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# DEVELOPMENT AND EVALUATION OF LIPID SUBSTITUTION APPROACHES TO REFORMULATION OF RAW FERMENTED SAUSAGE

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## I. INTRODUCTION

Natural lipids are mixtures of lipophilic substances consisting mainly of esters of glycerol and various fatty acids. The chemical structure of the fatty acyl residues has the crucial influence on the physical state of the triglycerides and the whole lipid matrix of a biomaterial, such as adipose tissue. More specifically, the presence of double bonds within the acyl moieties decreases drastically the melting point of a triglyceride: for instance, melting points of two triglycerides fully substituted with saturated octadecanoic (stearic) acid $C_{17}H_{35}COOH$ and monounsaturated octadecenoic (oleic) acid $C_{17}H_{33}COOH$ in $\beta'_1$ crystal form are 64°C and -13°C respectively [1,2]. For that reason the direct substitution of animal fat with a vegetable oil in meat products would inevitably lead to textural changes and increased softness of the product. Softness is a desired quality in such products as spread sausage. However it can have a negative influence on the acceptability of firm sausage, such as salami. Furthermore, certain meat products such as mortadella or firm raw fermented sausage are expected to present the traditional image containing visible lipid particles.

## II. MATERIALS AND METHODS

*Preparation of ethylcellulose (E462) oleogel.* Ethylcellulose (Ethocel 100 cP and 45 cP) was kindly donated by Dow Deutschland Anlagengesellschaft mbH. Production of oleogels was adapted from Zetzl et al. [3].
*Preparation of oleogel emulsion.* To prepare an oleogel emulsion a high-speed homogenizer (Bühler Ho 4, Hechingen, Germany) was used. 16 g of the corresponding oleogel and 64 g of $Na_2HPO_4$ / $NaH_2PO_4$ buffer containing 2% of Polysorbate 80 emulsifier (pH 7.0) were homogenized for 3 min at 35'000 rpm. For the oxidation tests, a buffer containing 0.1 % of a spin-trapping reagent N-*tert*-butyl-α-phenylnitrone (PBN) was used. Water-in-oleogel emulsion was separated from the excess of buffer by filtration or decantation.
*Measurement of primary oxidation.* The procedure for the accelerated oxidation method was adapted from Velasco [5]. The measurements were performed on ESR spectrometer Magnettech MS5000.

## III. RESULTS AND DISCUSSION

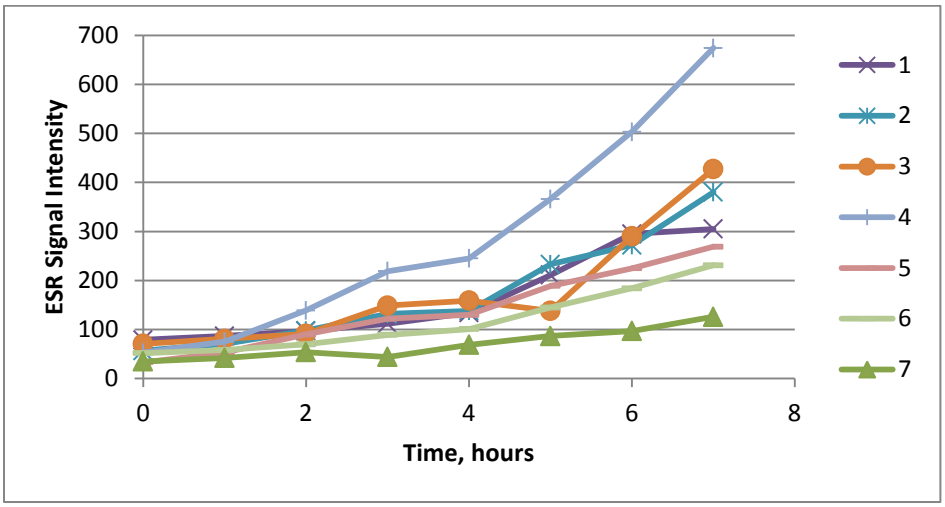


Figure 1. Accelerated oxidation of rapeseed oil, water/oleogel and water/oil emulsions

| Sample | Rapeseed oil | Ethylcellulose (EC) | Phosphate buffer |
|---|---|---|---|
| 1 | 81% | 9% 100 cP | 10% |
| 2 | 83.7% | 6.3% 100 cP | 10% |
| 3 | 70.2% | 7.8% 45 cP | 22% |
| 4 | 72.5% | 5.5% 45 cP | 22% |
| 5 | 100% | - | - |
| 6 | 90% | - | 10% |
| 7 | 80% | - | 20% |

Table 1. Composition of the samples 1-7 at Fig.1

Commercial ethylcellulose (EC) is characterized by the viscosity in a reference solution [3]. The viscosities of EC type 45 cP and type 100 cP are translated to the peak molecular weights 72.8 and 80.8 kDa respectively [5].

Prooxidative activity of EC in a blend containing rapeseed oil has been reported by Kim et al [6]. Indeed, water-in-oleogel emulsions demonstrate higher oxidation rates than water-in-oil emulsions (Fig. 1). Similarly to the oxidation of bulk oleogels [6], the dependence of the oxidation rate from EC concentration in water-in-oleogel emulsions appears to have a non-linear character. From the other hand, two different types of EC have a different effect on the oxidation of water-in-oleogel emulsions, which might be negatively correlated with the molecular weight of the polymer gelator.

## IV. CONCLUSION

A novel approach to the fat replacement in raw fermented sausage has been developed. Oleogel-based back fat replacers have demonstrated considerable potential for applications in raw fermented sausage [7]. Oxidative stability of oleogel emulsions can be improved by using higher concentration of EC and higher molecular weight polymers.

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