Action of Emulsifiers in Finely Comminuted Cooked Sausage (Brühwurst)

S.-H. CHEONG, D. JAUD and A. FISCHER

Institut für Lebensmitteltechnologie, Universität Hohenheim, W-7000 Stuttgart 70, Germany

SUMMARY

The aim of this study was to contribute to the clarification of the mechanism of action of certain emulsifiers in cooked sausages, and to establish criteria for the selection of suitable emulsifiers. The instability of the sausages was largely attributable to high jelly separation. The degree of fat separation was very low. None of the emulsifiers reduced the degree of jelly separation. No synergistic effect of emulsifiers with phosphate or citrate was observed. With current recipes and manufacturing technology, therefore, it is not necessary to add emulsifiers because fat stabilization is of subordinate importance. In the production of cooked sausages with reduced salt content and without the aid of phosphate or citrate, emulsification and stabilization of fat, which may otherwise be impaired, can be supported by appropriate emulsifiers.

INTRODUCTION

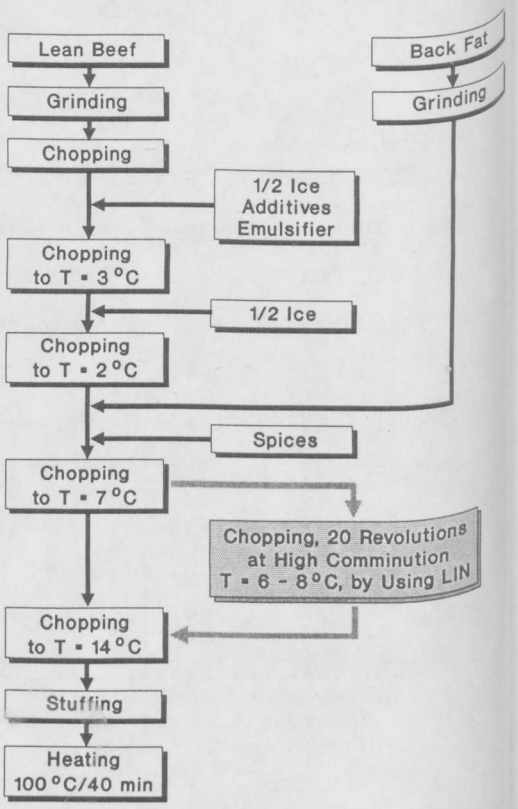
Water binding and fat binding are the decisive processes in the stabilization of the complex system of finely comminuted cooked sausage. Swollen and dissolved fibrillar muscle protein is responsible for the binding of water and fat and for structure formation. If insufficient myofibrillar muscle protein is activated during the production process, unstable products may result; their technological deficiencies become apparent in the form of fat and jelly separation. These deficiencies can be reduced by the addition of emulsifiers, which improve the formation or stabilization of emulsions (GDCh, 1983). While the positive effect of emulsifiers in simple emulsion systems is undisputed, contradictory results have been obtained on their behaviour in the complex system of cooked sausage (MEYER et al., 1964; SCHLATTERER, 1965; ABOUL-SAAD, 1976; HONIKEL and HAMM; 1983a). This study is intended to contribute to clarifying the mechanism of action of emulsifiers in finely comminuted cooked sausages and to establish criteria for the selection of suitable emulsifiers.

MATERIALS and METHODS

The raw materials used for production of the cooked sausages were beef shoulders with sinew and fat coarsely removed and back fat free of attached muscle and rind remnants. After being cut into roughly fistsized pieces, for standardization the materials were separately mixed, minced through a 3 mm plate and portioned. The cooked sausages were produced from a recipe of 42 % beef, 30 % back fat and 28 % ice in a 20-l-chopper, using the manufacturing model shown in Fig. 1. Each batch weighed 5 kg. 16 g nitrite curing salt, 0.5 g sodium ascorbate and 6.5 g mixed spices were used per kg of total material, and, as appropriate, 3 g phosphate or citrate per kg of meat and fat.

According to KATSARAS and PEETZ (1988), a reduction in the proportion of meat or an increase in the proportion of fat, or greater comminution, should result in deficiencies in fat binding. Diverging from the previous recipe, therefore, cooked sausages were produced using a recipe of 30 % beef, 40 % back fat and 30 % ice, more intensively comminuted, in order to provoke fat separation and better to document the action of emulsifiers. The batch size was 12 kg; production was carried out in a 60-l-vacuum chopper. The greater degree of comminution of the batter was achieved by extending the

Fig. 1: Manufacturing of finely comminuted cooked sausage



chopping time (20 revolutions); liquid nitrogen (LIN) was used in this chopping phase to maintain the batter temperature in the region of 6 - 8 °C (see Fig. 1). The addition of phosphate was reduced to 1.5 g per kg of meat and fat; the remaining production steps were identical to those of the previous experiments.

The emulsifiers used were monoglycerides of edible fatty acids (MG), their esters with citric acid (CMG), lactic acid (LMG) or diacetyl tartaric acid (DATEM), ethoxylated mono- and diglycerides (EMG), sorbitan tristearate (STS) and polysorbate 65 (PS). The amount added was 5 g per kg meat and fat. It was applied in the form of a hydrate dispersion in order to obtain better distribution in the meat batter. The quantity of water used to produce the emulsifier hydrte dispersion was taken into account by reducing the quantity of ice by an equivalent amount.

The determination of fat and jelly separation described by FISCHER et al. (1990) served as a measure of the stability of the cooked sausages. The can was heated in a water bath at 95 °C in order to liquefy the fat and jelly separation, and after brief cooling was drained through a sieve into a bowl of defined weight. The percentage total separation was calculated from the drained liquid. Segregation into fat and jelly separations was performed after liquefaction of the total separation with hot water in a separating funnel. After isolation of the water phase, the fat separation was determined as a percentage. The jelly separation was calculated by subtracting the fat separation from the total separation.

RESULTS and DISCUSSION

Influence of emulsifiers on the stability of cooked sausages without phosphate or citrate: The control batch (K), produced without emulsifiers, hat 16.8 % jelly separation, but only 0.3 % fat separation. There is obviously sufficient swollen and dissolved muscle protein in this recipe, even without the use of phosphate or citrate, to stabilize the fat particles and prevent fat separation. It can also be seen that instability in cooked sausage is primarily exhibited by jelly separation (Fig. 2). All emulsifiers used had either no influence or a negative influence to a greater or lesser degree on fat and jelly separation. Only in the case of the STS batch could no fat separation be detected; in relation to total separation, however, this is of subordinate significance. The use of LMG or DATEM resulted in high fat and jelly separation (approximately 38 %),

Fig. 2: Influence of emulsifiers on the stability of cooked sausage without phosphate or citrate.
Batches with different superscripts are significantly different ($\alpha = 0{,}05$), n = 8

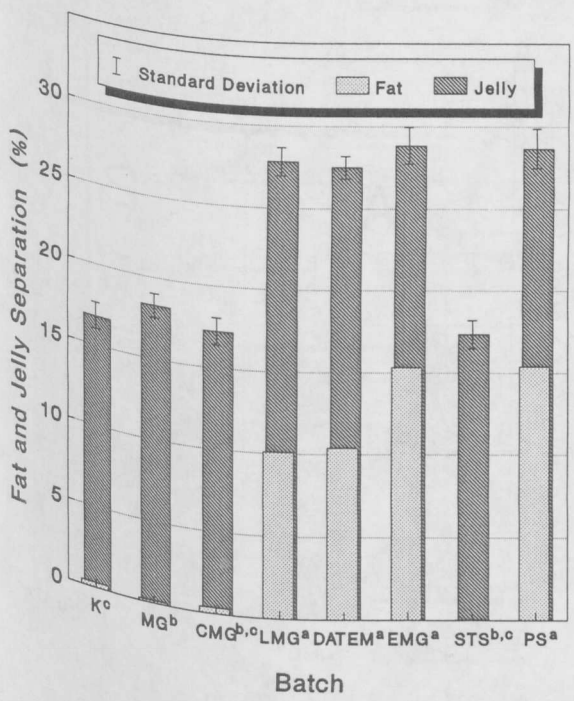
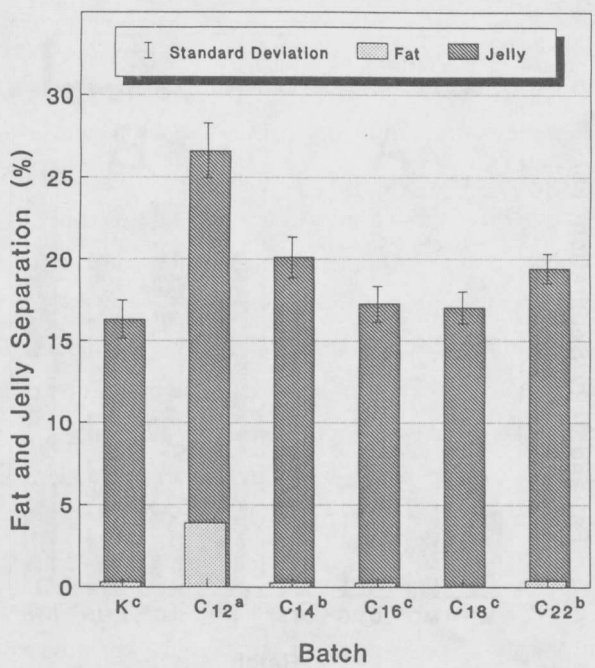


Fig. 3: Influence of monoglycerides with various chain lengths of fatty acid on the mechanism of action.
Batches with different superscripts are significantly different ($\alpha = 0{,}05$), n = 8



10 % beeing fat separation. The two raw batters were also very gritty in appearance. The LMG and DATEM hydr dispersions had pH values of 2.4 - 2.7 and 1.5 - 2.2 respectively. The pH values of the cooked sausage batters produc from those were 5.7 and 5.6 (control batch: 5.9). The lower pH value impaired the processes required for the binding water and fat. The functional characterisics of the myofibrillar proteins were plainly impaired as a result of negati interaction with these emulsifiers. The use of hydrophilic emulsifiers (PS and EMG) likewise resulted in high fat and jel separation (approximately 44 %). Similar negative effects were established by MEYER et al. (1964) and ABOUL-SA (1970). They attribute this to a negative change in the protein matrix caused by hydrophilic emulsifiers. An illustration these negative effects is provided by CHEONG (1991), who was able to detect agglomeration and rearrangement processes a liver protein network as a result of negative interaction with PS.

Influence of monoglycerides with various chain lengths of fatty acid on the mechanism of action: Monoglycerides wi C_{16} or C_{18} showed lower fat and jelly separation than monoglycerides with C_{12}, C_{14} or C_{22} (Fig. 3). Similar results we obtained by HONIKEL and HAMM (1983a), who established that fatty acids in monoglyerides with C_{16}, C_{18} or C_{20} exhi an optimum effect with regard to the stability of cooked sausage. Since these chain lengths correspond to those of the fat acids in the fats of slaughtered animals, they assume that these fatty acid esters are capable of positive interaction with fatty acids of the fat particles in the batter and hence of supporting the stabilization of the system. It must be said, though that the improvement in stability for the recipe used is not significantly different in comparison with the control.

Influence of emulsifiers in combination with phosphate or citrate: For all cooked sausages whether with or witho emulsifiers, the fat and jelly separation was reduced by phosphate (Fig. 4A) or citrate (Fig. 4B) in comparison with the sausages without phosphate or citrate (Fig. 2 and 3). In parallel with the results obtained by DENK and HONIKEL (1988) was extablished that none of the tested emulsifiers exhibited a synergistic effect because the stabilizers themselves alrea resulted in a hgh degree of batter stability.

Influence of emulsifiers in a low-meat and high-fat recipe with or without a greater degree of comminution: The fat-a jelly separation of the low-meat and high-fat cooked sausages with or without a greater degree of comminution, which are

Fig. 4: Influence of emulsifiers in combination with phosphate **(A)** or citrate **(B)**. Batches with different superscripts are significantly different (α = 0,05) n = 8

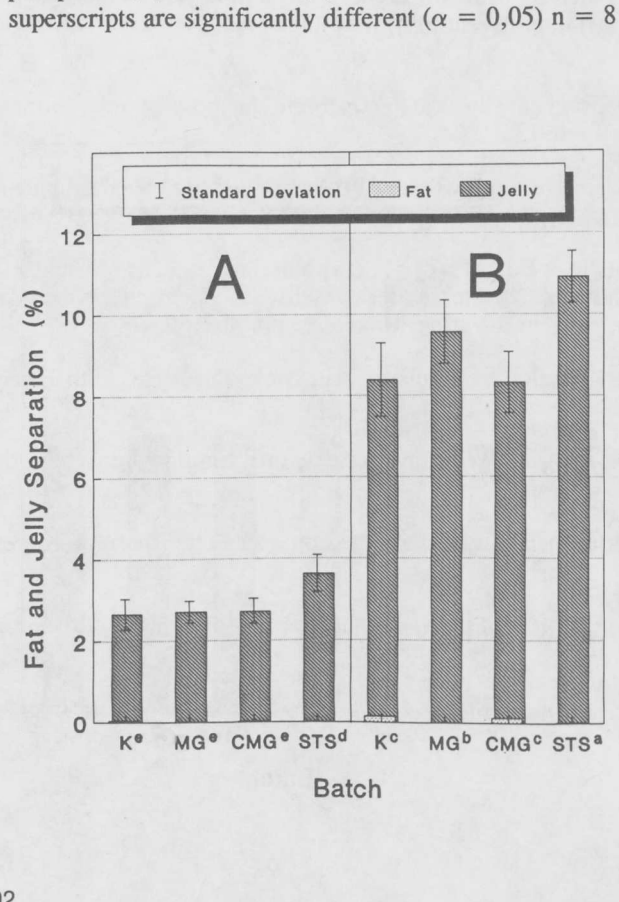
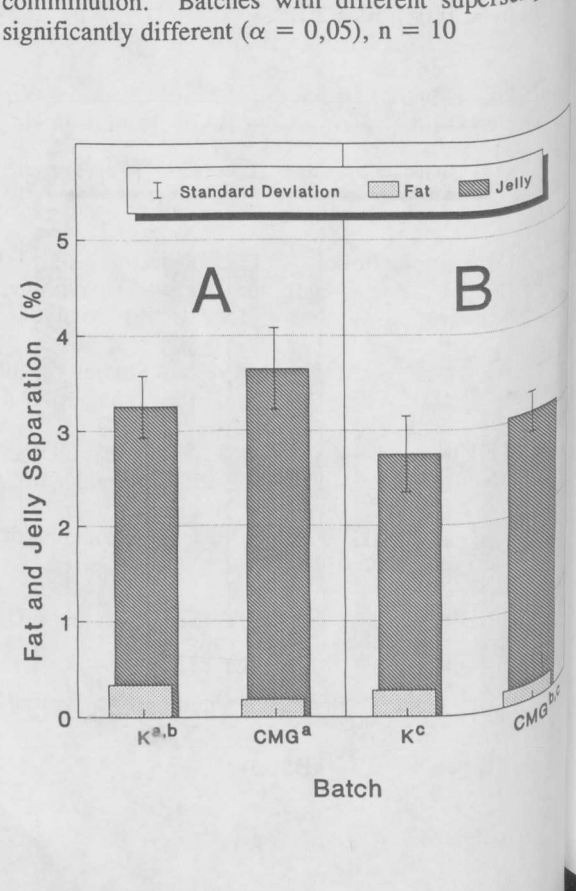


Fig. 5: Influence of emulsifiers in a low-meat and high fat recipe with **(A)** or without **(B)** a greater degree o comminution. Batches with different superscripts are significantly different (α = 0,05), n = 10



marketable in that combination, was merely 3.0 - 3.8 %, fat separation being 0.2 - 0.3 % (Fig. 5). The raw batters were very light in colour and extremely soft, but did not have a gritty appearance. Although only 30 % lean meat was used for production of the batters, a stable product was obtained even with a reduction in the addition of phosphate. The intention of increasing fat separation by varying the recipe and technology was not fulfilled, which was why the emulsifiers used showed no effect.

CONCLUSIONS

The resulting fat separation was negligible in all experiments. When certain lipophilic emulsifiers were used, fat separation was not detectable. In all experiments, the instability of the cooked sausages was essentially attributable to high jelly separation. Fat stabilization is only of subordinate significance in the structure-forming process when using conventional cooked sausage technology. According to HONIKEL and HAMM (1983b), emulsifier molecules increase the swelling of the unheated system of the cooked sausage by means of interaction with myofibrillar proteins. Depending on the type of emulsifier and the salt content, the emulsifier may interfere with or support the formation of a coherent network of denaturized myofibrillar proteins during heating and may increase or reduce the jelly separation. It was possible to detect the destabilizing effect in the experiments described here. An increase in swelling capacity and a resulting improvement in water binding, on the other hand, could not be achieved with any of the tested emulsifiers. With regard to increasing water binding, their use is unnecessary with the recipes for cooked sausage as commonly employed. If fat stabilization is impaired by a reduction in the addition of salt and the absence of phosphate or citrate, it can be supported by the use of suitable emulsifiers. According to the findings of these experiments and those of CHEONG and FISCHER (1991), monoglycerides of stearic acid or their esters with citric acid are suited to be used for stabilization of finely comminuted cooked sausage (Brühwurst), as well as finely comminuted spreadable liver sausage.

REFERENCES

ABOUL-SAAD, H.G. (1970): Studies on food emulsions. Diss. Univ. Georgia, Athens.

CHEONG, S.-H. (1991): Elektronenmikroskopische Betrachtung über die Fettstabilisierung und Einfluß von Emulgatoren bei feinzerkleinerter Leberwurst. Fleischwirtschaft 71: in Vorbereitung.

CHEONG, S.-H. und FISCHER, A. (1991): Wirkungsweise und Optimierung von Emulgatoren bei feinzerkleinerter Leberwurst (Teil I, II). Fleischwirtschaft 71: in Vorbereitung.

DENK, G. und HONIKEL, K. O. (1986): Über die Wirkungsweise von Glyceridemulgatoren, Diphosphat und Citrat in Brühwurstbräten. Mitteilungsblatt der BAFF Kulmbach Nr. 92: 6907 - 6913.

FISCHER, A., CHEONG, S.-H. und JAUD, D. (1990): Feinzerkleinerte Leberwurst - Wirkungsweise von handelsüblichen Emulgatoren. Fleischwirtschaft 70: 868 - 880.

GDCh (1983): Emulgatoren - Ihre Wirkung in Lebensmitteln. Bd. 1 der Schriftenreihe Lebensmittelchemie, Lebensmittelqualität. Fachgruppe Lebensmittelchemie und gerichtliche Chemie in der Gesellschaft Deutscher Chemiker (GDCh) - Arbeitsgruppe Zusatzstofftechnol. und -Analytik (Hrsg.), B. Behr's Verlag, Hamburg. pp. 46 - 50.

HONIKEL, K.O. and HAMM, R. (1983a): Studies on the mode of action of emulsifiers in cooked sausage. 29th Europ. Congr. Meat Research Workers. Proc. II, Salsomaggiore: 496 - 502.

HONIKEL, K.O. und HAMM, R. (1983b): Untersuchungen zur Wirkungsweise von Emulgatoren bei der Brühwurstherstellung. Der Metzgermeister 85: Nr. 25, pp. 6.

KATSARAS, K. und PEETZ, P. (1988): Elektronenmikroskopische Darstellung der Funktion von Fetten in Wurstwaren. Fleischwirtschaft 68: 1187 - 1192.

MEYER, J.A., BROWN, W.L., GILTNER, N.E. and GUINN, J.R. (1964): Effect of emulsifiers on the stability of sausage emulsions. Food Technol. 18: 1796 - 1798.

SCHLATTERER, B. (1965): Zur Bedeutung von Monoglyceriden für die Fleischverarbeitung. Diss. med. vet. Ludwig-Maximilians-Univ. München.