Engineering new food
“pre-cooked ground pork burger”

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France has seen a significant decline in fresh meat consumption over the last few years. Even if fresh pork meat is proving more resilient than other meats due to its affordable prices and attractive promotional offers, the porkmeat products subsector needs to carve out new openings and opportunities on new market segments.

Développement d’un « haché de porc précuit »

La consommation de la viande fraîche en France est en recul significatif depuis plusieurs années. Même si la viande fraîche de porc résiste mieux que les autres viandes grâce à son prix et ses promotions attractives, des débouchés modernes pour les produits de la filière sont à trouver sur de nouveaux segments de marché.

Keywords: pork, meat, burger, pre-cooked, texture, yield, colour, salt
Mots clés : porc, viande, haché, précuit, texture, rendement, couleur, sel
Introduction

Introducing porkmeat in modern market-adapted forms is key to enabling the pork industry to hold onto its market share.

The aim of this study is to engineer a pre-cooked ground pork preparation that makes tasty and tender end-foods. This fresh-prepared ground pork can then serve as a basis for a wide range of cold meat counter options and snack solutions.

The work to engineer this pre-cooked ground pork was carried out at the IFIP’s Maisons-Alfort-based technologies and trials lab. The pre-cooked ground pork burger test-products were evaluated based on parameters such as technical yield, colour and texture. Employing a two-phase process made it possible to define the preparation conditions for pre-cooked ground pork burgers through evaluation by a consumer taste panel.

**PHASE 1: choice of fabrication parameters (formulation, fabrication, heat processing)**

Testing

Several parameters were factored in so as to check they were effectively relevant and set their differential thresholds.

Heading the list of parameters studies were the raw materials. The overarching aim is to offer food manufacturers solutions for squeezing added value from certain low-revenue cuts: loin, collar and shoulder. Alongside characteristics tied to the muscle component (fiber type, collagen content, colour), their lipid content directly shapes the perception of tenderness of the ground pork burger. The start-levels of lipid content are directly tied to the type of raw-material meat: less than 5% for loin, around the 10% mark for shoulder, and around the 15% mark for collar.

In terms of grinding conditions, the only parameter selected for study was diameter of the grinder hole-plate holes (5 and 8 mm).

In terms of formulation, the decision was made to set salt content at a fairly routine level for pre-prepared meat products, i.e. 1.5%. Binding is ensured by a pork-source collagen-rich binder (pork proteins).

All other fabrication parameters were set to constant values:
- temperature of the raw materials at -5°C, which is a requisite threshold to minimize risks—especially smear of the fat component.
- salting conditions: a preparatory marinating-phase step was not deemed relevant for meat products designed for grinding. Direct incorporation of brine-mixed ingredients was the recommended way forward.
- unit format: the burger unit format adopted was 100–120 g. A 55–60 g puck-shaped patty format was factored in for sensory evaluation-tested products.

The final technological parameter factored in was the heat processing treatment. Various processing cycles were studied according to their defining characteristics: dry, wet or intermediate processing conditions; time–temperature cycle; one or two plateaus. These processing cycles were compared against a benchmark fresh steak cooking cycle (200°C for 8 min.).

Results

The various condition-sets were compared based on their influence on product texture—the critical parameter—and on technical yield and colour. The results of the analysis of variance point to the following product choices:

- **Raw materials**: the choice of raw material was guided towards collar and shoulder which produce the more tender burgers, whereas loin meat gives overly firm, dry products. These differences are explained by the natural composition of the meat muscle used rather than by any formulation or treatment applied. Furthermore, the redness of the collar and shoulder-based burgers likely has better consumer appeal than the paler loin-based burgers.

- **Grinder hole plate**: the studied diameters of grinder hole-plate holes (5 and 8 mm) had no significant influence on any of the three technological criteria studied— hence the decision to opt for the 8 mm hole size which can deliver an appearance with more potential consumer appeal as closer to ‘fresh-from-the-butcher’-type products.

- **Heat processing steps**: different cooking modes were studied with various combinations of dry or dry/wet conditions and time–temperature cycles that led the products satisfactory microbiological stability while at the same time minimizing the texture-ruining effects of over-high temperatures. Focusing on texture as the critical criterion for this study, dry cooking at one plateau appears to yield the least firm and most tender texture of the four modes studied. This is why further discussion in this study is based on slow-cooking (45–55 minutes) at low temperature (74–75°C).
Phase 2 made it possible to refine the formulations and heat processing treatments and thereby further improve the key characteristics of the pork burgers, especially texture. This was achieved by setting a min–max interval for each instrument-measured value (texture, yield, colour).

To work on formulation, we ran a series of tests focused not just on collagen-rich binder content but also on adding polyphosphates which improve meat water-binding capacity and meat grain–fat grain binding. This study opted to develop a simple recipe, without adding aroma compounds as this type of advanced formulation is down to the competence of industrial manufacturers who intend to use this type of ingredient in their product ranges.

**Results**

**Ground pork burger formulation**

The burgers prepared with polyphosphates have both the firmest texture and the highest technical yield. In both cases, the mean is at the upper bound of the objectives set, which is good for yield but not for texture.

The burgers prepared with collagen-rich binder give intermediate results midway, inside the upper-bound/lower-bound range of the objectives set on both compressive force and technical yield.

The clear texture differential is characterized by the depth of the grill marks, which stand out particularly badly in burgers made with polyphosphates. Polyphosphates look a useful addition for controlling technical yield, while the collagen-rich binder looks a useful addition for controlling texture. The combination polyphosphates plus collagen-rich binder is expected to deliver results closer to the objectives targeted.

The two recipes compared with nitrite curing salt and regular table salt lead to a texture that is inside the target range. The two salt options produce no difference in terms of technical yield, as both give values at the upper bound of the objectives set.
Focusing on product redness, the difference obtained corresponds to the result expected: while the value obtained with nitrite curing salt is inside the target range, the value obtained with regular table salt is well outside.

Just after manufacture, the ground pork burgers made with nitrite curing salt (top grill) start to grey under the oxidative action of free nitrite, whereas the burgers made with regular table salt hold the deep red colour of fresh meat.

Cooking stabilizes the pinkish colour of the nitrite-salted burgers yet denatures the myoglobin proteins in regular table-salted burgers, which leads to a greyer colour closer to the norm for cooked burgers. The decision was taken to continue with regular table salt for the sensory analysis tests.

**Heat processing**

Each run comprises 30 burgers. Two cooking modes are employed (table 1).

The results obtained are very satisfactory, since a majority of the measured compressive forces are near to—and in some cases even under—the lower bound. Only the 6A runs (collar + collagen-rich binder + polyphosphates) lead to firmness values slightly under the upper bound.

Furthermore, the technical yields are fairly high, with again, a majority near to or over the upper bound. The all-round results obtained are satisfactory, and the formulations studied were retained for subsequent sensory analysis.

<table>
<thead>
<tr>
<th>Table 1: heat treatments</th>
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<tbody>
<tr>
<td><strong>Cooking</strong></td>
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<tr>
<td>C1</td>
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<td>C2</td>
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</table>
Sensory analysis

A consumer tasting panel was brought together to evaluate how the various production technologies influence end-consumer ratings.

A panel of 60 consumers was used to evaluate potential consumer interest in these products. The people recruited onto the panel were 'naive' consumers that had not been selected for any particular sensory assessment skills and had not been trained in sensory evaluation.

Seven IFIP-made pork burgers (table 2) were compared against a supermarket-shelf control product that presented a different set of characteristics, i.e. raw material was ham, with added nitrite curing salt (the IFIP-made burgers studied were with regular table salt), and the presentation was better controlled.

This all-round assessment of eight pre-cooked ground pork burgers shows that the recipes tested did not score as high as the control product currently sold on supermarket shelves (table 3). However, at least two of our products achieved a score that was not significantly different from the control burger (m = 6.4), i.e. run 1 (m = 5.7) and run 7 (m = 5.6).

This analysis did however bring some interesting findings—the best texture results were obtained with pork collar:

• with a formulation featuring the collagen-rich binder only, when cooked at 69°C for 35 minutes,
• and with a formulation featuring a combination of collagen-rich binder plus polyphosphates, when cooked at 79°C for 25 minutes.

In both these cases, and like the control burger, percentage of consumers satisfied passed the 50% mark.

This match-up was also found on taste, on all-round assessment, and on re-eat intention.

<table>
<thead>
<tr>
<th>Product Mean score / 10</th>
<th>Rank (5%)</th>
<th>% consumers satisfied</th>
<th>Re-eat intention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6.4</td>
<td>A</td>
<td>64%</td>
</tr>
<tr>
<td>RM 1 (Raw material) – recipe 1 Cooking 1 run 1</td>
<td>5.7</td>
<td>AB</td>
<td>52%</td>
</tr>
<tr>
<td>RM 1 (Raw material) – recipe 2 Cooking 2 run 7</td>
<td>5.6</td>
<td>AB</td>
<td>55%</td>
</tr>
<tr>
<td>RM 2 (Raw material) – recipe 1 Cooking 1 run 2</td>
<td>5.5</td>
<td>AB</td>
<td>51%</td>
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<td>RM 1 (Raw material) – recipe 1 Cooking 2 run 6</td>
<td>5.4</td>
<td>AB</td>
<td>45%</td>
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<td>RM 1 (Raw material) – recipe 2 Cooking 1 run 3</td>
<td>5.0</td>
<td>BC</td>
<td>38%</td>
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<td>RM 2 (Raw material) – recipe 2 Cooking 1 run 4</td>
<td>5.0</td>
<td>BC</td>
<td>47%</td>
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<tr>
<td>RM 2 (Raw material) – recipe 1 Cooking 2 run 5</td>
<td>4.3</td>
<td>C</td>
<td>27%</td>
</tr>
</tbody>
</table>

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(1) SP: Significantly re-eaten – NS: Non-significant (opinions split) – SM: Significantly not re-eaten
Conclusion

This study produced interesting findings, and the results raise the prospects for preparing end-products that are liable to find a niche in the market. Further studies should re-focus on the formulation (salt content, potential alternatives to added polyphosphates, other binders…) and firm control of the heat processing steps. Nevertheless, there may still be a future for pork shoulder given the mean scores obtained in the sensory analysis on the pork shoulder-based burgers, and for pork loin which, despite not getting satisfactory results for taste and texture, still offers value-adding prospects as a competitor to processed poultry meat products.

Remerciement

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References for this paper