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Post-harvest treatment of post-harvest pea vine field residue for nutrient stabilisation

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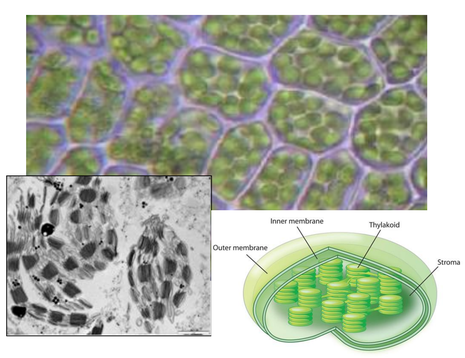
Introduction

During a UK pea harvest (25, 000 acres) **153, 000 tonnes** of residue, known as 'haulm' is generated. This is largely comprised of **vines, leaves and pods** and is conventionally left on the field. Some of this material is required for nitrogen fixation in the soil, for the next crop, but a large proportion is surplus and could be a source of untapped nutrients.

A theory developed by **Dr David Gray** (University of Nottingham) is that the **chloroplasts** of green plant biomass could be a source of **accessible nutrients**. Chloroplasts synthesise vitamins and are rich in galactolipids, from their membranes, and proteins, from the thylakoid membranes which conduct photosynthesis[1-5].



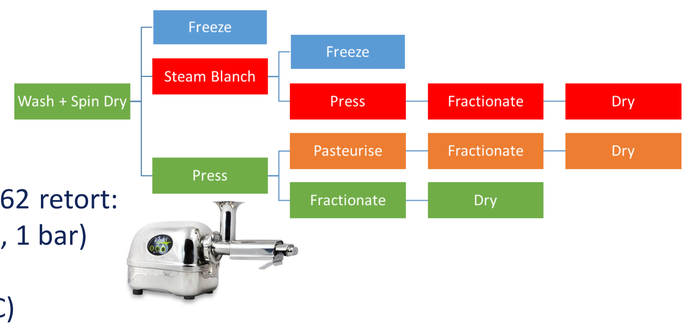
It is well known that the nutritional content of plants starts to decline after harvesting and that extensive decreases can occur if post-harvest handling leads to fermentation due to the **activity of enzymes**[6-7]. Frozen storage is also likely to induce a stress state in the plant biomass, activating enzymes which again will lead to degradation of the nutrients present[8-9]. Therefore, in this study, the 'knock-out' of enzyme activity through heat-treatment is investigated in order to stabilise/retain the nutritional content.

Methodology

Treatments and Processing

Four post-harvest treatment techniques were compared, to immediate processing on fresh pea haulm, for nutritional content and enzymatic activity:

- Frozen (-20°C)
- Steam blanched (Lagarde RP362 retort: 4 minute sterilisation at 100°C, 1 bar)
- Steam blanched and frozen
- Pasteurised (3 minutes at 90°C)



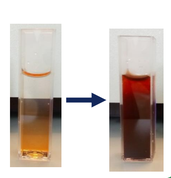
In short the material was jet-washed and dried using a salad spinner ahead of treatment, pressed to obtain a juice which was fractionated to obtain a chloroplast rich fraction (**CRF**) which was freeze-dried and ground.

Nutritional Analysis:

The ground CRF was analysed for native starch (*HK Assay*), protein (Pierce *BCA assay*), total lipids (Folch extraction), α-tocopherol (vitamin E), phylloquinone (Vitamin K), β-carotene (pro-vitamin A) and lutein (*HPLC*).

Assessing Enzyme Activity

Peroxidase enzyme activity in the juice was used to indicate enzymatic activity. This was assayed through measuring the colour change induced by the oxidation of guaiacol in the presence of H_2O_2.



Results

Effect of pre-treatment on Enzyme Activity

Steam-blanching the pea haulm ahead of pressing induced a 66% reduction in enzymatic activity whereas pasteurising the juice knocked out 100% of the peroxidase enzymes, when compared with that of untreated juice from fresh pea haulm. After 2 months of frozen storage there is an 80% reduction in the enzyme activity of juice from the steam-blanched pea haulm compared to that of untreated frozen pea haulm.

Effect of pre-treatment on CRF macronutrient content

The most notable effect induced by heat treatment, of either the pea haulm or the extracted juice, is the reduction of native starch, most likely due to gelatinisation.

A decline in protein content is also observed in the CRF isolated from pasteurised juice which may suggest that denaturation has been caused.

The lipid content appears to be unchanged.

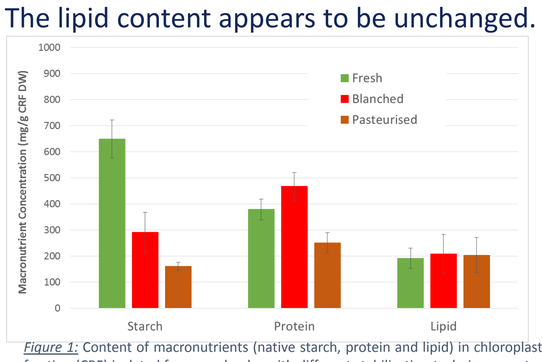


Figure 1: Content of macronutrients (native starch, protein and lipid) in chloroplast rich fraction (CRF) isolated from pea haulm with different stabilisation techniques: untreated (fresh) haulm, steam-blanched haulm and heat-treated (pasteurised) juice.

Effect of pre-treatment on CRF micronutrient content

Phylloquinone (vitamin K) appears to be particularly heat sensitive as it is reduced in both treatment techniques. Steam-blanching appears to cause a slight reduction (23%) in lutein content but there is no significant difference in the content of either β-carotene and α-tocopherol. Slight increases of either β-carotene and α-tocopherol in the CRF from pasteurised juice may be an artefact of the decreasing starch content 'concentrating' other compounds.

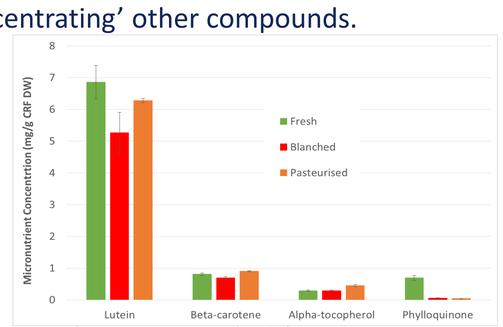


Figure 2: Content of selected micronutrients (lutein, β-carotene, α-tocopherol and phylloquinone in CRF isolated from pea haulm with different stabilisation techniques.

Effect of enzyme knock-out on micronutrient retention during frozen storage

The apparent increase in enzyme knock-out, after 2 months frozen storage, of steam-blanched pea haulm suggests that the enzyme activity of untreated pea haulm is increased in the stress conditions of freezing. This is reinforced by the stability of nutrients under these conditions.

α-tocopherol content is particularly reduced in frozen untreated pea haulm (93% reduction) and degradation is also seen, to a lesser extent, with β-carotene and lutein (46% and 32% decrease respectively).

But if the pea haulm is steam-blanched first, the micronutrient content appears to be stabilised; as the degradation of these micronutrients is minimal, with no significant difference in content after freeze storage.

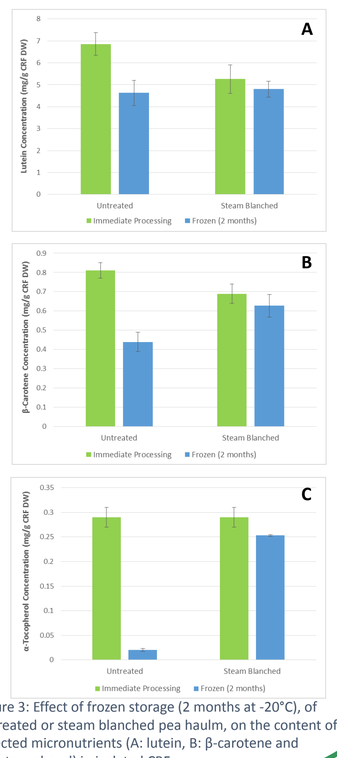


Figure 3: Effect of frozen storage (2 months at -20°C), of untreated or steam blanched pea haulm, on the content of selected micronutrients (A: lutein, B: β-carotene and C: α-tocopherol) in isolated CRF.

Conclusions

Chloroplast rich fractions (CRF) extracted from post-harvest pea residues (haulm) has been shown to be rich in starch, protein and lipid soluble vitamins such as lutein, β-carotene and α-tocopherol.

Heat treating pea haulm through steam-blanching stabilises the nutrients through reducing enzymatic activity without overtly reducing the nutrient content. This reduction in enzymatic activity is shown to protect the nutrients from degradation during frozen storage.

It is possible to heat treat extracted juice, prior to CRF fractionation, through pasteurisation; this technique appeared to knock-out 100% of the enzyme activity but displayed some possible denaturation of the CRF protein content.

Acknowledgements and References

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