milestone report

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APM case ready mince – evaluation of process design and shelf life

Milestone 1 – Interim report

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Abstract

Increasing the shelf life of minced meat products using emerging packaging innovation is of benefit to the Australian meat industry as secondary cuts and block trimmings can be repurposed as a value-added premium product. Furthermore minced meat products with an enhanced shelf-life have the potential to broaden market opportunities and demand for Australian meat overseas. Nevertheless as consumer perception of meat quality is greatly influenced by sensory properties, namely colour, packaging technology needs to address food safety and shelf-life requirements as well as visual appeal.

Various factors affect the quality of minced meat including meat temperature, pH, age duration as well as exposure to air and the food matrix structure. While minced meat contains the same constituents of a solid cut, the food matrix structure of minced meat is very different. The nature of the minced product in addition to packaging functionality needs to be considered in order to deliver a high quality product with extended shelf-life that meets consumer sensorial requirements.

Currently Argyle Prestige Meats pack minced meat for the export market using Darfresh® vacuum skin packaging. While the packaging seals well, air bubbles form on the surface of the mince overtime leading to both decreased shelf-life and acceptance from consumers. This report will focus on evaluating the current vacuum skin packaged minced meat process, explaining the science behind the dysfunctional packaging outcomes and suggest possible solutions.

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1 Background

While meat pH, aging duration, temperature, pre and post-slaughter techniques impact on meat quality, packaging has an important role in enhancing shelf life and perceived organoleptic properties of meat products. At point of sale, consumer perception of meat quality is based on meat colour (packaged and unpackaged), visible drip and visible fat. Cherry-red colour is associated with freshness, food safety, adequate shelf-life and good eating quality (Troy and Kerry, 2010, Chen et al., 2012, Hood and Riordan, 1973). Emerging packaging technologies, such as active vacuum skin packaging, have the potential to broaden demand for premium Australian meat products. With active packaging, secondary cuts and block trimmings processed into minced meat may have shelf-life longer than modified atmosphere packaging (MAP), Cryovac or Darfresh® skin packaging. Consequently as consumer purchase is prompted by perceived quality based on initial colour perception and the prevention of food-based illness after consumption, packaging used must meet both organoleptic and shelf-life requirements.

Although vacuum packaging is more economical and commonly used for primary cuts, MAP packaging is generally used for retail as MAP is able to generate the desirable cherry red colouration in meat (Chen et al., 2012). The principle pigment that affects colour in red meat is myoglobin. Myoglobin is a globular protein that contains a centrally located haem group responsible for light absorption and colour reflection. In a living cell, myoglobin is responsible for storing and delivering oxygen. Myoglobin content varies with species, age, sex and type of muscle (muscles with a higher work load contain more myoglobin). In fresh meat myoglobin can exist in 3 different forms depending on oxygen levels and the charged state of the haem iron group resulting in different colours from cherry red to purple and brown (Figure 1a). Freshly bloomed meat is a bright cherry red colour due to oxygen diffusing from the cut surface to the muscle interior where oxygen is utilized by enzymes reduce metmyoglobin (brown) to myoglobin (purple) which is then exposed to diffusing oxygen resulting in the red colouration. However enzyme activity decreases with time therefore allowing metmyoglobin to accumulate producing the brown colouration (Figure 1b).

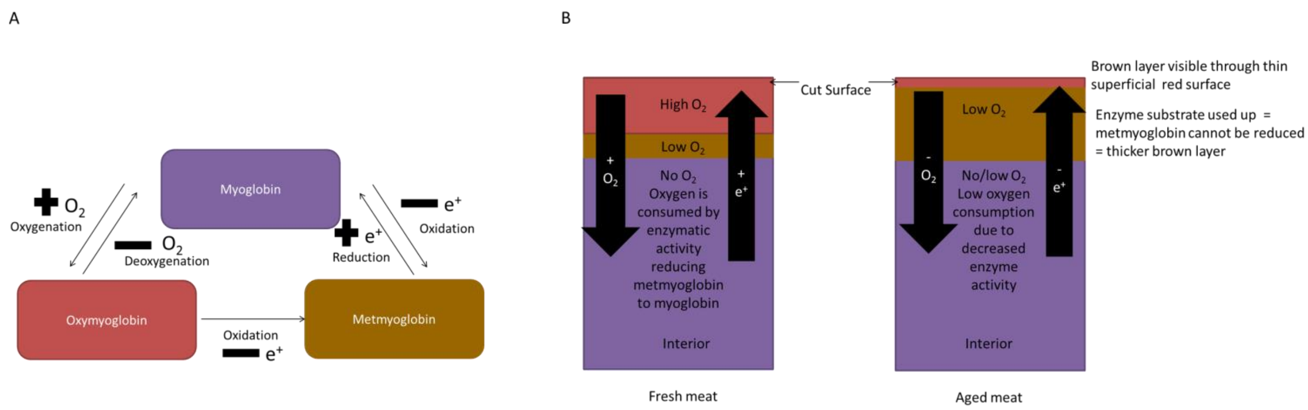

Fig. 1 (A) Factors that affect pigment formation in fresh meat; (B) Pigment development in meat over time (adapted from Bayliss (1995)).

While oxygen permeable packaging that enhances colour is suitable for short shelf-life applications, prevention of pathological microbial growth is vital in enhancing shelf life.

Therefore vacuum packaging is recommended as oxygen needed for pathological growth is removed and myoglobin is retained in the reduced state (purple) which will subsequently bloom (red) on exposure to oxygen when the package is opened.

Unlike a solid cut, the food matrix structure of minced meat is very different and highly aerated. Mincing decreases particle size resulting in increased surface area available for oxidation by air, fat lipolysis and UV exposure Potter and Hotchkiss, 1998, Damodaran et al., 2008). Smaller particle size will also increase exposure to volatiles responsible for odour. The process of converting a solid cut to minced meat via the mincing process allows air to be incorporated into the meat. Compression of minced meat via vacuum packing may lead to a product that has stronger odour properties upon opening of the pack due to concentration of highly exposed flavour and odour volatiles. The resultant minced meat product will therefore require a modified skin packaging process than a solid cut in order to ensure adequate removal of all residual air is removed. This may be in the form of altered packing settings, however due the porous nature of minced meat packaging using an active film that has oxygen and odour scavenging capacity may be more suitable.

Modified Atmosphere Packaging (MAP) where the headspace is gas flushed with a controlled mixture of gases (20:80 O_2 and CO_2 respectively for red meat) is an alternative to vacuum skin packaging, MAP packaging is commonly used for the domestic market rather than export. Gas absorption by food overtime may cause packs to collapse and/or pressurised packs are more susceptible to puncture than vacuum skin packaging decreasing viability for international markets.

Although vacuum skin packaging is not new technology, it is becoming more popular as it was initially developed to increase shelf life while enhancing visual appeal. Based on the principle of Cryovac packaging, the film in vacuum skin packaging moulds around product placed on a tray resulting in high quality clarity and presentation. By forming a vacuum, all gaseous volume surrounding the product is removed resulting in extended shelf life of products due to decreasing oxidative reactions which lead to food spoilage. Vacuum skin packing is currently used for premium products with a high density including smoked fish, pâté, fresh and processed meats, poultry and cheeses.

In principle vacuum skin packaging of minced meat may be more challenging than packing primal cuts as minced meat has:

1) Smaller particle size
2) Greater surface area, and
3) Greater proportion of air incorporated into the meat due to the mincing process

1.1 Review of current process and experimental design development

1.1.1 MS1 report

The University of Melbourne is to review the process for mince manufacture and submit trial design(s) and potential treatment effects that can be investigated in order to negate air bubble formations and browning in Darfresh vacuum skin packed mince. This is to include consideration for active packaging materials identified by

MLA from V.RMH.0027 research with Sealed Air. This report will describe key meat science fundamentals that impact shelf life quality and likely causes to current product/process and present current markdown/clearance data and cost impost in a commercial model.

2 Project objectives

The objectives of this project are to:

2.1 Understand and evaluate the APM process (as representative of typical centralised retail ready mince process) and identify critical control points for shelf life yield/quality

2.2 Present a suit of improvement/areas for consideration – include possible adoption of recent MLA science and technology platforms

2.3 Complete preliminary trials and learnings where possible in a commercial mode of these recommendations

3 Process assessment

3.1 Minced meat packaging issue

Minced meat product is currently being packaged using Darfresh skin packaging for the export market due to higher shelf-life properties than MAP packaging. While the Darfresh package seals appear to be well formed with optimal integrity, air "pockets" are developing after packaging indicating vacuum removal of all air is not being fully established (Figure 2). This is resulting in decreased shelf-life, unwanted colour changes and consumer rejection of product.

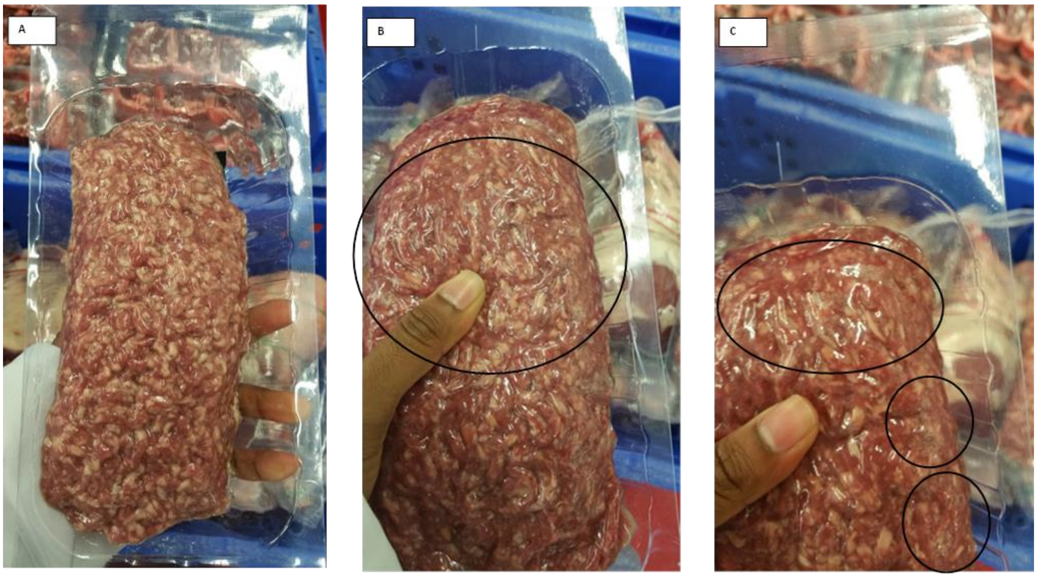

Fig. 2 – (A): Well sealed packaging, all air appears to be removed no residual air bubbles on the surface of mince; (B and C) Inadequate removal of air from minced meat with residual air evident on the surface of mince; the integrity of the seal on the tray surface does not appear to be a causal factor as evidence of air bubbles/film inadequacies (e.g. folding over)/tray warping is not evident.

3.2 Mince processing and packaging

Mince is produced from 50% frozen trim: 50% fresh carcase trim. Current batch of frozen trim is sourced from WA supplier and was packed in September 2015. Frozen trim (band sawed logs ~25mm x 25mm x 300mm) is used for temperature control after being allowed to temper overnight.

Mince is produced in the processing room (~5-6˚C) via fresh carcase and frozen trim being:

1) Initial grind 8mm plate

2) Second grind 4-5mm plate

3) Automatically formed (temp 1-2˚C) can cut to weight. Transferred to Darfresh thermoform machine via trolley.

4) Packed into 3 x 1 format Darfresh pack

5) Chiller storage and dispatch

4 Discussion

4.1 Temperature and hygiene control

Temperature is maintained at adequately low temperatures minimizing the potential for bacterial growth (Appendix 1). Fresh cuts and frozen meat portions are stored adequately until needed. Micro results are within specifications, therefore microbial contamination is most likely not an issue.

4.2 Minced meat temperature

Minced meat coming out of the 2^{nd} mincer is ~1-2˚C (room temp 5-6˚C). It may warm up slightly after packing and during storage causing meat to relax with gravity resulting in residual air on the surface of meat. Meat temperature after packaging was not noted.

4.3 Film packaging

It appears to be a vacuum skin packaging rather than Darfresh as there is only one layer of film without an additional oxygen barrier. The film does not seem very permeable to oxygen thereby decreasing the meat’s ability to bloom/breathe. However the machine has the capabilities to undertake a gas mixture flush prior to vacuum packaging.

5 Recommendations

5.1 Meat temperature

- Decrease the proportion of frozen to fresh trim meat in order to maintain a consistent mince temperature from the mincer through packaging. Also frozen trim can cause early discoloration in mince, due to the damaged meat structure and increased susceptibility to oxidation.

5.2 Mince compression

- In order to minimise air content in meat after mincing, mince could be formed in a block format. This would require a tool change in the 2^{nd} grinder head. Another option is to push down the mince manually after forming and forcing residual air out, if this seems feasible on the production line.

5.3 Film

- Using an oxygen permeable film is not recommended as shelf life will decrease considerably, not suitable for the export market.
- Change film to an active film that has oxygen and odour scavenging potential. Active film will scavenge residual oxygen in the vacuum skin pack resulting in uniform stable myoglobin (purple-red) colouration that will bloom once the package is opened. Active film that can control odour development is ideal to minimise the build-up of exposed volatiles.
- Trial the use of Sealed Air's Cryovac® Freshness Plus® Active Barrier film. This film is has been developed with oxygen and odour scavengers incorporated into the polymer with the aim to enhance shelf-life by inhibiting mould and aerobic bacterial growth. The scavenger is transparent therefore will not decrease appearance allowing consumers a clear view of the minced meat product.

5.4 Experiment design:

Part 1: University of Melbourne, sensory and meat science labs

- Mince meat, using fresh and frozen meat in the ratio 50:50, with the following pre-pack temps
  - 1-2˚C
  - 3-4˚C
- Vacuum skin pack minced meat using Freshness Plus active barrier bags (available) and Multivac T200.
- Determine shelf life at time = 0d, 3d, 7d, 10d, 14d, 21d, 28d via:
  - Colour change using the Hunter LAB chromameter
  - pH change
  - Stored in refrigerator simulating retail display
  - Visually assess and air bubbles arising in pack.
  - Assess any differences in smell/odour on pack opening

Part 2: SealedAir Pilot plant, Fawkner

- Vacuum skin pack minced meat using Freshness Plus active barrier film (need to order) and
  scale up using large-run production packaging machines
- Assess shelf-life, based on colour (not micro) based on pilot experiment at times determined

Part 3: APM, Nowra plant

- Onsite trial at APM Nowra plant using findings based on pilot studies at UoM and Sealed Air Fawkner (2days).

- Micro assessment using Argyle meat procedures and lab. Argyle Meats to coordinate the micro according to their HACCP procedures.

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7 Appendices

7.1 Appendix 1 – Production process flow