P-05-11

Surface treatment with condensed phosphates reduced efflorescence formation on dry fermented sausages with alginate casings (#315)

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Introduction

White efflorescence consisting of crystalline complexes formed on the surface of dry-fermented sausages is a big issue for the meat processing industry, because consumers reject the affected products because of misjudging it as microbial spoilage. However, the formation of white efflorescence is a physical mass transport phenomenon of acids and minerals from the core to the surface of the sausage [1]. It has been shown that the efflorescence formation is faster and more pronounced on sausages with alginate casings than with natural or collagen casings [2]. Alginate films are cross-linked with bivalent calcium ions which are mostly used in the form of calcium chloride ($CaCl_2$) solutions [3]. This could trigger the fast white efflorescence formation on the surface by complex formation with lactates. Di- and polyphosphates are known for the ability to form complexes with alkaline earth metals like magnesium and calcium [4]. Therefore, solutions (5%) of different commercially available phosphates, mixture of di- and polyphosphates TARI S78 and two polyphosphates P68 and P69, were applied to the surfaces of the sausages after drying to a weight loss of 42.5%. The hypothesis was that the addition of the chelators could bind the calcium and magnesium ions, which trigger the efflorescence formation.

Methods

Production of sausage and sample preparation

48 kg of sausage batter with following composition were produced: 35% minced lean pork shoulder (+2°C), 45% frozen lean pork shoulder (-10°C) and 20% frozen pork back fat (-18°C). 28 g/kg nitrite curing salt (0.5% nitrite), 0.1 g/kg starter culture (TEXEL® SA-308), 3 g/kg white pepper, 5 g/kg dextrose, and 0.5 g/kg ascorbic acid were added. The sausage batter was produced in a bowl chopper and co-extruded by an alginate co-extrusion unit (ConPro-System, Handtmann Holding GmbH & Co.KG) with a calcium alginate casing (90% water, 10% alginate powder). The sausages had a casing thickness of 0.2 mm and a caliber of 19mm. The alginate gel was cross-linked with a 25% $CaCl_2$ solution. Subsequently, the sausages were fermented and dried to a weight loss of 42.5%. After drying the sausages were divided into four batches. The control batch was not surface treated, whereas the other three batches were dipped for 5 s into 5% phosphate solutions. Two polyphosphates, P68 (chain length 17, pH 6.6) and P69 (chain length 22, pH 6.4) and one mixture of di- and polyphosphates (TARI S78, pH 5) were used. After dipping, the sausages were packaged in vacuum bags under modified atmosphere (20% CO_2, 80% N) and stored up to 8 weeks at 4 °C. 12 randomly selected sausages were taken for optical and chemical analyses every second week. The sausages were cut into four different layers, the surface layer with a thickness of 0.6 mm, layer I and II with 1.2 mm, and the core with a diameter of 6 mm.

Chemical, Image and Sensory Analysis

The elements calcium, magnesium, potassium, and sodium of the layers were quantified. The sensory analysis was conducted with at least 20 test persons. To conduct the image analysis, the sausages from the sensory evaluation were cut in half lengthwise (n = 16 halves). The surface of the halves was scanned and digitalized. All analyses were done according to Walz, Gibis [1].

Results

Figure 1 shows the visual appearance of the sausage during 8 weeks storage. On the control sample the white efflorescence formation started after 2 weeks. Compared to the control, the sausages treated with phosphates showed no or very less formation during storage. For a better comparison, a sensory and an image analysis were performed (**Figure 2**). Moreover, to evaluate whether the sensory and the image analysis are comparable, the correlation coefficient was calculated, and showed high correlations (control $r = 0.99$; TARI S78 $r = 0.84$; P68 $r = 0.98$; P69 $r = 0.93$).

The determination of the magnesium content is showed (**Figure 3**). The content of magnesium in the surface layer of the control significantly increased ($p < 0.05$) during the storage, from 0.58 ± 0.02 to 1.55 ± 0.11 mg/g DM after 6 weeks, whereas the content in the surface-treated samples increased only slightly (P68 and P69) or remained at the same level (TARI S78). The increase of magnesium on the surface of the control is due to the removal of magnesium ions from the diffusion equilibrium by complex formation with lactate on the surface leading to an increased diffusion of magnesium.

Conclusion

The study showed a promising approach to inhibiting the white efflorescence formation on dry-fermented sausages by the surface treatment with condensed phosphates after the drying. The efflorescence-causing mass transport of magnesium and calcium ions could be inhibited due to the com-

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plexation with condensed phosphates inside the sausage, preventing them from reaching the surface of the product. However, due to the weakening of the casing stability, the approach should be improved in further studies. For example, the concentration of the condensed phosphates in the solution could be modified in such a way that the free calcium cations would only be chelated and, simultaneously, the complexation of the calcium ions of the calcium alginate casing would be minimized.

References

1. Walz, F.H., et al., *Chemical and optical characterization of white efflorescences on dry fermented sausages under modified atmosphere packaging.* Journal of the Science of Food and Agriculture, 2017. **97**(14): p. 4872-4879.
2. Walz, F.H., et al., *Influence of casing material on the formation of efflorescences on dry fermented sausages.* LWT, 2018. **89**: p. 434-440.
3. Rhim, J.-W., *Physical and mechanical properties of water resistant sodium alginate films.* LWT - Food Science and Technology, 2004. **37**(3): p. 323-330.
4. Bobtelsky, M. and S. Kertes, *The polyphosphates of calcium, strontium, barium and magnesium: Their complex character, composition and behaviour.* Journal of Applied Chemistry, 195 **4**(8): p. 419-429.

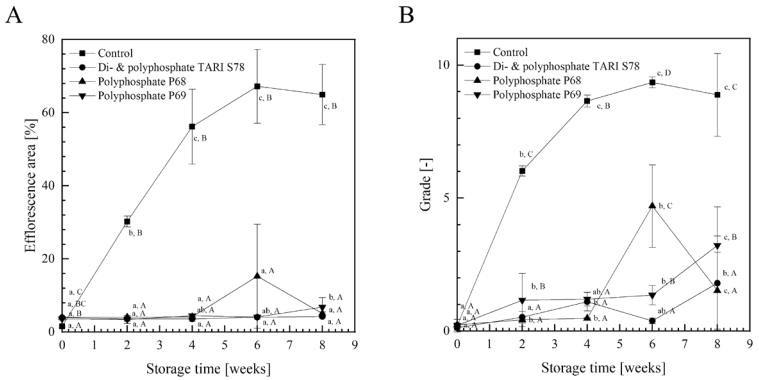

Figure 2. Optical sensory (A) and image analysis (B) of the sausage surfaces during storage.

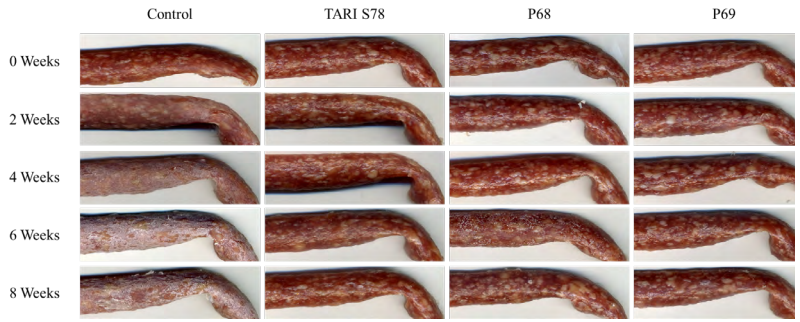

Figure 1. Visual appearance of the sausages during 8 weeks of storage

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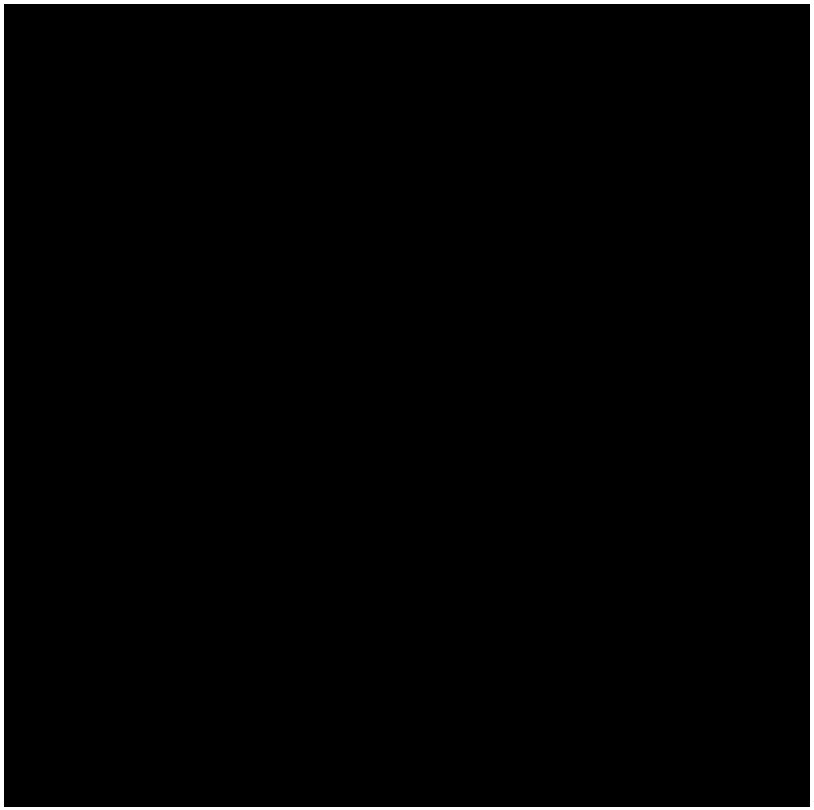

Figure 3. Magnesium content (mean ± standard deviation mg/g DM) of the sausages (A=Control, B=TARIS78, C=P68, D=P69) during storage.

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