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AN ALTERNATIVE SURFACE CULTURE FOR SALAMI

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Introduction

In meat processing, surface cultures are mostly applied for firm raw sausages and some raw cured meat products as dried beef (e.g. Buendnerfleisch). Their use facilitates flavor formation, microbial competitiveness, peeling of the skin and protection against too intense drying and oxidation processes (Sunesen and Stahnke, 2002). To get a more unique color on the surface, rice meal or marble powder are sometimes supplemented additionally. Penicillum strains (mainly *Penicillum nalgiovense*) are the principal components of such cultures, whereas yeast strains can be introduced to improve skin adhesion (Sugimoto, 2004).

Objectives

Based on the long-term experiences of ALP in developing cheese surface cultures (Bachmann et al., 2005), a yeast culture originally dedicated to cheese was tested for its application to raw sausages as salami.

Methodology

The salamis were produced according to a traditional recipe with pork meat and beef, bacon, salt, herbs and some additives (including starter culture Scheid LMP, nr. 7527) at the ABZ Spiez. Meats and bacon were minced, mixed with the other components and stuffed into natural skins for both treatments together. One group of the salamis was then dipped into a suspension of surface culture Scheid nr. 7615 with *Penicillum nalgiovense* (control salami, CS), the other group was treated with a suspension of an ALP culture with *Geotrichum candidum* (experimental salami, ES). To avoid cross contamination between the two groups, seven salamis per treatment were air-dried in two separated climate chambers for five weeks by allowing a reddening period of five days at the beginning of the drying process.

The sausages were analyzed for nutrient contents and microbial counts by the usual chemical, enzymatic and microbial methods.

Aroma components were characterized by solid-phase microextraction (SPME) gas chromatography - mass spectrometry (GC-MS) in combination with GC-olfactometry (GC-O) by a panel of six trained internal panelists. Identification was based on the linear retention index (RI), mass spectrum and odor quality of the compounds.

The salamis were also assessed for their sensory profile (14 different odor, flavor and texture criteria on a 10-point intensity scale) by a panel of ten trained internal panelists.

In three salamis per treatment, culture adhesion on the surface (as relative skin friction) and skin peeling were determined by inhouse-methods (Guggisberg, 2005). Warner Bratzler shear force was measured to characterize salami firmness.

Results & Discussion

Nutrient and lactate contents were similar for ES and CS (table 1). Dry matter content was slightly higher in ES, which could be due to minor condition differences in the two chambers. Nitrate reduction seemed to be elevated in ES, which is indicated by a higher nitrite and a lower nitrate concentration. It may be partly explained by the also higher pH value (+ 0.34 units).

Table 1: Nutrient content, lactate content and pH in salami (per kg salami)

Parameter	**Control salami (CS)**	**Experimental salami (ES)**
Dry matter (g)	640	624
Crude protein (g)	265	247
Crude fat (g)	325	317
Crude ash (g)	55	48
Nitrate (mg)	2.22	2.02
Nitrite (mg)	0.70	1.47
L-lactate (g)	3.23	2.95
D-lactate (g)	2.14	2.26
Total lactate (g)	5.37	5.21
Percentage of L-lactate (%)	60.1	56.6
pH	6.39	6.73

Table 2: Microbial counts in salami (CFU/ml)

Type of microorganism	**Control salami (CS)**	**Experimental salami (ES)**
Moulds	7.6×10^3	7.1×10^3
Yeasts	< 10	< 10
Lactic acid bacteria	2.2×10^8	2.2×10^7
Salt-tolerant bacteria	5.1×10^5	9.9×10^5
Enterococcaceae	6.6×10^3	4.1×10^3
Bacillus cereus	< 10	50
Aerobic psychrotrophic bacteria	1.8×10^8	1.1×10^8
Coagulase-positive Staphylococcaceae	< 10	< 10
Enterobacteriaceae	< 10	< 10
Coagulase-negative Staphylococcaceae	5.5×10^5	1.1×10^6
Pseudomonadeae	< 10	< 10
Pediococcaceae	7.5×10^5	1.8×10^6

Microbial counts were comparable (table 2) and fulfilled Swiss regulations. *Bacillus cereus* was only detected in ES, whereas lactobacilli were 10 times higher in CS. In both treatments, no yeasts but similar counts for moulds were found. This may be due to the fact that the salami samples were peeled for the microbial analyses, according to the eating process. It may be concluded for future trials, that microbial analyses should also be performed for intact salami (including the skin).

Sensory panel tests showed no significant differences for none of the odor, flavor and texture characteristics evaluated (figure 1). This is in accordance to Selgas et al. (2003), who also found no significant differences in organoleptic characteristics between control and yeast-inoculated dry fermented sausages, in spite of the enzymatic activity of the yeasts. In general, the salamis were characterized by a quite high tenderness, medium intense salty and spicy notes as well as by slightly pungent and roasted notes.

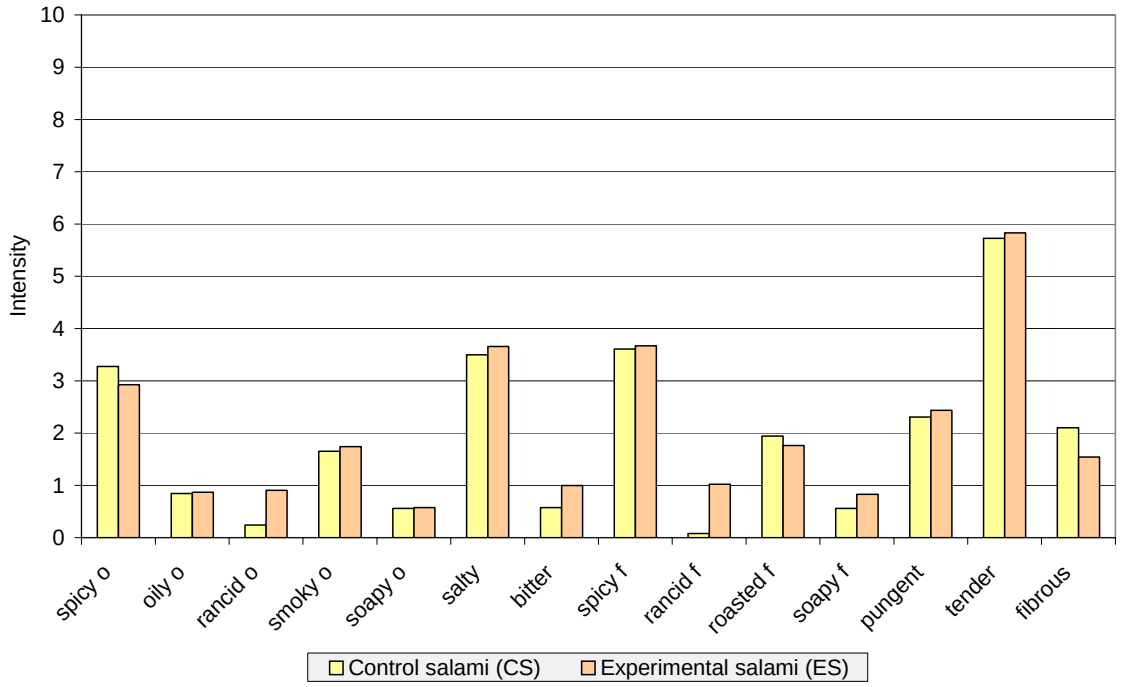

Fig. 1: Sensory profile of the two salami types (o = odor, f = flavor)

Preliminary results for aroma analysis obtained by GC-O in combination with GC-MS revealed an intense roasty popcorn-like odor note, identified as 2-acetyl-1-pyrroline present in both samples. 2-Acetyl-1-pyrroline was first described in salami by Stahnke (2000) and also found by Blank et al. (2001) in Italian-type salami. Both samples revealed the presence of terpenes and sulfur aroma compounds which are mainly caused by spices or feed of plant origin, e.g. allyl sulfide, diallyl sulfide, α- and β-pinene, α-phellandrene, limonene and linalool. Typical lipid oxidation products such as the mushroom-like smelling 1-octen-3-ol, aldehydes such as hexanal (green odor note), heptanal and nonanal (both having a fatty, soapy aroma) were detected in both types of salami. 2-Heptanone and 2-nonanone, further lipid oxidation products, were also found in both salami types, however, the peak heights differed between the two types of salami. 4-

Heptanone was only present in the ES sample. The higher signals for the ketones originating from lipid oxidation in the ES sample, might be at least partly responsible for the slightly more pronounced rancid note perceived for ES by the sensory panel. CS alone revealed the presence of the roasty smelling 2,5-dimethyl pyrazine and showed 10 times higher peak intensities for 2,6-dimethyl pyrazine which was described as roasty by the panelists, too (table 3). Only in ES, 2,3-butandione, which exhibits a buttery-creamy aroma note, was detected by GC-O. These results indicate some shift in metabolic pathway due to the type of surface culture as it was also stated by Sunesen et al. (2004).

Table 3: Prominent aroma differences detected in the two types of salami

Aroma compound	**Linear retention index (RI)**	**Control salami (CS)** ***Peak height/1000***	**Experimental salami (ES)** ***Peak height/1000***
1-Octen-3-ol	978	51	74
Hexanal	793	303	441
Heptanal	896	81	94
Nonanal	1'099	166	189
2-Heptanone	886	27	115
4-Heptanone	868	n.d.	96
2-Nonanone	1'087	67	309
2,3 Butandione	575	n.d.	detected by GC-O only
2,5-Dimethyl pyrazine	908	22	n.d.
2,6-Dimethyl pyrazine	904	226	23

n.d. = not detected

No treatment differences could be seen in firmness by WBSF (table 4). Culture surface adhesion was significantly lowered and peeling was easier ($p < 0.10$) in ES.

Table 4: Skin adhesion and firmness of salami

Parameter (n = 3)	**Control salami (CS)**	**Experimental salami (ES)**	**p-value**
Relative skin friction (‰ of salami weight)	0.468 ± 0.084	0.804 ± 0.173	0.01
Skin peeling - average of force (50-150 mm) [N]	1.680 ± 0.169	1.141 ± 0.340	0.07
- median of force (50-150 mm) [N]	1.674 ± 0.187	1.144 ± 0.360	0.09
Firmness - Maximum of force [N]	75.35 ± 22.02	82.39 ± 28.93	0.75
- Total work [mJ]	2'277 ± 195	2'351 ± 576	0.83

Conclusions

In comparison to CS, similar nutrient and lactate contents, a higher pH-value and an increased nitrate reduction could be seen for ES. Microbial counts were also comparable and in the regulation limits. Similar characteristics were observed in sensory profiles in CS and ES, whereas remarkable differences were determined for some single aroma components. Firmness was comparable between the two salami treatments, whereas the easier peeling of the skin in ES could be in relation with the decreased adhesion on the skin.

It was concluded that the tested cheese yeast surface culture can be a valuable alternative to the known mould applications for salami. Further analyses should elucidate whether the yeasts are also competitive to unfavorable moulds (Vallone et al., 1995), which may occasionally appear in some processing plants.

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