INFLUENCE OF GRINDING, CHURNING, AND COOKING ON ADHERENCE OF A HIGHLY INJECTED HAM TO ITS COOKING BAG

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INTRODUCTION The cook-in-the-bag technology for ham manufacturing has been used successfully for the last 15 years. The technology involves vacuum-packaging the raw ham emulsion in a heat-retractable plastic bag and subsequently steam cooking the bag in a smokehouse. The finished product is not unpacked until its final use, at the retail level. This prevents post-cooking bacterial contaminations and therefore increases the available refrigerated storage period to up to six months. Even though the technology is satisfactory, overall, recurring quality problems are known to occur, including the lack of adherence between the packaging film and the cooked product, with concurrent accumulation of unsightly exudate in the package. As part of a broader study aiming at understanding the product-package interactions during the cooking of cured hams, this project explored the possible causes for lack of film-product adherence.

MATERIALS AND METHODS A commercial recipe was used to prepare cooked cured hams representative of the products currently manufactured in Canada for mass distribution. Accordingly, the raw hams were injected to 65% of the green weight with a brine containing sodium chloride, dry glucose extracts, sodium phosphate, vegetable protein hydrolysate, sodium erythorbate, and sodium nitrite (6.47% w/v, 2.54% w/v, 1.27% w/v, 0.64% v/v, 0.18% w/v, and 0.05% w/v, respectively, final concentrations). The injected muscles were subsequently lacerated through a grinder (kidney plate), churned for 24 h at an intensity varying from 360 to 4500 total turns, and mixed with carrageenin (0.15% w/v, final concentration) and a mixture of ham trimmings and shanks (20% of the meat block), emulsified in brine overnight. The raw ham was then stuffed under vacuum in a Cryovac cook-in-the-bag plastic tube (type CNS10C), excess air was evacuated, and the tube was clipped shut, forced into a 10 cm x 10 cm stainless steel mould, and steam-cooked in a smokehouse to an internal temperature of 69°C, using one of the three following cycles: constant external temperature of 74°C or 84°C, or three successive plateaus at 50°C (45 min), 70°C (45 min), and 84°C. Two variations of the formula were also prepared. In the first one, the raw ham mixture was homogenized through a colloidal mill to obtain a very fine texture, while in the second one, trimmings and shanks were omitted to provide a rougher texture. For all treatments, the adherence between the packaging film and the cooked ham was evaluated after 2 and 20 days of storage at refrigeration temperature, by measuring the force necessary to tear a partially excised band of film off the product, at an angle of 180°. As well, the amount of exudate in the package and the water holding capacity of the raw mixture (after cooking in a 85°C water bath, grinding, and centrifugation at 35,500 x g) were determined.

RESULTS AND DISCUSSION Regardless of ham formula, churning intensity, and cooking cycle, detachment of the product from its cooking bag was never observed during the 20 day refrigerated storage period and only minor differences were recorded between adherence values after 2 and 20 days of storage. The following discussion will therefore be focused on the results obtained after storage for 20 days.

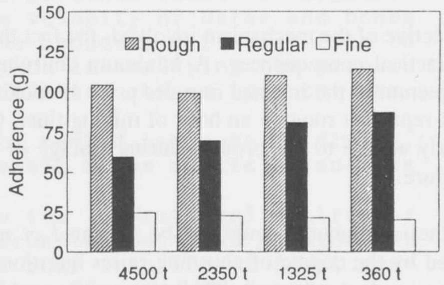

Figure 1: Influence of texture on film-product adherence (stepwise cooking)

Variations in the ham texture had the most striking effect on the extent of film-product adherence. Irrespective of churning intensity or cooking cycles, adherence between the film and the product always decreased with increasing amounts of emulsified fractions in the formula (see typical example in Figure 1). This is consistent with previous reports and cannot be explained by the proposition, put forward in the scientific literature, that film-product adherence is mediated by salt extractable proteins. Rather, careful observation of the film being peeled off the product during adherence measurements suggests that higher adherence values associated with products with fewer emulsified parts merely reflect the fact that the measurement method used actually evaluates a combination of film-product adherence and product resistance to shear (directly related to the amount of intact muscle fibres), instead of adherence alone.

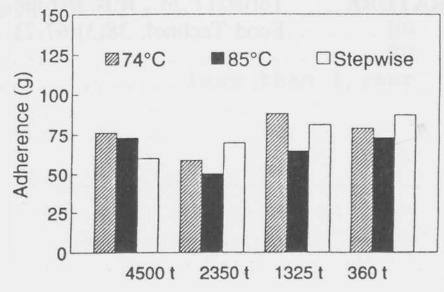

Figure 2: Effect of cooking on film-product adherence (regular formula)

The influence of cooking on adherence of the regular product (20% emulsified shanks and trimmings) to its cooking bag is shown in Figure 2, for the various churning intensities. Statistical analysis of these results and the results obtained with products having a rougher or a finer texture (not shown) indicated that, overall, film-product adherence was not influenced ($P>0.05$) by the cooking cycle, regardless of the product texture or churning intensity.

In practice, the choice of a cooking cycle will be limited by two constraints. Firstly, the legal requirement to reach a temperature of 69°C at the core of the product implies that the temperature of the cooking chamber cannot be much lower than about 74°C in the final stage of cooking. Secondly, the chamber temperature cannot be raised above about 84°C since this would promote the formation of gelatin pockets at the product surface. The fact that, within the 74-84°C temperature range imposed by the legal and processing constraints, film-product adherence was not affected by the specific cooking cycle used indicates that detachment of the film from the product surface cannot be caused by a slight deviation from a regular cooking procedure. Instead, the results obtained in this study are consistent with the undocumented report (Shurpack Inc., personal communication) that adherence establishes itself very early in cooking and suggests that only major undercooking might result in lack of film-product adherence.

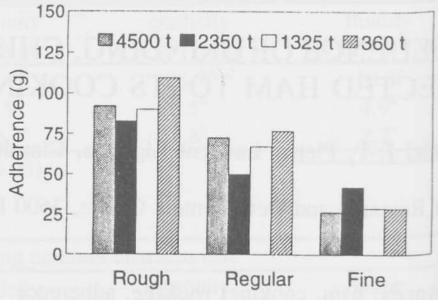

Figure 3: Effect of churning on adherence (85°C cooking)

It has been proposed in the scientific literature that the adherence of meat products to their cooking bags was mediated by salt soluble proteins (Terlizzi *et al.*, 1984). Churning was therefore expected to have a marked influence on film-product adherence, since the main effect of churning is to extract salt soluble proteins. Yet, statistical analysis indicated no overall significant ($P > 0.05$) effect of churning on adherence (see typical results in Figure 3). This led us to consider the 3 following hypotheses:

1. the different churning cycles used in this study generated similar amounts of salt soluble proteins,
2. even the least intensive churning cycle used (360 total turns) produced enough salt soluble proteins to achieve good film-product adherence,
3. the salt extractable proteins do not play a major role in the adherence of highly injected ham to its cooking bag.

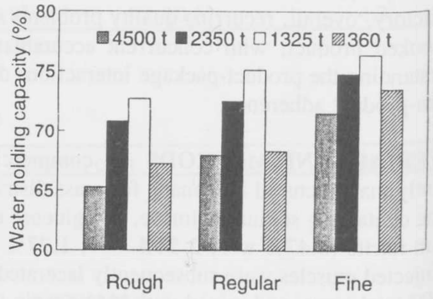

Figure 4: Effect of churning on water holding capacity of the raw emulsion

The results of the water holding capacity measurements gave indirect evidence that hypothesis number 1 was wrong and that the concentration of proteins extracted by salt indeed changed with the extent of churning. Clearly, the water holding capacity of the raw ham, known to be directly related to the presence of salt extractable proteins, was affected by churning (Figure 4), increasing first when churning was increased from 360 t to 1325 t, then decreasing as a result of protein denaturation by excessive mechanical action. The results of an additional experiment (not shown) further established that 3 times as much salt soluble proteins were extracted during extensive churning (4500 t) than during light churning (360 t).

Hypothesis number 2 cannot be rejected on the basis of the information available since, assuming that salt soluble proteins are indeed responsible for film-product adherence, the amount of proteins necessary to initiate adherence is unknown. Given the fact that fractionating muscles through a kidney plate will result in a large surface area available for cure action, it is quite possible that sufficient amounts of salt soluble proteins were extracted during the least intensive churning cycle used (360 t) for film-product adherence to take place.

Irrespective of the mechanism involved, the fact that good film-product adherence was achieved after only 360 rotations of the churn has practical consequences. A minimum churning time is required to mix the emulsified trimmings and shanks, as well as the carrageenin, to the injected muscles prior to cooking and it is not conceivable, in practice, to churn for much less than 360 t, which would represent roughly an hour of mixing time. Consequently, our results indicate that an accidental failure of the cooking film to properly adhere to the product during storage of highly injected ham cannot be due to a mere deviation from a regular churning procedure.

Hypothesis number 3 could not be validated or refuted within the scope of the present study but the fact that adherence was not affected by the degree of churning raises questions about the proposition previously made that salt soluble proteins are responsible for film-product adherence. This proposition, which originated from earlier observations that uncured products failed to adhere to their cooking bags, seemed reasonable at the time but it has never been substantiated. Clearly, more work is required in the matter.

LITERATURE

Terlizzi F.M., R.R. Perdue, and L.L. Young. 1984. Processing and distributing cooked meats in flexible films. Food Technol. 38(3):67-71.