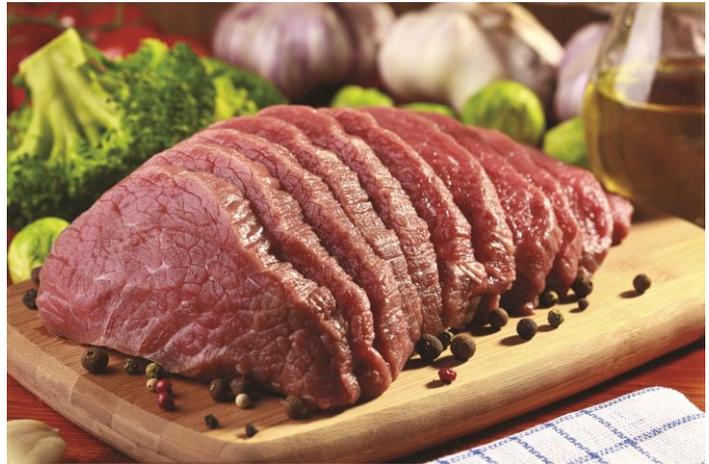


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Novel pre-treatment packaging regime to enhance the value and quality of vacuum packed retail cuts of beef



Key external stakeholders:

Meat processors, retailers, policy makers

Practical implications for stakeholders:

- A known beef exposure-time to carbon monoxide (CO) which will not mask spoilage and is safe for producers and the consumer.
- A new way to present packaged meat to the consumer that is attractive in appearance while avoiding negative aspects of MAP packaging
- A packaging technique which is already approved in wider export markets but is currently prohibited in the EU
- New findings to support any potential revisions to current meat packaging legislation

Main results:

The CO gas mixture pre-treatment time of 5 hours is of particular interest as the a* redness values decreased below the limit of acceptability by day 28, thus replicating the color change that a consumer would normally expect in MAP packed meat at the end of their display life.

Opportunity / Benefit:

While CO is prohibited in the EU for use in meat packaging, it is permitted in several countries worldwide. Some of these countries are established export markets for Irish beef or have the potential to become future export markets. The concern with the use of CO in beef packaging in the EU arises from fears it may mask spoilage therefore misleading consumers. Nonetheless, it is known that the most common form of beef packaging, modified atmosphere packaging (MAP), has many disadvantages. Although vacuum and skin-packaging do not suffer from these disadvantages they have their own disadvantage of resulting in meat being of a darker colour than consumers expect. This project demonstrated a known quantity and exposure-time of low concentrations of CO for vacuum-packed beef whose colour would decrease prior to a shelf-life of 28 days and therefore, would not mask spoilage as indicated by colour change. If permitted, this could offer manufacturers a new form of packaging for beef which preserves meat colour of vacuum-packed meat making it more attractive to the consumer.

Collaborating Institutions:

Dublin Institute of Technology (DIT)

Teagasc project team: Dr. Paul Allen (PI)
Dr. Ciara McDonnell (Acting PI)
Dr. Lauren Anne Van Rooyen

External collaborators: Dr. David O'Connor (IT Sligo/ DIT)

1. Project background:

Consumers assess meat quality primarily through visual appearance. Meat colour is used by consumers as a strong indication of freshness or wholesomeness. The most common fresh meat packaging technology is high oxygen modified atmosphere packaging (MAP) which induces the bright cherry red colour (oxymyoglobin) in beef which is desirable to consumers. However, disadvantages to this packaging technology include reduced tenderness, limited colour stability and limited shelf-life due to lipid oxidation leading to off-odours. Vacuum packaging (VP) is a technology that prevents lipid oxidation, prolongs shelf-life, reduces microbial spoilage and is the most common packaging method used to age primal cuts to improve tenderness. VP is less suited to retail ready cuts of beef packed as the absence of oxygen in the vacuum packs results in a dark purple colour (deoxymyoglobin) which is unattractive to consumers. Carbon monoxide (CO) induces a cherry red colour (carboxymyoglobin) similar to oxygen but the colour is much more stable so the meat looks attractive to consumers for much longer. However, concerns have been raised by regulatory authorities and some consumer groups as unscrupulous use of CO could be used to mask meat spoilage and meat might be sold beyond its sell-by-date due to the product's long-lasting bright red colour. The objective of this study was to optimise the application of 1 to 5% CO pre-treatments prior to vacuum packaging of retail cuts of beef to induce the desirable superficial cherry red colour while facilitating natural levels of discoloration by the sell-by-date (28 days) thus allowing customers to trust the colour they see in terms of judging freshness

2. Questions addressed by the project:

- Can Teagasc and DIT determine a pre-packaging CO quantity and exposure-time for beef that will decrease by the end of the shelf-life and therefore, not mask spoilage?
- What are the effects of the new proposed packaging technique on beef quality?
- Is the new packaging applicable to various beef muscles?

3. Main results:

A range of pre-treatment exposure times was applied to striploin steaks using a mixture of gases including Carbon Monoxide (CO), Carbon Dioxide (CO₂) and Nitrogen (N). To replicate consumer desired levels of colour, instrumental colour analysis was performed. A redness "a* value" of approximately 12 on the CIE scale was used as the threshold for acceptability. Microbial analysis, lipid oxidation, tenderness and cooking loss were analysed to determine if the pre-treatment had any effect on the quality of the steaks. The CO gas mixture pre-treatment time of 5 hours is of particular interest as the a* redness values decreased below the limit of acceptability by day 28, thus replicating the colour change that a consumer would normally expect in MAP packed meat at the end of their display life. Bacterial growth levels were well below the normal spoilage levels indicating that the acceptable colour shelf life was shorter than the spoilage life. Pre-treatments had no effect on lipid oxidation, tenderness and cooking loss. Well designed and controlled CO pre-treatment is a potential innovative solution to current packaging issues within the meat sector adding value to the product, increasing safety, enhancing meat quality and ensuring the consumer of a reliable visual indication thus addressing consumer and regulatory concerns.

4. Opportunity/Benefit:

If permitted by the EU, the new pre-treatment regime will allow retail ready steaks to be presented to consumers in vacuum packs, while maintaining the attractive red colour. These steaks will have the attractive colour of MAP packed steaks but without the adverse effects caused by the high oxygen atmosphere in MAP packs. The treatment regime will impart a colour shelf life that is not longer than their shelf life to ensure that they are unattractive to consumers before they spoil due to bacterial growth.

Industry has responded to the negative aspects of MAP packaging, such as increased oxidation and reduced tenderness, by using vacuum skin packaging for some premium steak cuts. However, the beef has a dark purplish colour that is unattractive to most consumers, limiting the potential for this type of packaging. The

results from this task demonstrate to industry how these problems could be overcome by exposing the meat to low concentrations (1 to 5%) of CO for 5 hours followed by vacuum packaging. The beef will have an attractive bright red colour which will become visually unacceptable by about 28 days before the meat begins to spoil, ensuring that consumers will not buy beef with an attractive colour that has already spoiled. The use of CO is already permitted in several export markets including USA.

5. Dissemination:

Main publications:

- **Van Rooyen, L. A., Allen, P., Crawley, S. M., & O'Connor, D. I. (2017).** The effect of carbon monoxide pretreatment exposure time on the colour stability and quality attributes of vacuum packaged beef steaks. *Meat Science*, 129, 74-80.
- **Van Rooyen, L. A., Allen, P., & O'Connor, D. I. (2017).** The application of carbon monoxide in meat packaging needs to be re-evaluated within the EU: An overview. *Meat Science*, 132, 179-188.
- **Van Rooyen, L. A., Allen, P., Gallagher, E. I., & O'Connor, D. I. (2018).** The effect of temperature during retail display on the colour stability of CO pretreated vacuum packaged beef steaks. *Meat Science* 145, 16-22.
- **Van Rooyen, L. A., Allen, P., Kelly-Reese, C., & O'Connor, D. I. (2018).** The effects of varying gas concentrations and exposure times on colour stability and shelf-life of vacuum packaged beef steaks subjected to carbon monoxide pretreatment. *Food Packaging and Shelf Life*. 18, 230-237
- **Van Rooyen, L. A., Allen, P., & O'Connor, D. I. (2018)** Effect of muscle type and CO-pretreatment combinations on the colour stability, protein oxidation and shelf-life of vacuum packaged beef steaks. *Meat Science*, 145, 407-414

Popular publications:

- **Van Rooyen, L.A, Allen, P., O'Connor, D.I.** The effect of pretreatment regimes to enhance meat quality on vacuum packaged beef steaks, *18th World Congress of Food Science and Technology, 21st-25th August 2016, Dublin Ireland.* 384.

6. Compiled by: Dr. Ciara McDonnell