6.9 IMPROVING PRODUCTION OF MINCED FISH PRODUCTS

Rosnes, J.T, Kleiberg, G.H. Bekkeheien,T. Øines,S. and Skipnes.D.

Introduction

Seafood products made of minced fish, like fish cakes, fish balls and fish pudding, are passed through a traditional double heat process with baking (emulsification and top encrustation), chilling, vacuum packaging , pasteurisation and cooling. The production method is time- and energy consuming due to two heating steps with intervening chilling. In 2002 the seafood industry in Norway initiated a project to modernise the production of minced seafood products with a specific aim to improve the sensory quality and to make a more cost-effective production. A target requirement was to obtain a shelf life of 8-12 weeks in chilled storage (0-4 ^{o}C) without increased safety hazards. Fish pudding was chosen as a general model product and the production and improvements were carried out during ordinary production at an industrial plant. The work was focused on heat treatment, new hygienic production layout and to maintain comparable shelf life and sensory quality.

Materials and methods

Fish puddings (800g) were produced at a local producer near Stavanger, Norway. Ingredients are greater argentine (*Argentina silus*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*) together with milk, starch, salt and spices.
Pudding samples of 25 g were homogenised in 225 ml of peptone water (0.9 % NaCl (w/v), 0.1% peptone (w/v) and homogenised for 2 min in a Stomacher 400 Laboratory Blender (Seward, Medical, England). After suitable dilutions, 1.0 ml duplicate samples were added to melted Plate Count Agar (Merk) and incubated at 30^{o}C for 3 days to enumerate total aerobic plate counts (APC).
The texture analyses were performed using a Texture Analyser TA.XTplus (Stable Micro Systems Ltd, UK), equipped with a 5 kg load cell and a 5mm Ø stainless steel spherical probe (P/5S). Cylindrical samples for texture analysis (30mm high, 30 mm Ø) were cut from fish pudding preheated to 20 °C. The samples were wrapped in plastic film to avoid drying of the surface. The gel strength was defined as Force*Distance and the brittleness as Force/Distance at the breaking point.

Results

Modification of the baking line

The baking line was modified with increased temperature and time, in order to achieve a comparable pasteurisation value as in the original process with both baking and pasteurization. A heat transfer model was programmed in FemLab (FemLab 2.3/ 3.0, Comsol AB) based on measurement of conductivity in the pudding and emmisivity of the surface. Convection heating was estimated by experiments. Further experiments were done to verify and optimise the model. The General Method used for calculation of inactivation is based on the following assumptions:

In general, the pasteurizing value is determined from the following equation:

$$P_{T_{ref}} = \int_0^t 10^{\left(\frac{T_c(t)-T_{ref}}{z}\right)} \cdot dt$$

Test procedures for heat penetration tests are based on recommendations from Institute for Thermal Processing Specialists (IFTPS, 1995). Test procedures for temperature distribution tests are based on recommendations from Institute for Thermal Processing Specialists (IFTPS, 1992).

Table 1. Pasteurisation values in the core of the minced fish product

Method	A - P_{90}^{10}	A - P_{80}^{10}	B - P_{90}^{10}	B - P_{80}^{10}
Baked and Pasteurised (BP)	4.1	41.3	-	-
Baked (B)	3.1	30.7	8	80

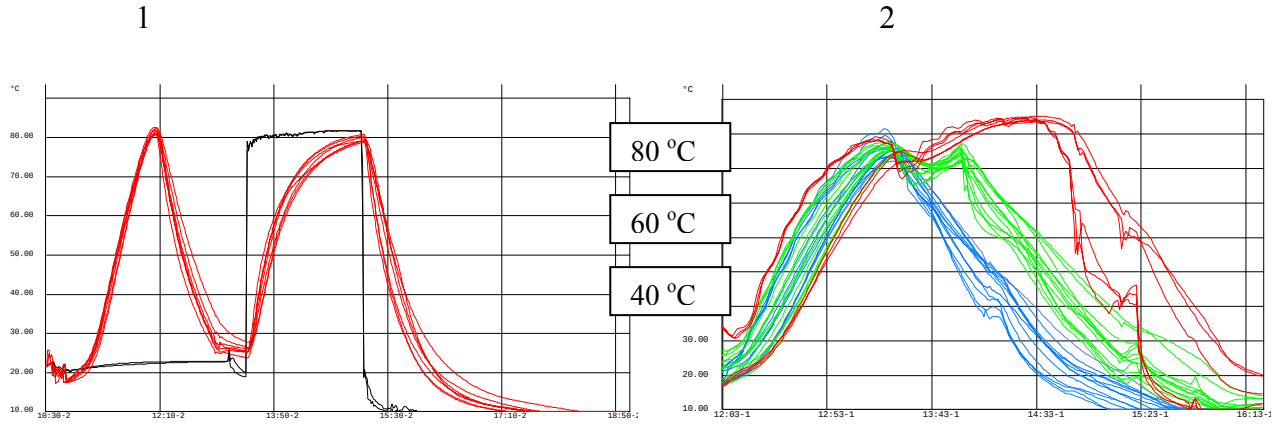


Fig. 1. Core temperature profiles in 1) baking and pasteurisation (BP) and 2) only baking (B) with extended heat processing

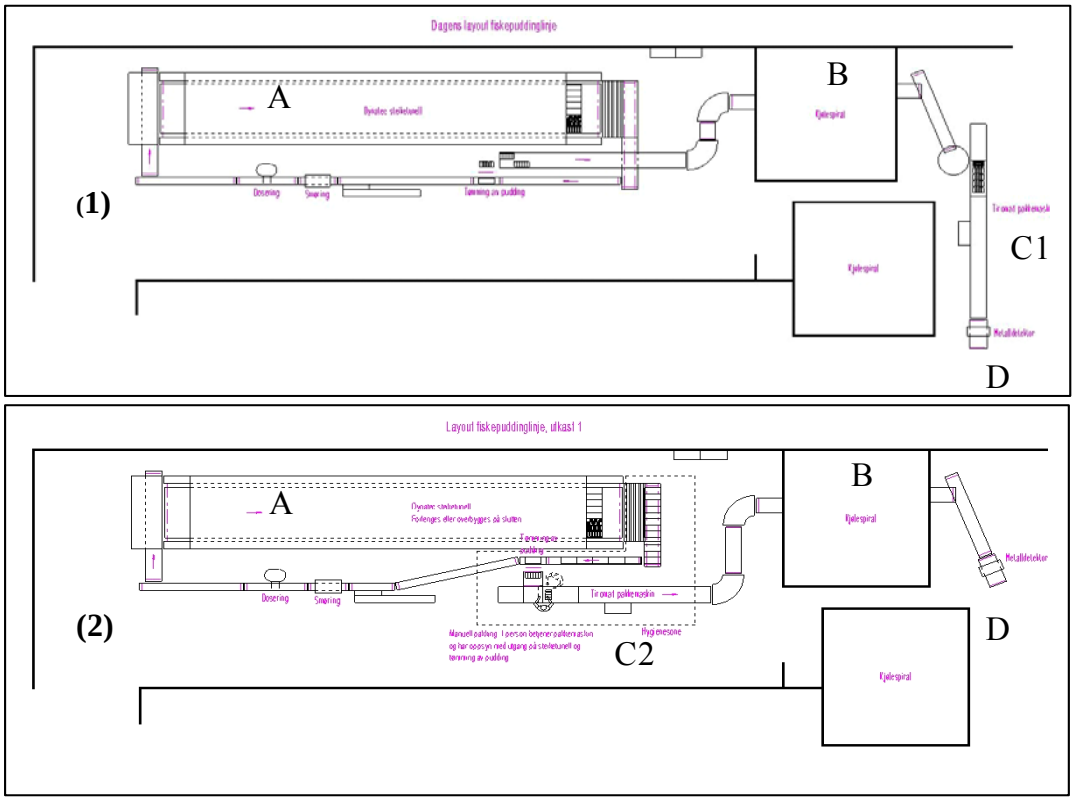
It is a commonly accepted concept to use calculations to gain a 6 decimal reduction of non-proteolytic *Clostridium botulinum* for pasteurised refrigerated products with long shelf life. Reference temperature for *Clostridium botulinum* type E and B is commonly set to 90°C, D_{90} -value of 1.6 minutes and a z-value of 7.5 to 10°C. For practical use it has been recommended to use a z-value of 7.5°C below 90°C and 10°C above 90°C (European Commission, 1999), as this represent the worst case values reported on each side of 90°C. A change in z-value would complicate the comparison of the processes and not reflect a realistic profile, and therefore a constant z-value has been chosen. These values are general recommendations and are not specific for fish mince based products. In the Norwegian industry another criteria has been used for fish mince and through decades proved to be safe, using 80°C in the core of the product for 30 minutes (P_{80}^{10}=30). Hence, in this study the pasteurization value is calculated using the following expressions:

$$P_{90}^{10} = \int_0^t 10^{\frac{T(t)-90}{10}} dt \qquad P_{80}^{10} = \int_0^t 10^{\frac{T(t)-80}{10}} dt$$

The results shown in Table 1 and Fig. 1 showed that an extended time in the baking line (B), and subsequently an extended holding time, gave a lower pasteurization value (P_{90}^{10} = 3.1) compared to baking and pasteurization (BP) (P_{90}^{10} = 4.3), but still in the same order of magnitude.

Reorganised production layout

There is an increased risk of bacterial growth caused by recontamination when the products are packaged after heat processing with no secondary heating. Vacuum packaging at high temperatures (>70°C) with a steam flushing process was therefore tested. A survey of microbial contamination on equipment, conveyor belts and surrounding air was carried out to evaluate contamination routes and the requirement that had to be met with a new hygienic production design. From these requirements a new hygienic layout was planned with hot fill packaging in a superhygienic sone (Fig. 2, C2) compared to packaging after chilling (Fig. 2, C1).



Shelf life and quality

Several shelf life studies were carried out with fish pudding processed at different temperatures and time regimes. During a storage period of 80-90 days, samples for microbiological analyses were collected both in the centre of the product, to confirm surviving spore forming bacteria, and on the surface to conform recontamination. The aerobic plate counts were similar to the modified baking process compared to baking and pasteurisation (Fig. 4). Stiffness and gel strength were also comparable, but varied with the different heat processes. Colour, stiffness and gel strength were measured and used for process optimisation (Fig. 3).

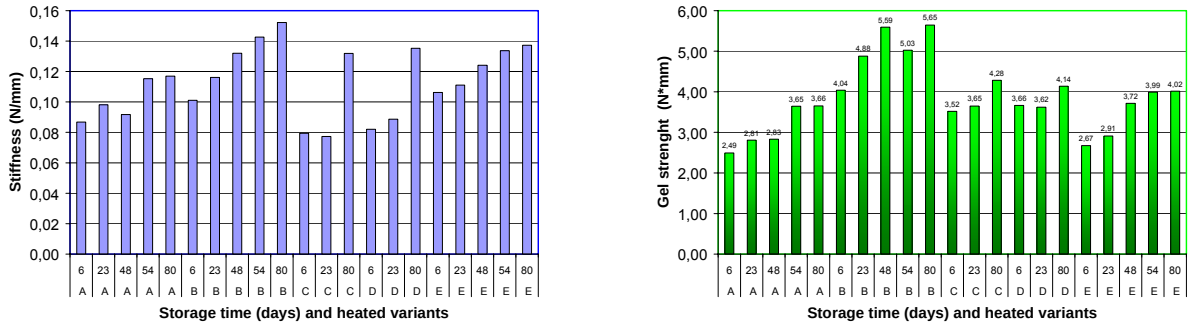


Fig. 3. Stiffness and gel strength with different heat processes. Heating time: 60 min (A), 80 min (B), 100 min (C), 120 min (D) and 60 min + pasteurisation (E)

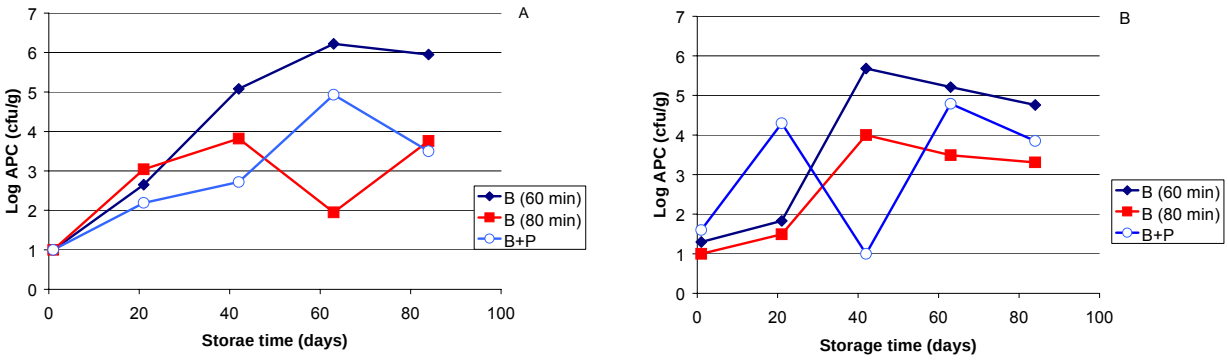


Fig. 4. Aerobic plate counts in two experiments (A and B) in fish pudding during chilled storage in 83 days at 4 °C.

Conclusions

- Comparable pasteurisation values were obtained with one heating step (baking) in stead of two (baking and pasteurisation).
- Microbiological analyses, stiffness and gel strength were comparable for baking compared to baking and pasteurisation.
- The new process design is more cost effective and will simplify the production process considerably

Authors

Jan Thomas Rosnes, Norconserv, Niels Juelsgt. 50, P.O.Box 327, 4002 Stavanger, Norway. Telph: (+47)51844600/31, Fax (+47)5144651, e-mail: jtr@norconserv.no, www.norconserv.no

Gro Haugvalstad Kleiberg, Norconserv, Telph: (+47)51844623, e-mail: ghk@norconserv.no
Tove Bekkeheien, Norconserv, Telph: (+47)51844638, e-mail: tb@norconserv.no
Sigurd Øines, Norconserv, Telph: (+47)51844644, e-mail: soe@norconserv.no
Dagbjørn Skipnes, Norconserv, Telph: (+47)51844634, e-mail: ds@norconserv.no