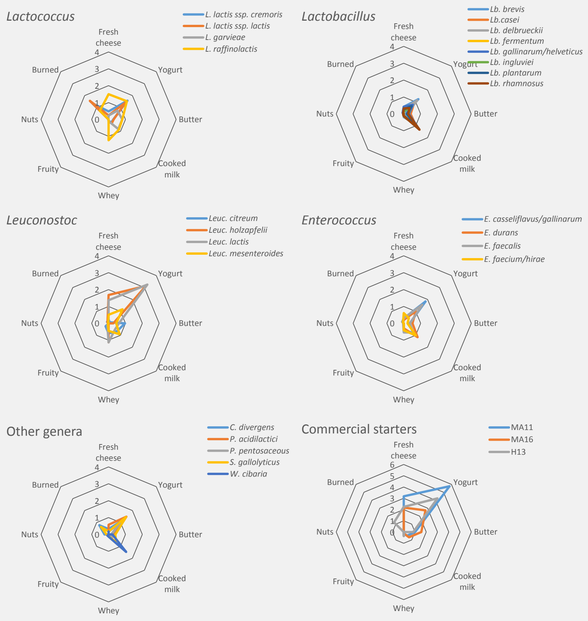
Table 1. Bacterial strains used in this study, their origin (C, from Cádiz cheeses; M, from Málaga cheeses) and the strains selected for the GC-MS characterization of their volatile profile in inoculated curds

Genus	No.	Species	No.	Selected strains
Lactococcus	76	*lactis* ssp. *cremoris*	12	C3, M870
		lactis ssp. *lactis*	59	C2, C57, C387, M5, M13, M18, M899
		garvieae	3	M12
		raffinolactis	2	C374, M881
Lactobacillus	88	*brevis*	5	C521
		casei	33	C176, C530, C541, M81
		delbrueckii	9	C187, M961
		fermentum	3	C184, M981
		gallinarum/helveticus	7	C156, M971
		ingluviei	7	M82
		plantarum	17	C194, M87
		rhamnosus	7	C542, M960
Leuconostoc	61	*citreum*	2	M938
		holzapfelii	1	M924
		lactis	2	M882
		mesenteroides	56	C112, C490, C496, M53, M117, M923
Enterococcus	60	*casseliflavus/gallinarum*	7	C99, M147
		durans	8	C455, M156
		faecalis	40	C77, C442, M139, M167, M1002
		faecium/hirae	5	C75, M169, M1022
Carnobacterium	2	*divergens*	2	M30
Pediococcus	4	*acidilactici*	1	C168
		pentosaceous	3	C549
Streptococcus	5	*gallolyticus*	5	C28, M906, M994
Weisella	2	*cibaria*	2	C150

Results

Sensory evaluation of milk cultures

Figure 1. Scores for selected individual odour attributes obtained in the sensory evaluation of milk cultures of 298 strains of autochthonous lactic acid bacteria and three commercial starters



Among wild LAB, *Leuconostoc* and *Lactococcus* strains reached the highest scores for dairy odour attributes in goat milk cultures. However, commercial starters generally obtained higher values for dairy odour attributes than wild strains.

Volatile profile of lactic curds

Total no. of compounds: 34
- 5 carboxylic acids
- 11 alcohols
- 6 aldehydes
- 6 ketones
- 1 ester
- 5 miscellanous compounds

Table 2. Levels (AU x 10^5) of 13 compounds detected in the volatile fractions of all or most curds (WS = wild strain, CS = commercial starter)

Compound	Range	WS (min)	WS (max)	CS (range)	Unioculated curd
Acetic acid	6.56-1622.27	42.31 *P. acidilactici*	778.57 *Leuc. mesent.*	336.77-1622.27	6.56
Butanoic acid	23.26-231.55	23.26 *Lb. ingluviei*	231.55 *W. cibaria*	56.41-96.41	40.35
Hexanoic acid	21.54-72.69	21.54 *Lb. ingluviei*	72.69 *L. l.* ssp. *crem.*	41.76-62.59	25.18
Octanoic acid	9.71-32.5	9.71 *Leuc. lactis*	32.50 *P. pentosac.*	17.70-29.00	10.88
Ethanol	99.46-1056.04	58.75	1102.28	190.46-265.35	40.57
1-Propanol[1]	0.63-20.67	0.63 *Lb. ingluviei*	20.67 *Leuc. citreum*	0.80-2.98	0.92
1-Butanol[1]	0.66-26.95	0.66 *L. garvieae*	26.95 *Lb. brevis*	1.70-2.51	2.26
Ethanal[2]	0.58-6.55	0.75 *S. gallolyticus*	6.55 *P. acidilactici*	3.77-5.17	0.58
Benzaldehyde	1.07-7.16	1.07 *Lb. ingluviei*	7.16 *Leuc. lactis*	1.57-2.52	1.62
2-Propanone	45.85-130.40	54.24 *L. l.* ssp. *crem.*	130.4 *Lb. plantarum*	45.85-58.14	58.31
2-Butanone	16.78-84.72	21.59 *Lb. brevis*	84.72 *Lb. gallin./helv.*	16.78-27.58	19.84
2,3-Butanedione	0.99-333.12	2.82 *W. cibaria*	333.12 *Lb. rhamnosus*	39.98-272.33	0.99
3-Hydroxy-2-butanone	1.10-2132.30	1.73 *Leuc. lactis*	982.00 *E. faecalis*	183.47-2132.30	1.10

[1] not detected in *Leuconostoc citreum*, *holzapfelii* or *lactis*.
[2] not detected in *Pediococcus pentosaceus*.

Figure 2. Levels (AU x 10^5) of 16 compounds only detected in the volatile fractions of specific strains within a species

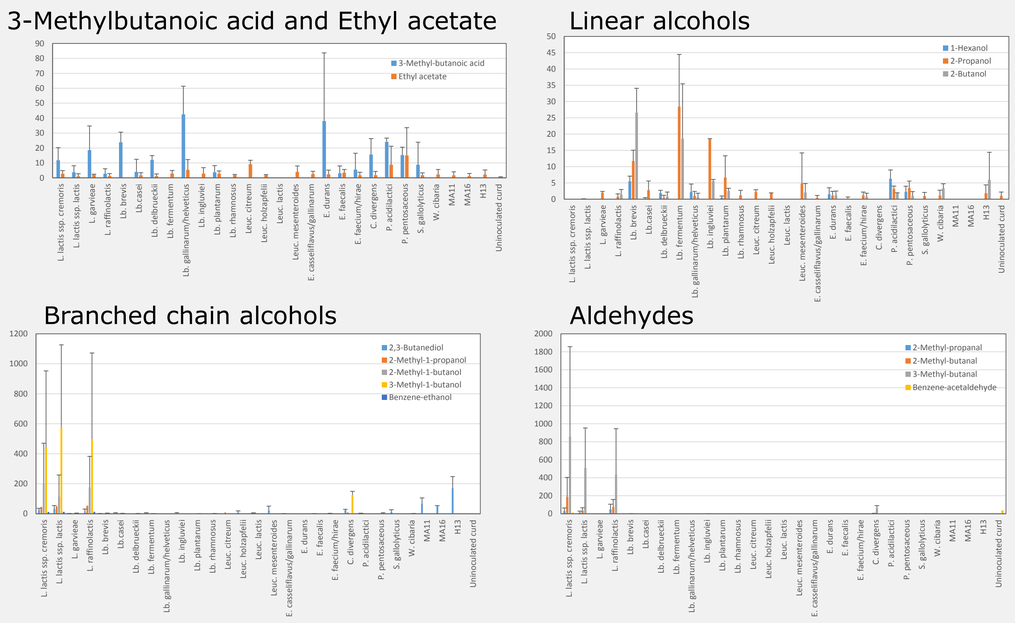
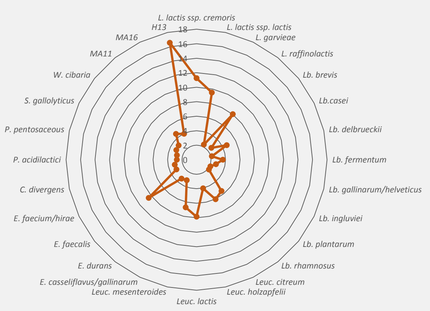


Figure 3. Volatile index[1] of curds



[1]Total volatiles / Total volatiles in uninoculated curd

Conclusions

- *Leuconostoc* and *Lactococcus* obtained the highest scores for dairy odour attributes.
- Up to 33 volatile compounds were detected in lactic curds made with individual strains.
- Variations in the number and levels of volatile compounds illustrate differences in metabolic pathways and /or in enzyme activities between wild LAB strains and commercial starters.
- Major differences in volatile generation were related to amino acid catabolism.
- Volatile production differed significantly even among LAB strains of the same bacterial species, and points to the feasibility of strain selection and the use of wild LAB strains to modulate cheese flavour and aroma.

Acknowledgments

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