Recovery of functional components from by-products of fruit, vegetable and fish processing

FIRM Project No: 06RDTAFRC519

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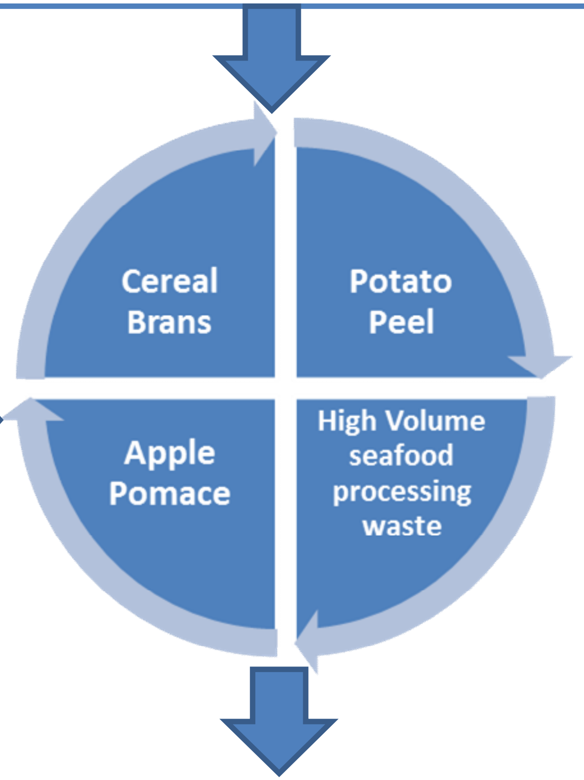
Outline

- Research approach
- Target sources and compounds
- Screening
- Optimisation of extraction conditions
  - Solid Liquid extraction
  - Pressurised Liquid extraction
  - Enzymatic
  - Extraction of gelatine
- Functional and physical properties of extracted ingredients
- Conclusion

Research Approach

Screen Fruit, vegetables and Seafood processing waste

- Solid Liquid Extraction
- Pressurised Liquid Extraction
- Enzyme assisted extraction



- Antioxidant activity
- Phenolic Content
- Gelatine, chitosan content

Physical, biological and technological Activity of crude extracts

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Target Sources - Compounds

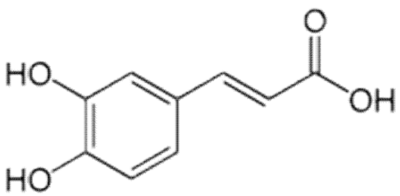
Potato Peel

Apple Pomace

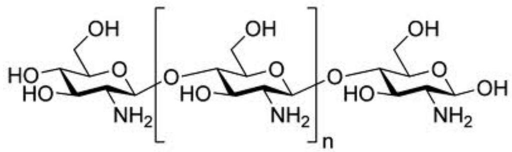
Cereal Brans

Crab Shell

Pelagic fish processing waste



Poly phenols, antioxidants



Chitosan

Gelatine

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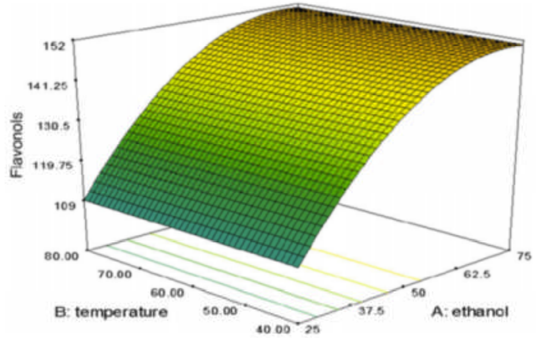
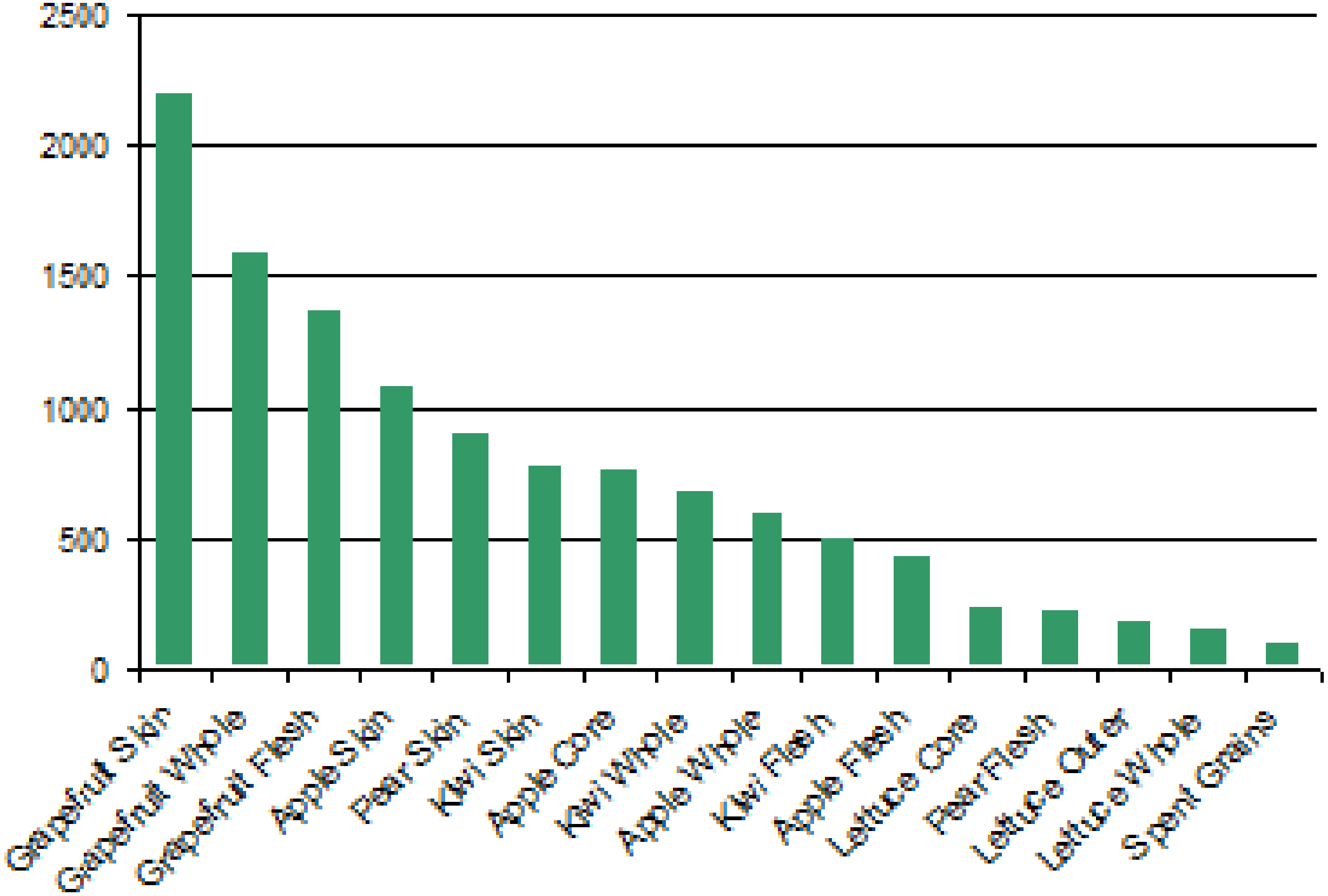
Response surface methodology

- Statistical technique which uses a series of designed experiments to optimise a response
- Box-Behnken or Central composite design
- No of experiments dependent on number of independent variables
- Results presented a contour plots
- Design Expert 7.1.3
- Determines optimal conditions and predicts the value for a response
- Repeat experiment using optimal conditions to validate model

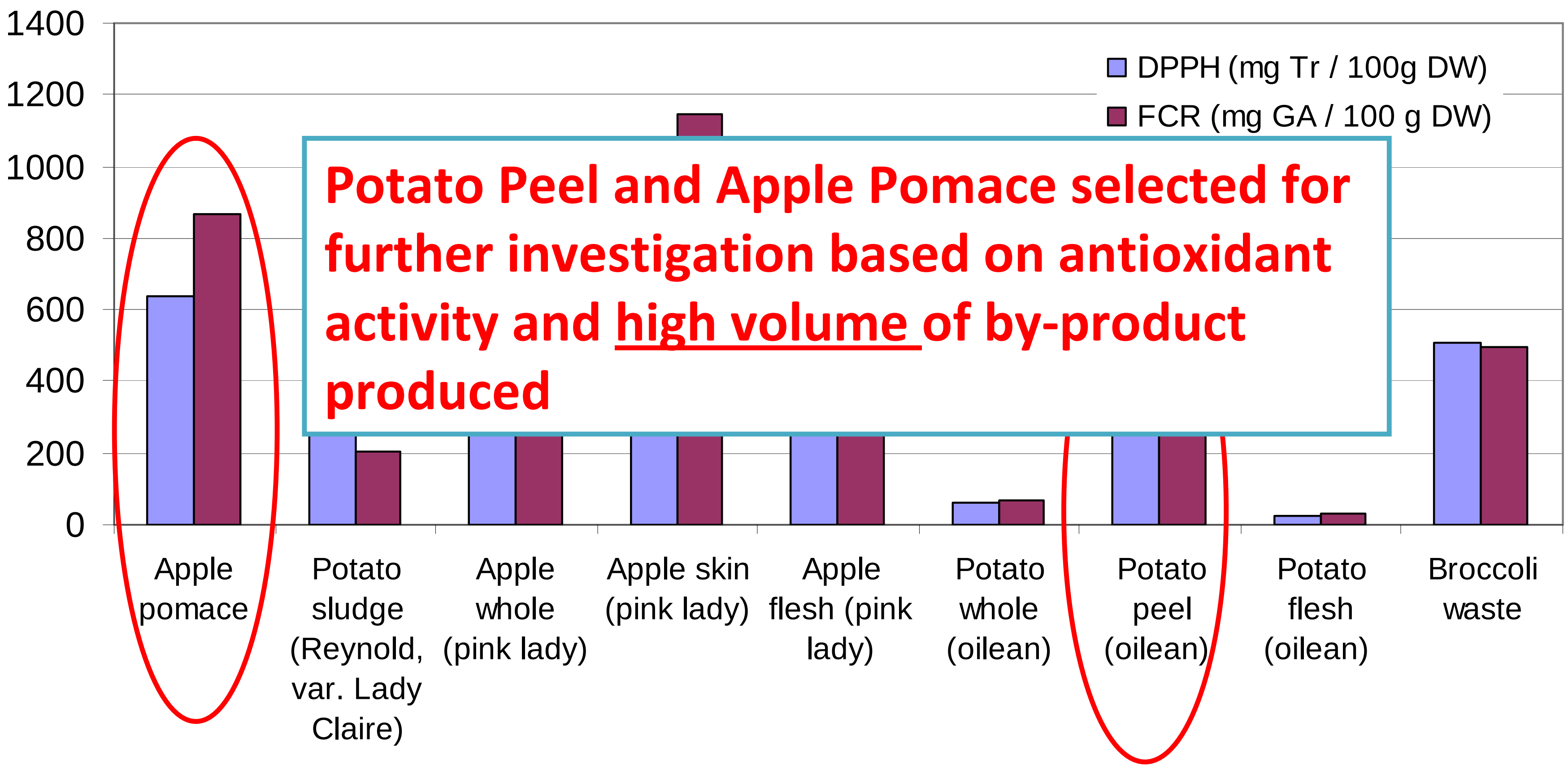


Screening – polyphenol content



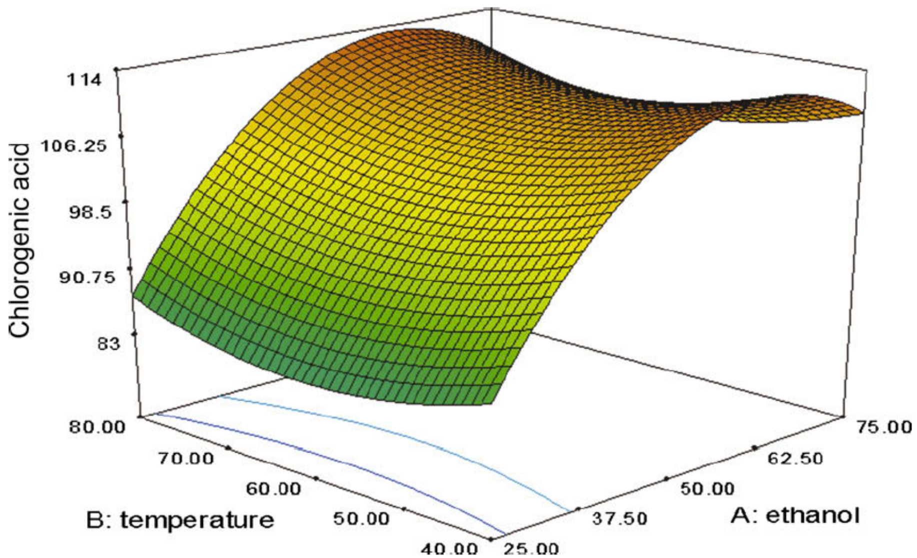
Screening

Potato Peel and Apple Pomace selected for further investigation based on antioxidant activity and <u>high volume</u> of by-product produced



Wijngaard, H. H., Rößle, C., & Brunton, N. (2009). ***Food Chemistry, 116(1), 202-207.***

Solid Liquid Extraction – Apple Pomace



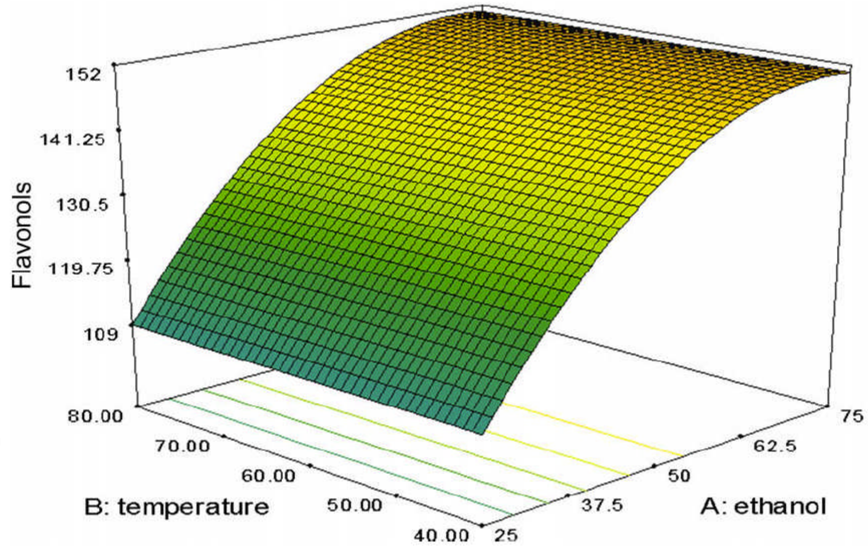


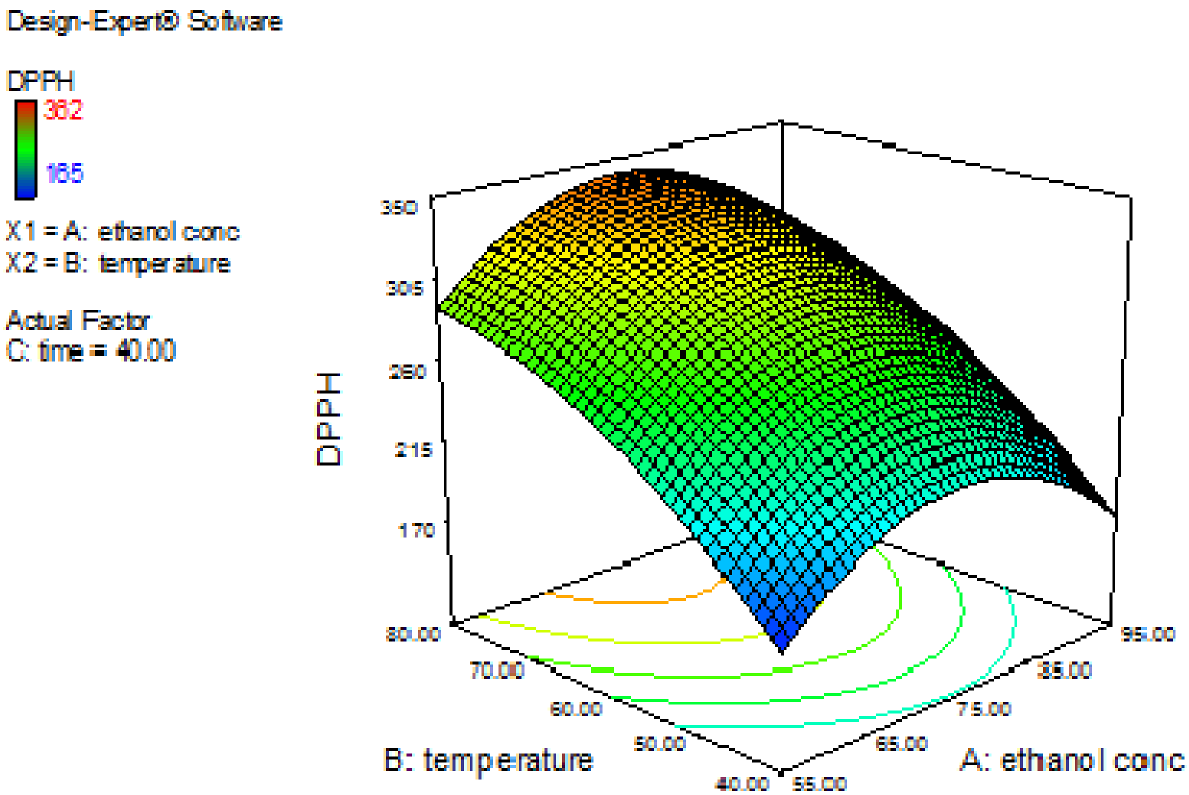
Table 5

Optimal conditions for extracting compounds with antioxidant activity and the predicted and actual response values with X_1 = ethanol conc. (%), X_2 = temperature (°C); X_3 = time (min); DPPH = antioxidant activity (mg TE/100 g DW); FCR = phenol level (mg GAE/100 g DW); CHA = level of chlorogenic acid (μmol chlorogenic acid/100 g DW); FLA = sum of level of flavonols (μmol rutin/100 g DW); PHLOR = level of phloretin glycoside (μmol phlorizin/100 g DW).

	Response 1 DPPH		Response 2 FCR		Response 3 CHA		Response 4 FLA		Response 5 PHLOR	
	Pred.	Actual	Pred.	Actual	Pred.	Actual	Pred.	Actual	Pred.	Actual
56% Ethanol, 80 °C, 27 min	403	449	1065	1092	114	158	147	159	113	100
65% Acetone, 25 °C, 60 min	529	436	1511	1415	121	137	177	170	126	124

Wijngaard, H. H. and Brunton, N. 2010. Journal of Food Engineering, 96(1), 134-140

Solid Liquid Extraction – Potato Peel



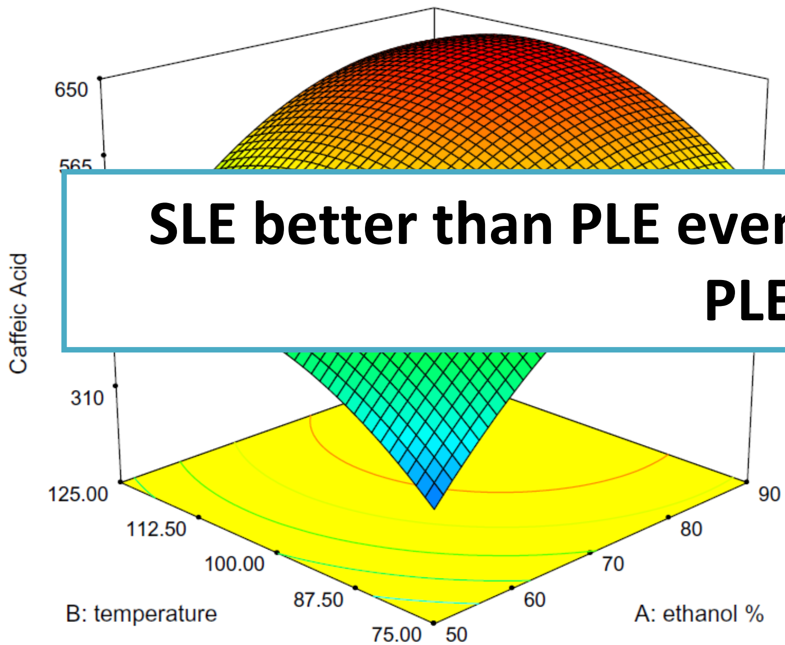
Optimal point for ethanolic extraction was: 75% ethanol, 80°C and 22 min

Pressurised Liquid Extraction

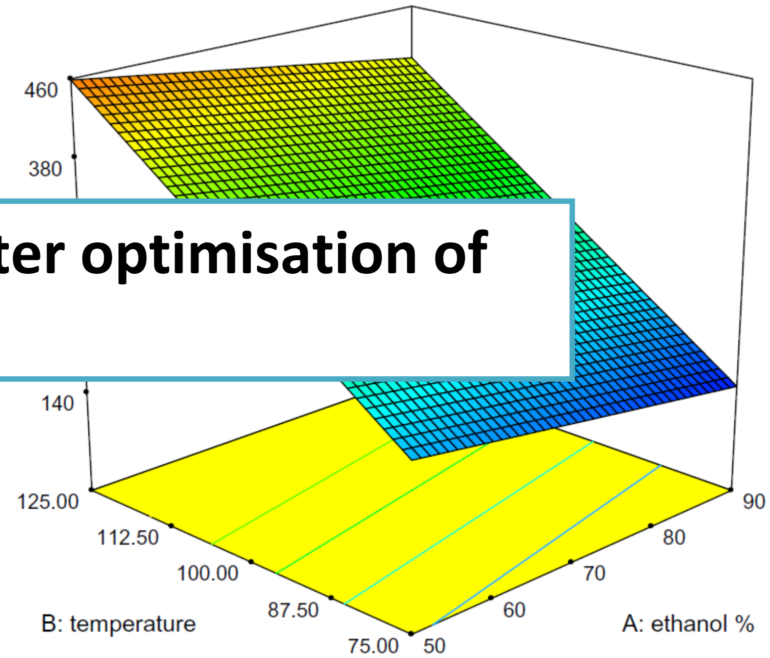
- No solvent evaporation, due to applied pressure
- Higher temperatures can be used than normal
- Better extraction?
- High capital cost
- Upscaling?

PLE – Potato Peel

Caffeic Acid



Total Phenolic Content

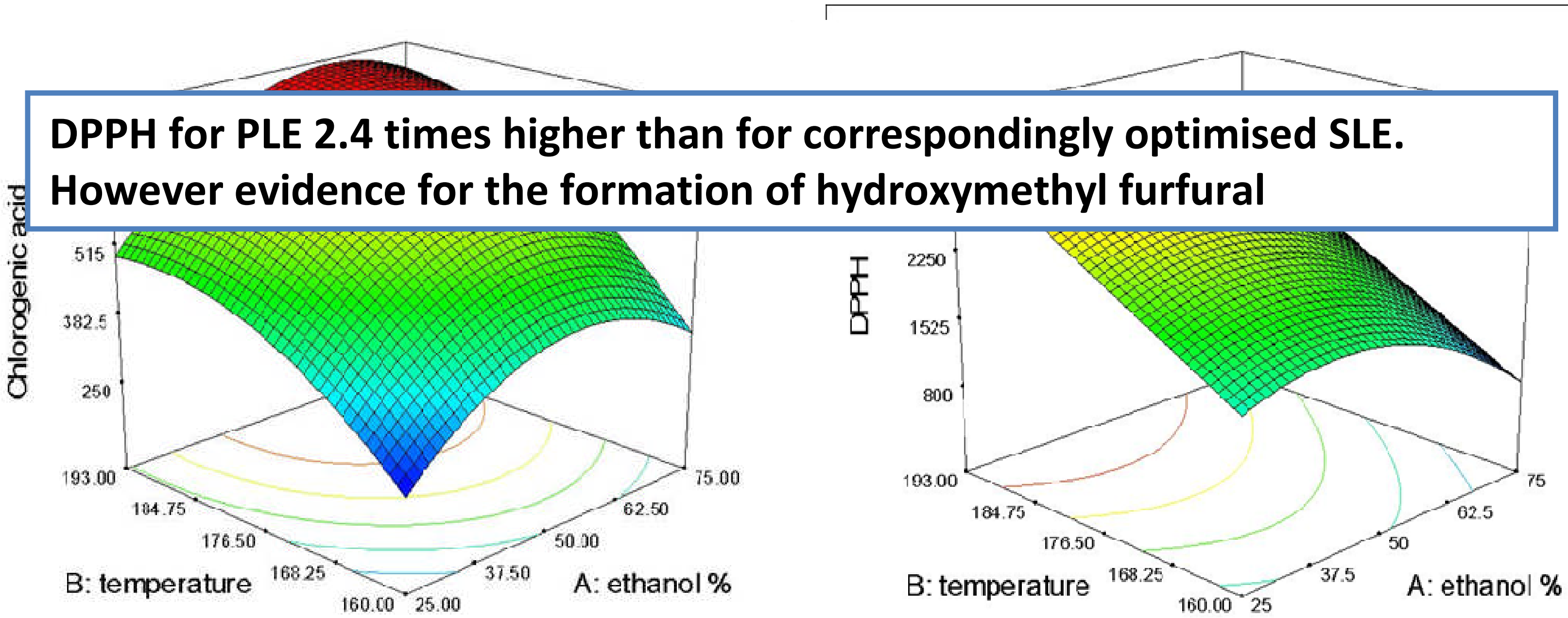


SLE better than PLE even after optimisation of PLE!

	Response 1 DPPH		Response 2 FCR		Response 3 CA	
	Pred.	Actual	Pred.	Actual	Pred.	Actual
Conventional extracts: methanolic extracts	NA	200 ± 4	NA	126 ± 7	NA	465 ± 13
Solid–liquid extraction: 75% ethanol, 80 °C, 22 min	355	352 ± 0	409	394 ± 1	606	651 ± 9
PLE: 70% ethanol, 125 °C	365	339 ± 5	431	368 ± 0	573	563 ± 10

PLE – Apple Pomace

DPPH for PLE 2.4 times higher than for correspondingly optimised SLE. However evidence for the formation of hydroxymethyl furfural



Wijngaard, H., & Brunton, N. (2009). Journal of Agricultural and Food Chemistry, 57(22), 10625-10631.

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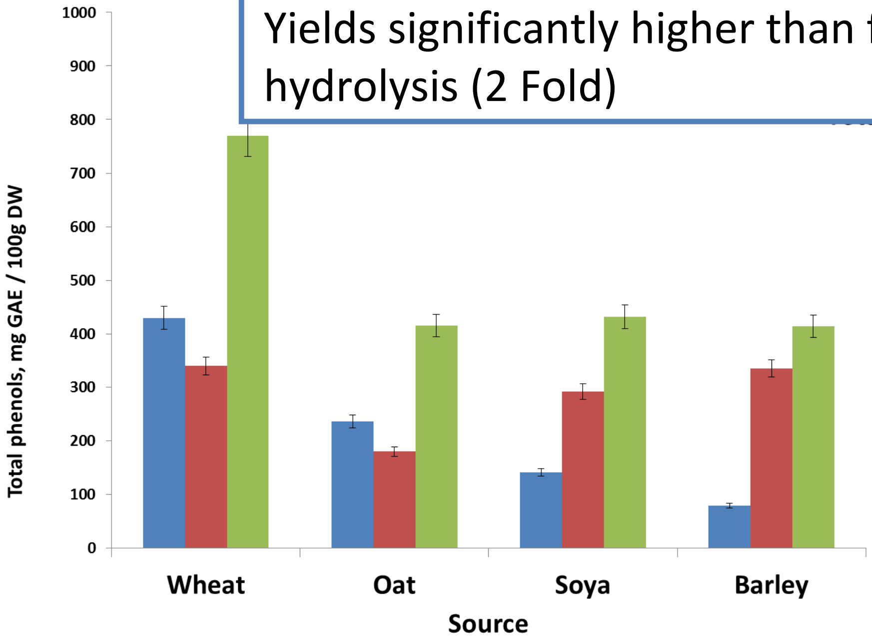
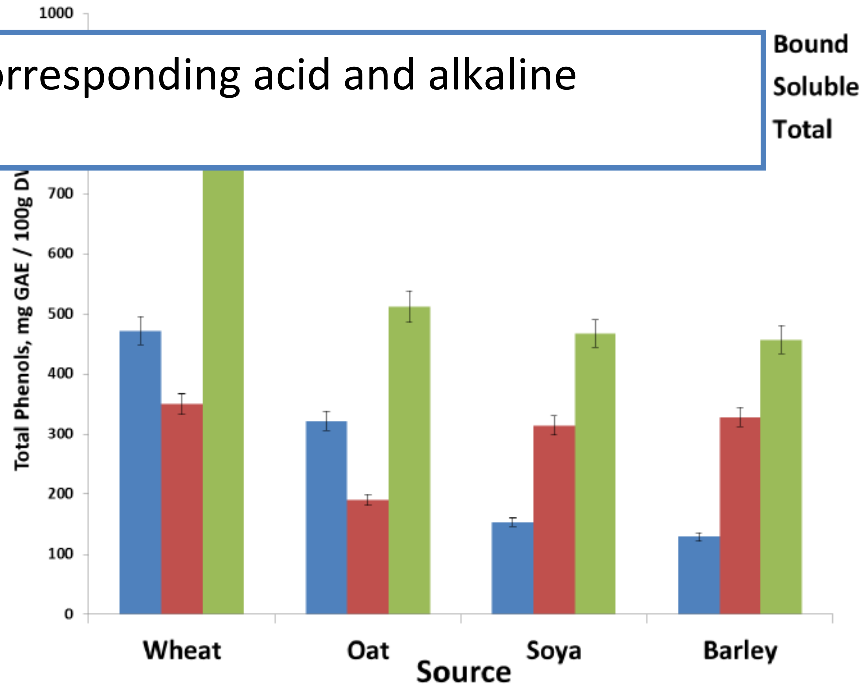
Enzymatic extraction – Cereal Brans

Yields significantly higher than for corresponding acid and alkaline hydrolysis (2 Fold)

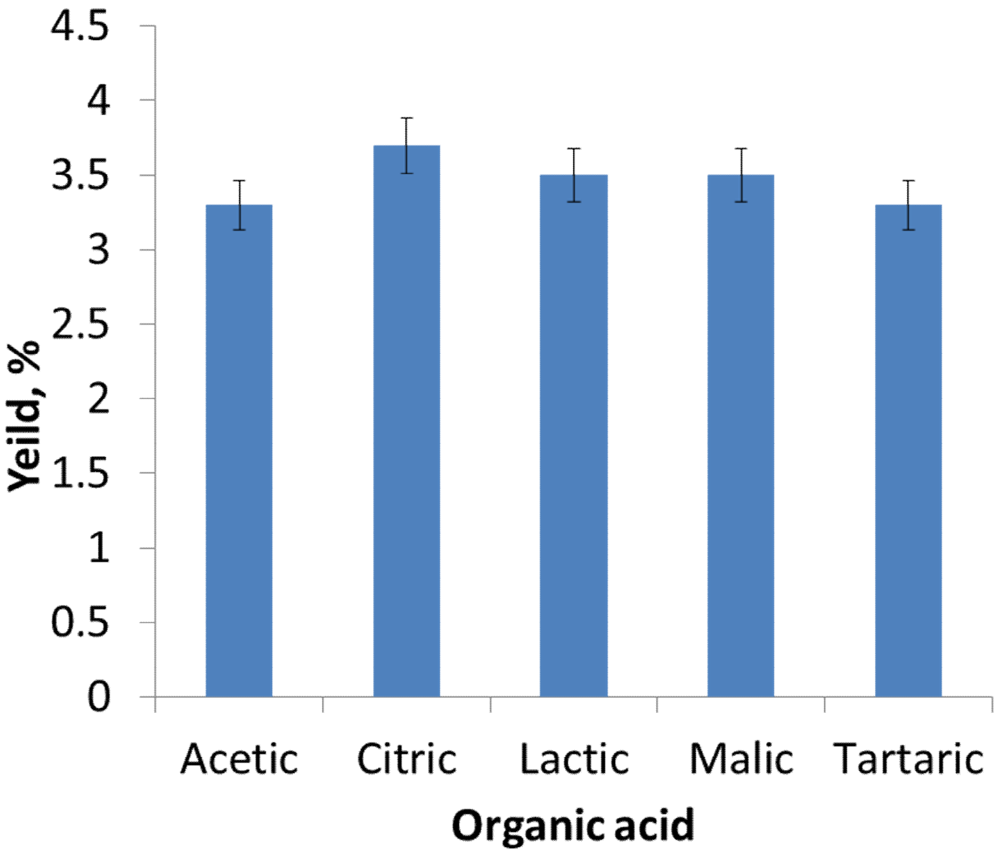


Levels of Polyphenols released from various Cereal Brans by Cocktail 2A at 70ºC over 24 hours



Levels of Polyphenols released from various Cereal Brans by Cocktail 2A at 70ºC over 48 hours

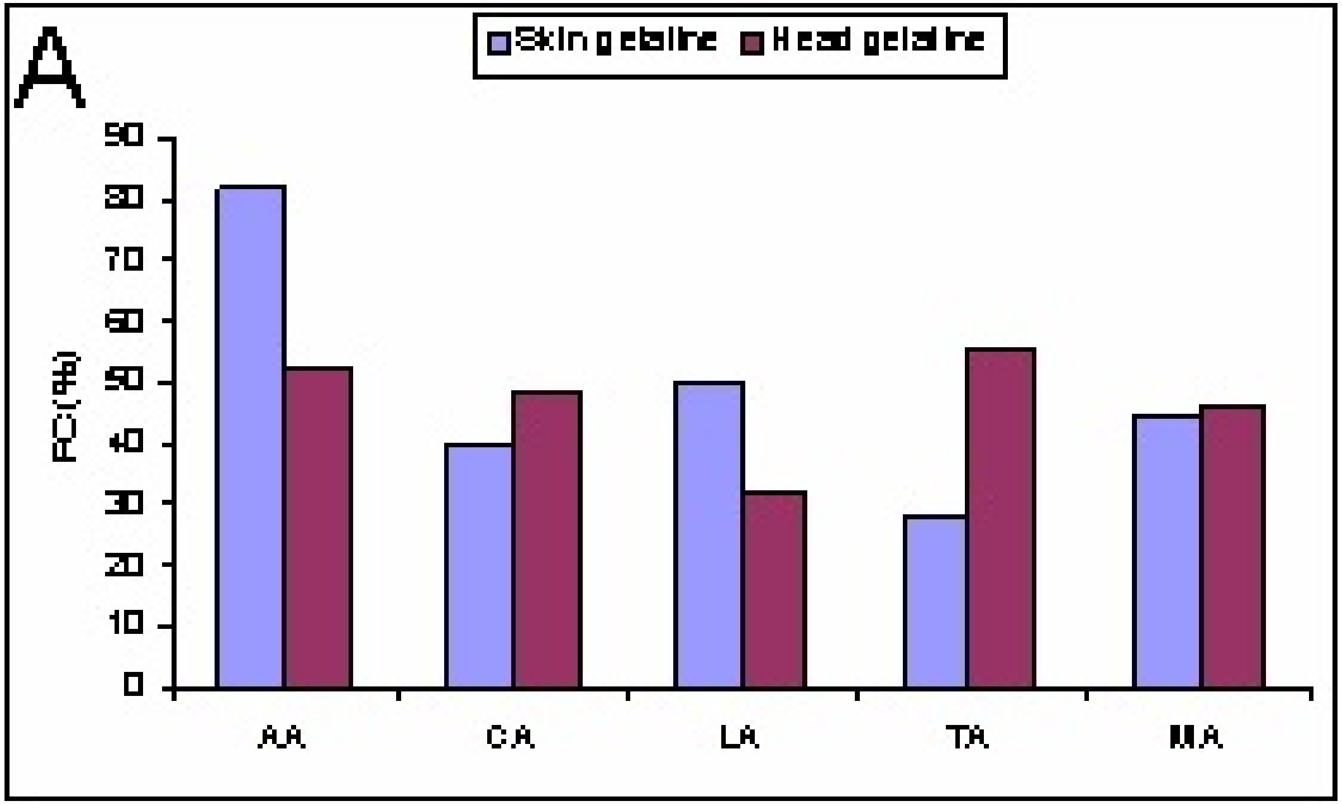
Extraction of gelatine from mackerel heads



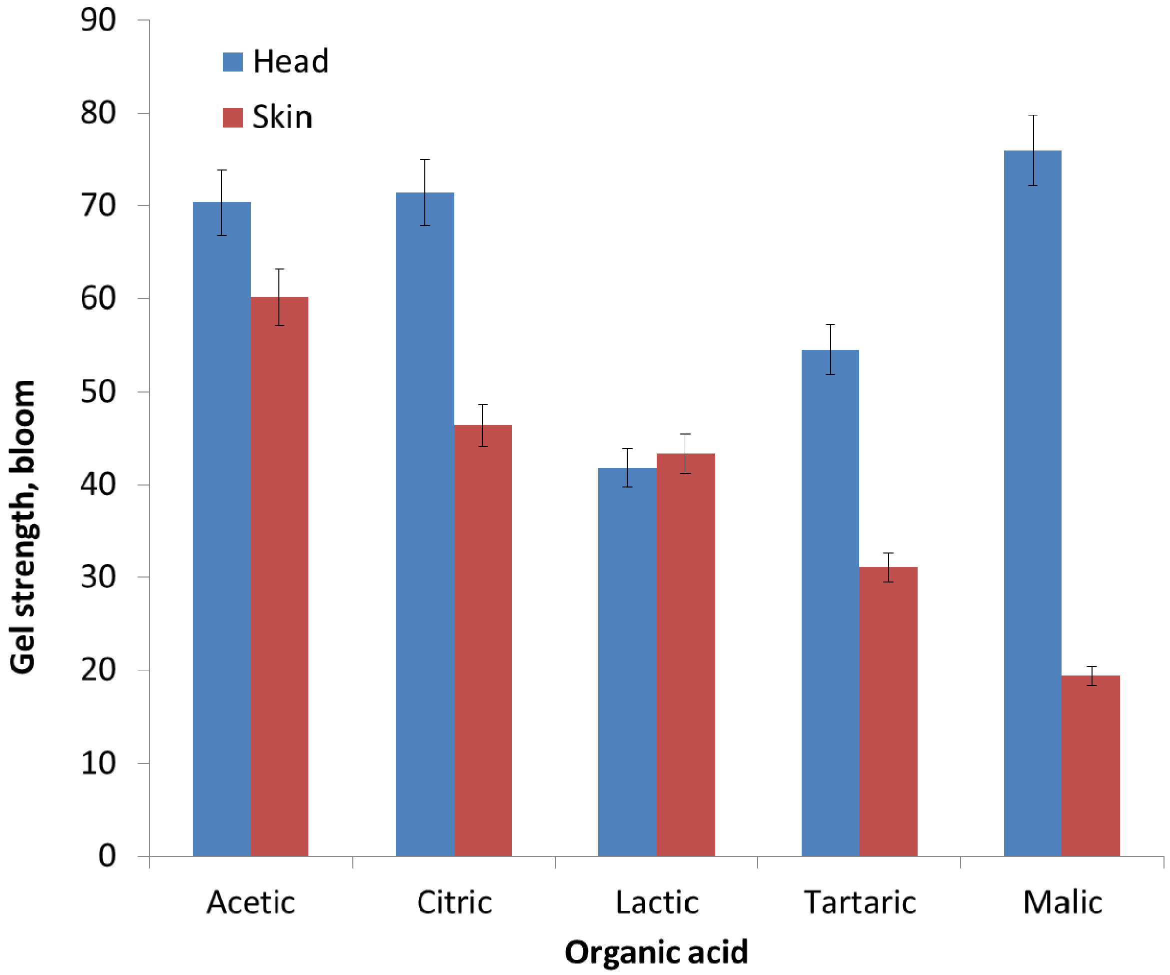
- Lactic and tartaric acids degraded the molecular structure of the gelatines
- Acetic acid showed a significantly ($p<0.05$) higher b* value
- Lactic acid higher turbidity (176±3.2 FTU),
- Best quality citric and malic acids

Khiari, Zied, et al. Journal of Fisheries Sciences. com 5.1 (2011): 52-63.

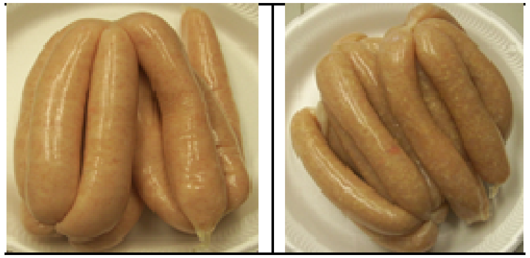
Physical Properties – Extracted Gelatine

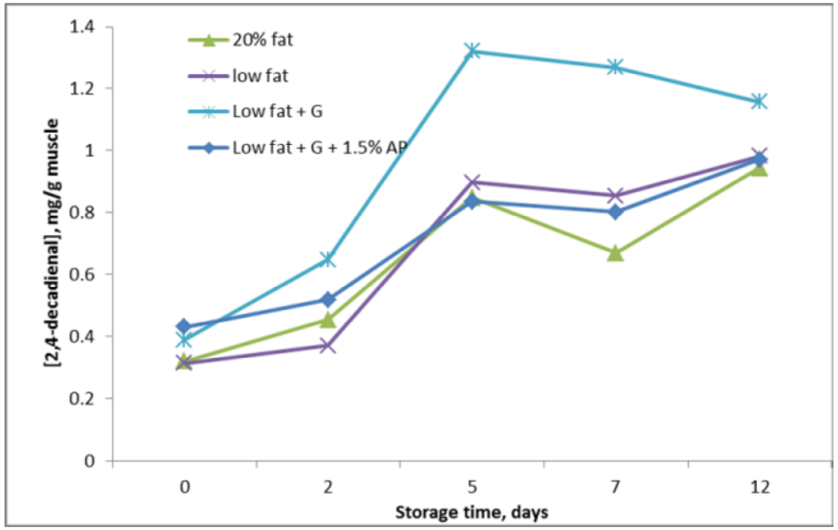


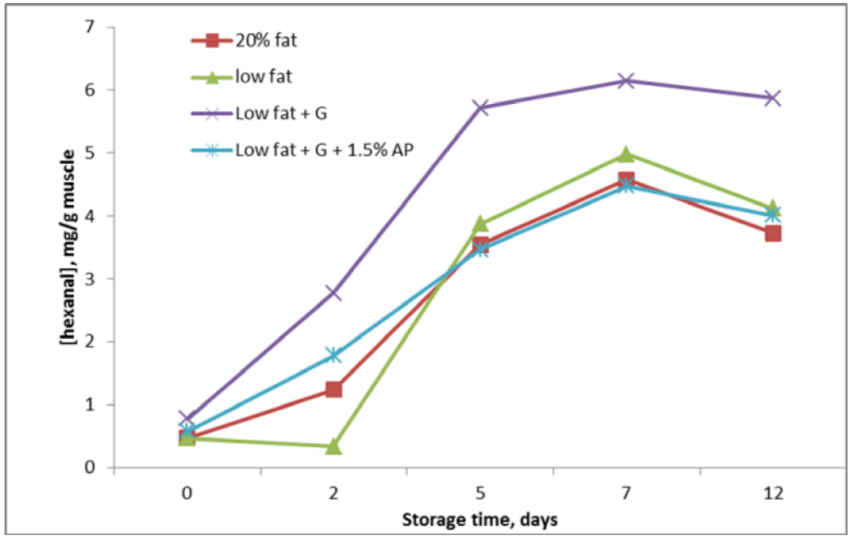
Physical Properties – Gel strength



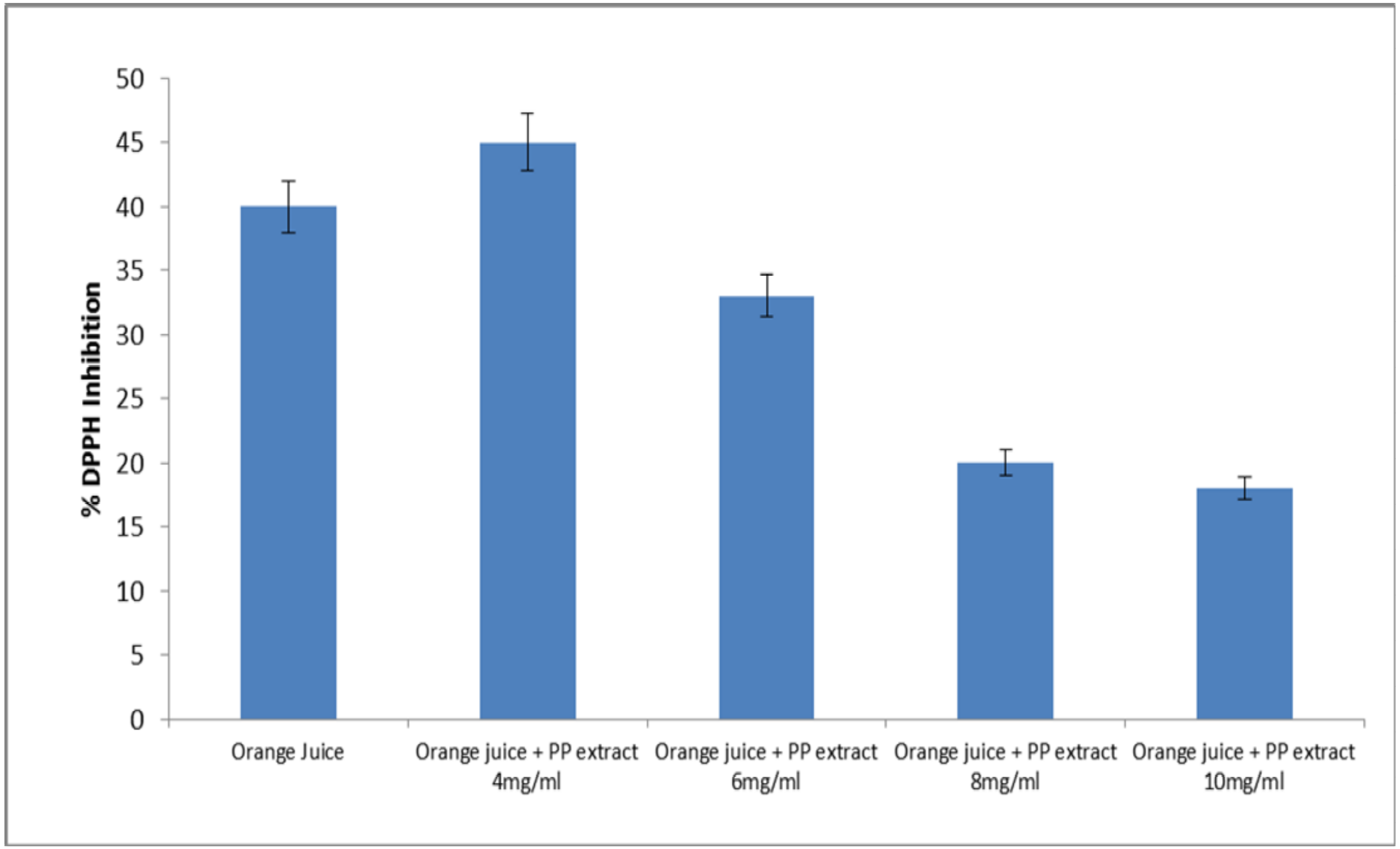
Functional Properties – Apple Pomace







Functional Properties – Potato Peel



Conclusions

- High volume uniform waste required
- Extraction methods – depend on capital cost
- PLE gave better yields for AA's from apple pomace in some cases but resulted in formation of HMF
- Glycoalkoids co-extracted from potato peel
- Supercritical fluid extraction gave low yields for carotenoids from apple pomace

Conclusions

- Enzyme assisted extraction releases cell wall bound polyphenols from cereal waste
- Yields and functional properties of gelatines extracted from mackerel waste not affected by organic acid but affected by source – head
- AA capacity and lipid stability of foods with extracts from by-products increased.

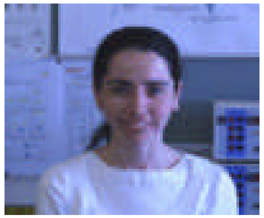
Acknowledgements

The Funding for the project was provided under the National Development Plan, through the Food Institutional Research Measure, administered by the Department of Agriculture, Fisheries & Food

Dublin Institute of Technology

Catherine Barry-Ryan

Zied Khiari



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Publications

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4. Khiari, Zied; Rico, Daniel; Martin-Diana, Ana Belen; Barry-Ryan, Catherine. 2010. The extraction of gelatine from Mackerel (Scomber scombrus) heads with the use of different organic acids. Journal of Fisheries Sciences 5(1): 52-63 (2011).
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