Food Chemistry **23** (1987) 235–243

Presalting Effects on Water Retention of Pork and Beef Batters

Svein Aage Gumpen & Oddvin Sørheim

Norwegian Food Research Institute, PO Box 50, N-1432 ÅS-NLH, Norway

(Received 14 May 1986; accepted after revision 16 June 1986)

ABSTRACT

Presalting effects were studied by measuring cooking loss as a function of chopping time for pork and beef batters. Presalting (ground meat/salt/water = 100/3/20, by weight, 24 h) as compared with direct salting in the chopper, substantially reduced the cooking loss of pork batters, but only when the batters were relatively coarsely chopped. With more extensive chopping (exceeding 10–15 min at low chopper speed) no presalting effects were found, indicating that salt diffusion, protein dissolution and myofibril swelling were completed also in control batters salted in the chopper. Presalting of beef had a much weaker, although similar, effect on water retention properties.

The practical implications are that presalting may help in reducing cooking loss of coarsely comminuted sausages, particularly pork products. Presalting, however, has no beneficial effect on finely comminuted, bowlchopper-produced sausages.

INTRODUCTION

The effect of presalting on the functional properties of chilled meat intended for sausage production is still obscure.

Reichert (1983) showed that presalting significantly increased the water retention of meat emulsions during heating, both at pasteurizing and sterilizing conditions. Hermansson (1982), on the other hand, concluded from industrial scale experiments that presalting did not affect the fat- or water-binding of frankfurter type sausages. Other authors have found positive (Acton & Saffle, 1969; Ranken, 1973; Puolanne & Ruusunen, 1980), or no (Hamm, 1957, 1958) effects.

Food Chemistry 0308-8146/87/$03·50

None of the cited studies included any examination of what are the optimum chopping times with regard to water binding. This is unfortunate, since both under- and overchopping will result in decreased water retention. Obviously, there is no reason to expect the optimum chopping time to be the same for presalted meat and control meat. Thus, the effect of presalting cannot be elucidated by simple comparisons of water retention after equal times of chopping.

The aim of this study was to elucidate the effects of presalting on the water retention of meat batters, by measuring the water-holding capacity of batters after different times of chopping, using presalted or control meat as raw materials.

Both pork and beef were used, since Reichert (1983) has indicated different effects of presalting of meat from the two species.

MATERIALS AND METHODS

Raw materials

Model experiments were performed with pork (23% fat) or beef (18% fat) trims, standardized, packed and frozen by the meat packer. The salt used was food grade sodium chloride ('vacuum-salt') without added nitrite. Commercial type products were made using similar raw materials plus other common ingredients.

Presalting of meat samples

Meat was thawed at 4°C, mixed and ground through a 5 mm plate. The ground meat was divided into two equal samples. One was mixed with salt and water (4°C) in a Vakona mixer for 8 min. Meat/salt/water was 100/3/20 by weight in the main experiment and 100/4/20 in an additional experiment to check the effect of different ionic strengths. The presalted samples and the untreated (control) ground meat samples were held covered at 3°C until used for batter productions 24 h later.

Production of model batters

Presalted samples (5 kg meat) were chopped with additional water (4°C) and control meat samples (5 kg) were chopped with salt and additional water (4°C) in a Kilia 20-litre bowl chopper at low speed, according to the schemes shown in Fig. 1. Samples for measurement of water retention ability were drawn at 4, 7, 10, 13, 18 and 25 min of chopping and placed in moisture-tight plastic boxes at 3°C.

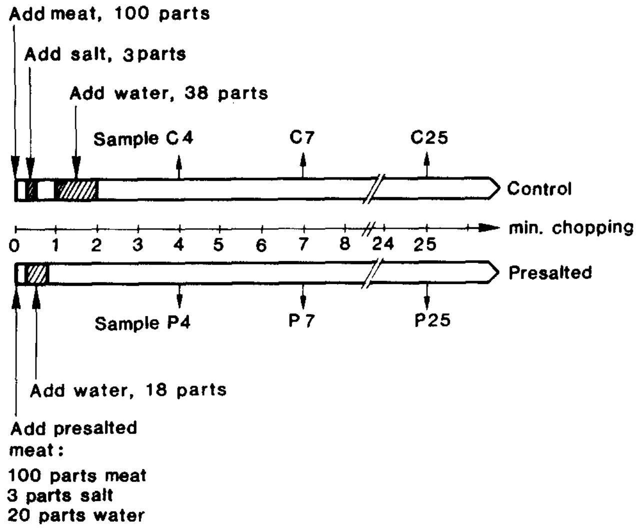

Fig. 1. Chopping and sampling scheme. Chopping at low speed (1500/10 rpm) in a Kilia 20 litre bowl chopper equipped with a six blades knife head. Control (C) and presalted (P) samples drawn at different times as indicated (4, 7, 10, 13, 18 and 25 min).

Preparation of commercial type batters and sausages

Sausages were made from presalted or unsalted pork meat, and other ingredients according to the recipes of Table 1.

The meat was ground and presalted as described above. The batters were produced by adding the ingredients to the meat in the Kilia chopper at low chopper speed. The total chopping time was 5 min, giving relatively coarse products. Samples were placed in closed plastic boxes at 3°C for later water retention measurements. Sausages for sensory evaluations were produced in 25 mm cellulose casings, smoked with atomized liquid smoke and cooked to 71°C internal temperature.

Determination of water retention ability

Model batters chopped at different lengths of time were examined after 4 h holding at 3°C. Six samples (approximately 10 g) of each batter were heated in test-tubes (15 ml) in a waterbath at 75·0 ± 0·2°C for 30 min. After 20 min of cooling, the cooked meat mixture was withdrawn from the tubes, and the released juice measured by weighing. The amount of released juice, expressed as per cent of raw batter weight, was taken as a measure (inverse) of the water retention ability. The water retention of commercial type batters was also determined after 4 h holding at 3°C by heating in test-tubes as described for the model batters.

TABLE 1
Commercial-Type Sausage Recipes
(Lean and fat meat were ground through a 5 mm plate. Presalting time was 24 h. All ingredients were mixed and chopped for 5 min in a six blades 20-litre Kilia bowl chopper at low speed (1500/10 rpm))

Ingredients	*Control (kg)*	*Presalted (kg)*
Pork (23% fat)	2·850	—
Presalted pork		
Pork meat 2·850		
Salt 0·090	—	3·510
Water 0·570		
Salt	0·090	—
Water	1·487	0·917
Potato starch	0·185	0·185
Skim milk powder	0·125	0·125
Spices	0·013	0·013
Pork fat trim (69% fat)	0·250	0·250

Sensory evaluations

Sausages at 68°C were served to a trained profile panel consisting of 10 persons. Seven different taste and texture properties were evaluated on 9-point scales (1 = very low, 9 = very high). Three production batches of each of presalted and control samples were used, and the test was performed twice.

RESULTS

The effect of a 24-h period of presalting of pork meat (meat/water/salt = 100/20/3, by weight) on the water retention of model batter is shown in Fig. 2. There is an appreciable improvement in the water-holding capacity of presalted meat as compared with the control meat, as seen at the early stages of chopping. The presalting effect gradually decreases and disappears as the chopping time increases.

Figure 3 demonstrates the corresponding effect for the beef model batters. The tendencies are the same as with pork. However, the presalting improvement of the water retention is about twice as high with pork as compared with beef.

Figures 4 and 5 compare the presalting effects at the high ionic strength

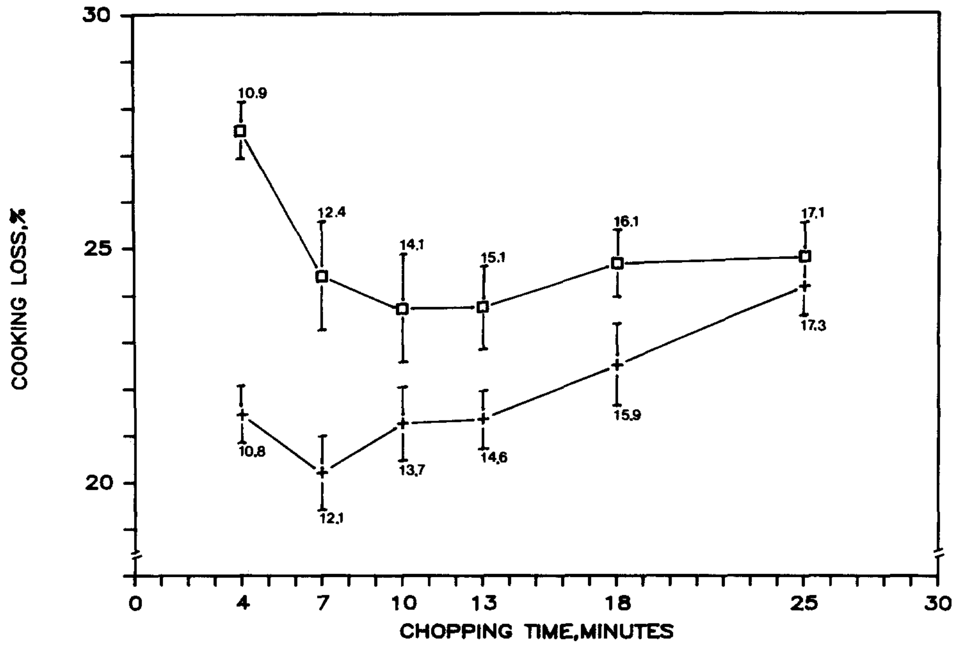

Fig. 2. Cooking loss of presalted (+) (meat/salt/water = 100/3/20, by weight) and control (□) model pork batters at different chopping times, as measured after heat-treatment of 10-g samples in test tubes in a waterbath at 75·0 ± 0·2°C for 30 min. Mean values of six batters ± SE. The numbers shown are mean batter temperatures (°C) at the various chopping times.

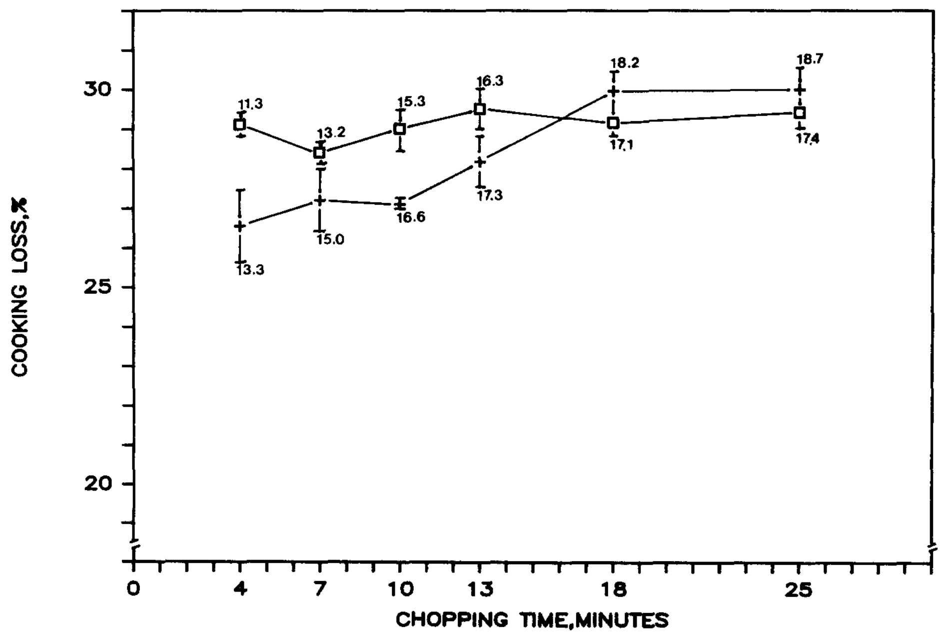

Fig. 3. Cooking loss of presalted (+) (meat/salt/water = 100/3/20, by weight) and control (□) beef model batters at different chopping times. Mean values of five batters ± SE. See Fig. 2 for further details.

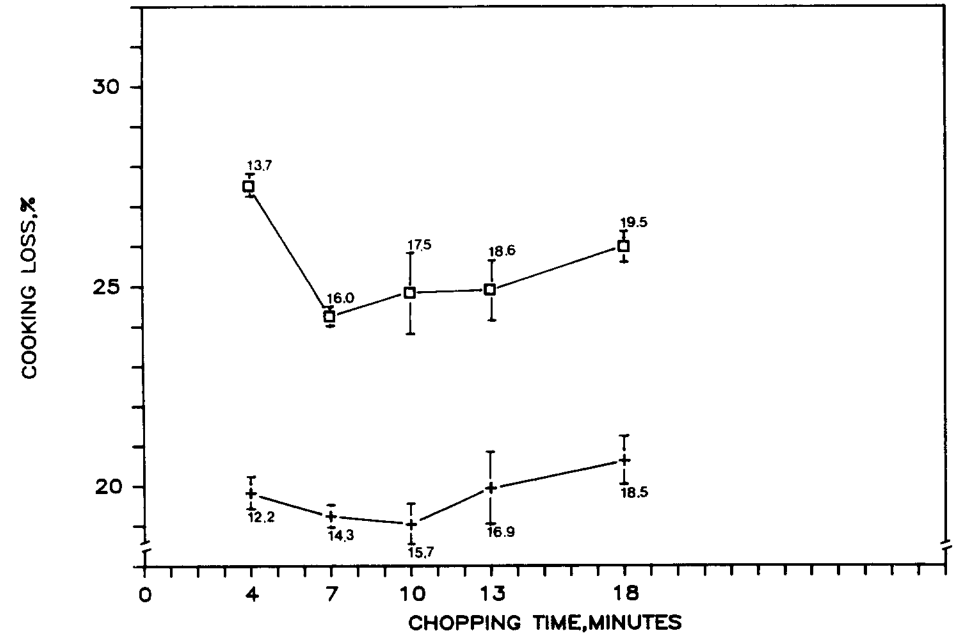

Fig. 4. Cooking loss of presalted (+) (meat/salt/water = 100/4/20, by weight) and control (□) pork batters at different chopping times. Mean values of two batters ± SE. See Fig. 2 for further details.

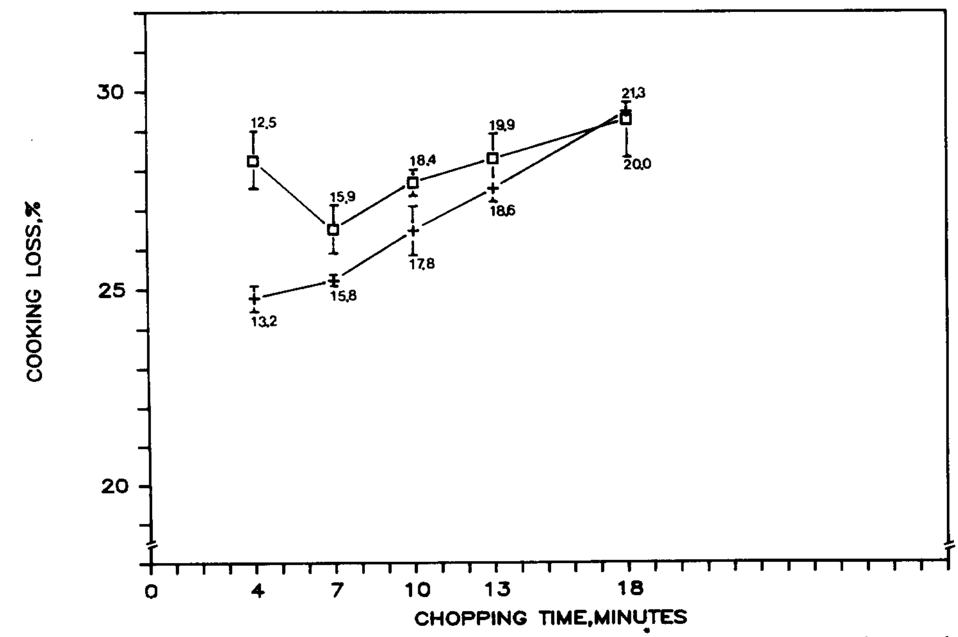

Fig. 5. Cooking loss of presalted (+) (meat/salt/water = 100/4/20, by weight) and control (□) beef batters at different chopping times. Mean values of two batters ± SE. See Fig. 2 for further details.

TABLE 2
Sensory Properties of Sausages made from Presalted or Control Pork Meat
(Recipe as in Table 1. Nine-point scales (1 = very low, 9 = very high). Mean ± SE of three batches) (No significant differences)

	Control	*Presalted*
Meat taste	5·5 ± 0·1	5·5 ± 0·2
Rancidity	1·6 ± 0·1	1·6 ± 0·2
Saltiness	4·4 ± 0·2	4·6 ± 0·2
Juiciness	5·8 ± 0·1	5·9 ± 0·2
Firmness	4·8 ± 0·1	4·6 ± 0·1
Coarseness	4·0 ± 0·3	3·7 ± 0·2
Adhesiveness	3·5 ± 0·1	3·5 ± 0·2

of presalted mixes with 4 parts of salt/100 parts of meat and 20 parts of water. Even at this high salt concentration the presalting effect on beef is very limited. The effect on pork, however, is even more pronounced than with the lower salt concentration.

The results of the sensory evaluation of commercial-type sausages, i.e. sausages containing added potato starch and skim milk powder, are shown in Table 2. No presalting effects were found. Likewise, no significant differences were found when the cooking losses of commercial-type batters were measured by the water retention ability tests. The cooking losses (%) were 12·2 ± 0·5 and 11·5 ± 0·4 for the batters made from control or presalted meat, respectively (Mean ± SE of six batters).

DISCUSSION

The binding curves (cooking loss as a function of chopping time) for presalted and control model batters differ, and the highest water retention with presalted meat is significantly better than the highest water retention obtained without presalting (Figs 2 and 3). A possible explanation can be given with reference to Fig. 2. With a 24 h period of presalting of ground meat (5 mm plate) there is no further dissolution of myofibrillar proteins or swelling of myofibrils during the subsequent comminution in the bowl chopper. Consequently, there is no further improvement of the water-holding capacity during chopping. In fact, the curve indicates that the water retention is at its best at the very beginning (4 min) of the chopping, and that it steadily decreases when the meat is further comminuted.

When, on the other hand, salt is added directly to the meat in the chopper, salt diffusion, protein dissolution and myofibril swelling need at least 10–15 min chopping time to be completed under the conditions used in these experiments. During that period the water retention tends to improve due to the effect of salt on protein solubility and myofibrillar swelling but, at the same time, to decrease due to increased disruptions of muscle fibres, as with the presalted mixture. Thus, due to this competition between the two opposing mechanisms, the u-shaped form of the binding curve (Fig. 2) is created. This competition also implies that the best water retention with direct salting can never exceed the best water retention obtained with presalting.

Our results confirm the findings of Reichert (1983) that the presalting effect on pork is larger than on beef. The results show, however, that this is not merely a difference in the meat's response to presalting, but a more general species difference with regard to the effect of salt on water binding. The straight form of the cooking loss curves of the beef control samples compared with the u-shaped pork sample curves (Figs 2 and 3), show that the water binding of beef does not benefit from salt addition to the same extent as does pork. As a consequence, the cooking loss of beef emulsions is generally higher than that of pork batters. Thus, in our model batters, with 3% salt, the cooking losses were typically 24% and 28% for pork and beef control batters, respectively, at optimum times of chopping.

Hermansson (1982) did not find presalting to improve water retention in frankfurters. Reichert (1983) speculated that this might be due to the use of 40 mm meat chunks instead of ground meat in her preblends. This seems likely, since salt diffusion is very slow at the low presalting temperatures used. It is also possible that some disintegration of the myofibrils, resulting from the grinding, is necessary to get the full salt effects. In addition, we also found that the presalting effect was very limited with commercial products with high binding abilities due to added non-meat binders, e.g. potato starch and milk proteins. In fact, the non-meat binders seemed to hide any presalting effects both on water retention and sensory properties. Thus, the presalting effects under practical industrial conditions are still uncertain.

One consequence of our results is that presalting should only be used when the time of chopping is short, i.e. in the production of coarsely comminuted products. This is in accordance with the results of earlier studies at the Swedish Meat Research Institute (pers. comm.). The results also imply that presalting may be of greater benefit in the grinder–mixer–emulsifier process than in the bowl chopper procedure, because of the very short holding time in the emulsifier/microcutter.

In conclusion, presalting may be of some benefit under certain circumstances, to increase the water-holding capacity and reduce the cooking loss of the products. This applies in particular to coarse comminuted products, and probably more generally when the grinder–mixer–emulsifier process is used. The beneficial effects may be overshadowed by other factors, however; for example, by the use of non-meat binders.

Certainly, the preblending technique should be used wherever it simplifies the material handlings in the factory, regardless of the effect on water retention: fresh, unsalted meat can, for microbial reasons, not be safely stored in the chill room for more than two days, compared with two weeks with 3 parts of salt added. In addition, in some processing procedures, the need for time to do proximate analysis on the meat mixture calls for the use of preblending.

Although nitrite was not used in our water retention experiments, it should be used in all practical presalting to reduce bacterial growth and fat rancidity. Ideally, all the salt to be used in the product should be added at the preblending stage, to get the highest possible salt concentration. There will be a small loss of nitrite during the holding period in the chill room. This, however, should cause no problem if the holding time is less than 3 days, even with only 50 ppm nitrite added.

Finally, we will emphasize that the presalting effect on chilled meat, as involved in this study, should not be confused with the effects of salting of pre-rigor meat, which are undisputable.

REFERENCES

Acton, J. C. & Saffle, R. L. (1969). Preblended and pre rigor meat in sausage emulsions. *Food Technology*, **23**, 367–71.

Hamm, R. (1957). Das Salzen von Fleisch. Die Bedeutung des Vorsalzens bei der Brühwurstherstellung.

Hamm, R. (1958). Das Salzen von Fleisch. II. Das Salzen abgehängten Fleisches und seine Bedeutung für das Wasserbindungsvermögen. *Fleischwirtschaft*, **10**, 700–1, 773–5.

Hermansson, A.-M. (1982). The effect of presalting of meat on the properties of finely comminuted meat products. *Proceedings 28th European Meeting of Meat Research Workers, Madrid*, 208–11.

Puolanne, E. & Ruusunen, M. (1980). Kochsalz und Phosphat in ihrer Wirkung auf das Wasserbindungsvermögen von Brühwurst. *Fleischwirtschaft*, **60**, 1359–62.

Ranken, M. D. (1973). Some effects of added water and salt on the cooking losses of meat. *Proceedings 19th European Meeting of Meat Research Workers, Paris*, 1151–70.

Reichert, J. E. (1983). Der Einfluss des Vorsalzens von Schweinemagerfleisch auf das Wasser- und Fettbindevermögen von Brühwurst. *Die Fleischerei*, **34**, 494–503.