INVESTIGATION OF EXOPOLYSACCHARIDE-PRODUCING STRAINS IN FAT-REDUCED SPREADABLE RAW FERMENTED SAUSAGE

Jonas Hilbig[1*], Julia Gisder[1], Myriam Loeffler[1], Kurt Herrmann[1] and Jochen Weiss[1]

[1]Department of Food Physics and Meat Science, Institute of Food Science and Biotechnology, University of Hohenheim, Garbenstrasse 21/25, 70599 Stuttgart, Germany

I. INTRODUCTION

Nowadays meat products are often associated with a negative influence on human health not only but also due to their high fat content (product dependent). The consumers' demand for healthier products is hence a challenge the meat industry has to face [1]. Spreadable raw fermented sausages ("Teewurst") usually contain approx. 40% fat to guarantee a soft texture and hence spreadability at a product pH of ~ 5. Therefore, reducing the fat content is directly related to a decrease in spreadability [2]. However, *in-situ* produced microbial exopolysaccharides (EPS) could be a possible solution to maintain spreadability of fat-reduced products through the formation of an EPS-protein network. Depending on the *Lactobacillus* ssp., sugar source and processing conditions used homopolysaccharides (HoPS) or heteropolysaccharides (HePS) may be formed [3]. We therefore hypothesize that the application of a HePS- (*Lactobacillus plantarum* TMW 1.1478) or HoPS- producing strain (*L. sakei* TMW 1.411 or *L. curvatus* TMW 1.1928) may improve spreadability of fat-reduced raw fermented sausages through *in-situ* EPS formation without having a negative influence on the sensory properties of the final products.

II. MATERIALS AND METHODS

Preparation of fat reduced raw fermented sausages:
The sausages were prepared using lean pork meat (60, 70, 80%), pork belly fat S IX (20, 30, 40%), spices, nitrite curing salt (NCS containing 0.5% NO_2^-; 26 g/kg), either glucose or sucrose (5 g/kg), and the respective starter culture (~10^6 CFU/g meat). For each fat content a control batch with a non-EPS forming strain (*L. sakei* 1.2037) was produced. The meat and the fat tissue were minced (2 mm) and afterwards chopped (3000 rpm) with all ingredients except the salt. Finally, NCS was added, the meat batter again chopped (1500 rpm), filled into casings (caliber 45) and then placed in a smoke chamber to ferment the sausages at 24 °C for 24 h. Afterwards, the sausages were smoked for 1 h at 24 °C and dried at 18 °C until a weight loss of 6% was reached.
Chemical and physical investigations:
The pH-value and weight of the samples were monitored during the fermentation- and drying period. The total microbial load (Plate count agar; aerobic incubation, 24 h at 30°C) of the raw material as well as the growth behavior of the starter cultures (MRS agar; anaerobic incubation, 48 h at 30°C) were evaluated directly after production, after 24 h of fermentation and in the final product. The texture properties of the samples were investigated performing a texture profile analysis (TPA; double compression method), rheological measurements (frequency sweep test), and a sensory evaluation with 20 panelists (comparison to the respective control samples). A paired t-test was performed using SPSS (IMB SPSS Statistics 24, IBM, USA) for the TPA and rheological measurements to investigate significant differences between the samples and the control ($p < 0.05$). The fat content was determined according to the method by Weibull-Stoldt and the EPS content (detected: glucose, galactose/mannose, rhamnose) quantified using HPLC.

III. RESULTS AND DISCUSSION

The raw material quality was in the acceptable range (10^3 – 10^4 CFU/g) and the number of anaerobic viable cell counts increased during the fermentation and drying period from ~10^6 CFU/g sausage to ~10^7 CFU/g for *L. sakei* 1.411 and to ~10^8 CFU/g sausage for *L. plantarum* 1.1478 and *L. curvatus* 1.1928, respectively. Accordingly, the pH-values of the sausages decreased from around 5.65 ± 0.15 to 4.95 ± 0.15, depending on the strain used. The final fat content ranged between 31-33% for 40% added belly fat S IX, 24-26% for 30%, and 17-20% for 20% added belly fat, respectively. No significant differences in texture could be determined between sausages produced with the HePS-producing strain *L. plantarum* 1.1478 and the corresponding control (*L. sakei* 1.2037), whereas sausages produced with *L. sakei* 1.411 or *L. curvatus* 1.1928 were found to be significantly softer as demonstrated in Figure 1. The rheological measurement results showed the same tendency. The loss and storage moduli were smaller compared to the corresponding controls, which indicates a softer structure. In Table 1 the determined EPS concentrations (example: sausages with 30% added belly fat) are shown and were found to be much higher for sausages produced with the HoPS-producing strains (independent of fat content), which can be explained by the less energy-demanding pathway of EPS formation. Table 2 exemplarily summarizes results of the sensory analysis performed with raw fermented sausages produced with 30% added belly fat. All samples containing EPS-forming strains were found to be softer (improved spreadability) and had a better mouthfeel as compared to control samples. Except for *L. plantarum* 1.1478 the taste of the sausages was not negatively influenced in presence of the EPS- and non-EPS producing strains, independent of the fat content used.

Table 1 Determined EPS concentrations (control subtracted) in sausages produced with 30% added fat.

strain	EPS concentration (g/kg sausage)
L. plantarum 1.1478	0.30 ± 0.04*
L. sakei 1.411	0.48 ± 0.04*
L. curvatus 1.1928	0.86 ± 0.01*

*Numbers are means ± standard deviations from duplicates, each examined two times (n=4)

Table 2 Results of the sensory evaluation of sausages (30% added belly fat) produced with EPS forming starter cultures compared to control samples (control = 5; > 5 indicates softer products, better mouthfeel and/or taste).

Strain	Attribute
	Hardness
L. plantarum 1.1478	5.90 ± 1.65*
L. sakei 1.411	6.04 ± 1.34*
L. curvatus 1.1928	6.23 ± 1.46*
	Mouthfeel
L. plantarum 1.1478	5.86 ± 1.15*
L. sakei 1.411	6.07 ± 1.19*
L. curvatus 1.1928	6.45 ± 0.99*
	Taste
L. plantarum 1.1478	4.66 ± 1.47*
L. sakei 1.411	5.02 ± 1.08*
L. curvatus 1.1928	5.45 ± 1.53*

*Numbers are means (n = 20) ± standard deviations

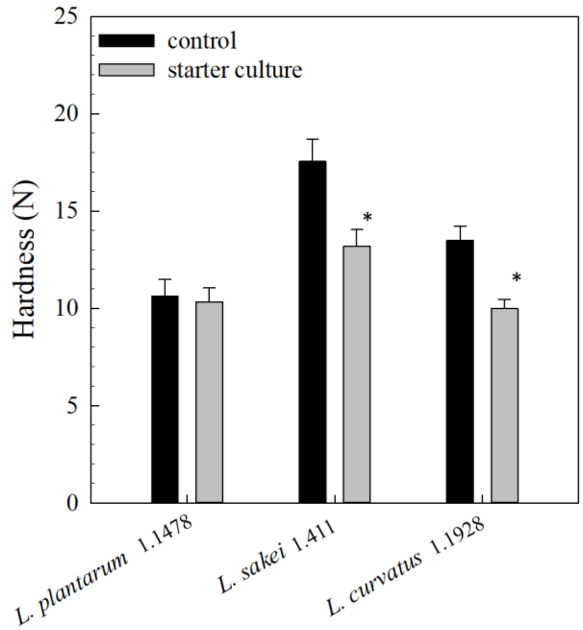

Figure 1. Texture profile analysis of sausages produced with 30% belly fat and the different starter cultures (n=10). An asterisk indicates significant differences to control samples (P < 0.05).

IV. CONCLUSION

The results of the study clearly demonstrate that texture and spreadability of fat-reduced raw fermented sausages can be significantly improved by adding HoPS-forming starter cultures during processing. The results are thus of great interest to the meat industry.

V. ACKNOWLEDGEMENTS

This project was supported by the FEI (Forschungskreis der Ernährungsindustrie e.V.), Bonn, Germany via AiF/BMWI (AiF 18357N).

REFERENCES

1. Weiss, J., Gibis M., Schuh V., Salminen H. (2010). Advances in ingredient and processing systems for meat and meat products. Meat Science 86: 196-213.
2. Feiner, G. (2006). Meat products handbook: Practical science and technology. Elsevier.
3. Vu, B., Chen M., Crawford R. J., Ivanova E. P. (2009). Bacterial extracellular polysaccharides involved in biofilm formation. Molecules 14: 2535-2554.