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Antioxidant status of fully processed fruits, vegetables and their products: technology optimisation to minimise losses

Key external stakeholders:

Vegetable processors, government authorities/legislators, consumers, food research scientists

Practical implications for stakeholders:

Thermal and non-thermal processing effects on fruits and vegetables influence their antioxidant capacity.

The outcomes of the investigation are:

- Thermal processing such as *sous-vide* and post-processing storage decrease the antioxidant activity and concentration of antioxidant compound groups in fruits and vegetables.
- However the effect is not clear cut with some thermal and non thermal strategies resulting in an increase in antioxidant activity.
- In general post-processing storage at temperatures above 0°C resulted in a decrease in antioxidant levels.

Main results:

- Sous-vide processing is a promising strategy for retaining the antioxidant capacity and colour of thermally processed carrot disks.
- High hydrostatic pressure processing at ambient temperature and pressures of 400-600 MPa is an excellent food processing technology which has the potential to retain antioxidant compounds in strawberry, blackberry, tomato and carrot puree while also ensuring the foods are effectively pasteurised.
- Blast freezing and storage at -18°C is a good technique for preserving ascorbic and antioxidant activity in broccoli and greens but not carrots, provided the samples had been blanched prior to freezing.

Opportunity / Benefit:

This project developed relatively novel processing techniques, sous-vide and high hydrostatic pressure processing, which are attractive options for end-users as they allow retention of antioxidants in fruits and vegetables and also aid in increasing the shelf-life of the products. Expressions of interest in this research are welcome.

Collaborating Institutions:

University of Limerick

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1. Project background:

Consumer demand for ready-to-use convenience foods has led to dramatic changes in the marketing of fruits, vegetables and their products. Many items are now retailed from the chill cabinet in gas flushed packs or as fully processed convenience fruit and vegetables/products with an extended shelf life. This practice places extra stresses on in-product antioxidants and significant losses may occur. The proposed research will quantify this emerging problem of poor retention of antioxidants in fully processed ready-to-use fruits, vegetables and their products. It will compare retention levels with those in fresh unprocessed fruits and vegetables and with fully processed products. Finally, it will provide integrated solutions to minimise losses, protect the consumer, and help assure the long-term viability of this industry sector in Ireland.

2. Questions addressed by the project:

The project seeks answers to:

- How is the antioxidant activity affected due to thermal and non-thermal processing?
- What are optimum processing parameters to retain maximum levels of antioxidants?

3. The experimental studies:

The effects of a number of full scale industrial practices on antioxidant potential were investigated in pilot scale equipment housed in the Industrial Development Unit at TFRC Ashtown. These experiments used processing protocols currently in use in industry and samples were processed to specific pasteurisation values and then stored at temperatures and for periods appropriate for these pasteurisation values. Pasteurisation values were monitored using an electronic thermocouple system (E-Lab). This is a relatively new approach as previous experiments on the effect of thermal processing on the antioxidant potential of fruits have not used industrially relevant protocols or monitored pasteurisation values the key determinant of the shelf-life of the processed product. Following thermal processing the antioxidant potential of the products was monitored during storage. In addition in order to develop new approaches to retaining the antioxidant potential of fruit and vegetable products, novel industrial practices such as sous-vide processing and high hydrostatic pressure processing were examined. Strategies to retain the antioxidant potential of thermally processed fruit and vegetable products were then formulated as result of the outcomes of these experiments.

4. Main results:

Important insights into the extent of lose/retention of antioxidants following full processing were provided.
The following recommendations will aid fruit and vegetable processors to retain antioxidants in their products:

- Sous-vide processing is a promising strategy for retaining the antioxidant capacity and colour of thermally processed carrot disks.
- High hydrostatic pressure processing at ambient temperature and pressures of 400-600 MPa is an excellent food processing technology which has the potential to retain antioxidant compounds in strawberry, blackberry, tomato and carrot puree while also ensuring the foods are effectively pasteurised.
- Blast freezing and storage at -18°C is a good technique for preserving ascorbic and antioxidant activity in broccoli and greens but not carrots, provided the samples had been blanched prior to freezing.
- Low temperature storage (4°C) is ideal for strawberry jam as degradation of vitamin C and anthocyanin is significantly lower compared to higher temperature (15°C).
- Polynomial regression models have good potential for predicting the effect of time/temperature/storage regimes on antioxidant activity and instrumental colour of canned carrots, these models could aid food processors to optimise critical operating parameters (holding time) for desired product quality attributes.

5. Opportunity/Benefit:

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Sous-vide and high hydrostatic pressure are relatively novel processing techniques and are attractive options for the end-users to retain the antioxidants in fruits and vegetables and will also aid to increase the shelf-life of the products.

6. Dissemination:

Main publications:

Patras, A., Tiwari, B.K., Brunton, N.P. and Butler F. (2009) Modelling the effect of different sterilisation treatments on antioxidant activity and colour of carrot slices during storage. *Food Chemistry* **114(2):** 484-491.

Patras, A., Brunton, N.P., O'Donnell, C., and Tiwari, B.K. (2010) Effect of thermal processing on anthocyanin stability in foods; mechanisms and kinetics of degradation. *Trends in Food Science & Technology* **21(1):** 3-11.

Patras, A., Brunton, N.P., Downey, G., Rawson, A., Warriner, K. and Gernigon G (2011). Application of principal component and hierarchical cluster analysis to classify fruits and vegetables commonly consumed in Ireland based on in vitro antioxidant activity. *Journal of Food Composition and Analysis* **24(2):** 250-256.

Popular publications:

Patras, A., Brunton N., Pieve, S.D., Butler, F. and Downey G. (2009). Effect of thermal and high pressure processing on antioxidant activity and instrumental colour of tomato and carrot purées. *Innovative Food Science & Emerging Technologies* **10(1)**: 16-22.

Patras, A., Brunton, N.P., Pieve, S.D. and Butler, F. (2009). Impact of high pressure processing on total antioxidant activity, phenolic, ascorbic acid, anthocyanin content and colour of strawberry and blackberry purees. *Innovative Food Science and Emerging Technologies* **10(3):** 308-313.

Patras, A., Brunton N. P, Tiwari, B. K., Butler, F. (2011). Stability and degradation kinetics of bioactive compounds and colour in strawberry jam during storage. *Food and Bioprocess Technology* **4 (7):** 1245-1252.

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