Assessing bioavailability of carotenoids from sea buckthorn using in vitro digestion

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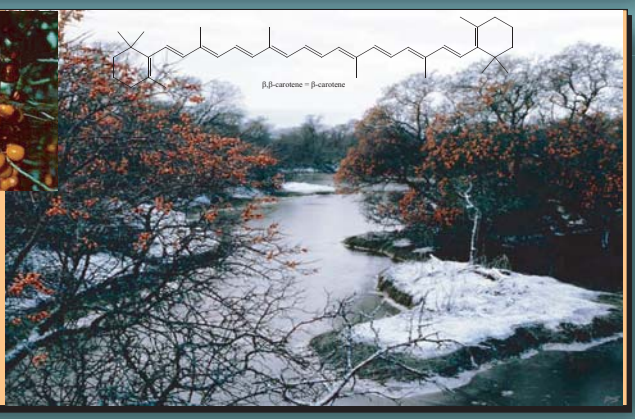
Introduction



Carotenoids are essential for human health. These hydrophobic isoprenoid derivatives are precursors for Vitamin A (retinol) and deficiency of dietary carotenoids can lead to health problems such as age-related macular degeneration and enhanced risk of cardiovascular problems (1). The uptake and stability of these essential micro-nutrients is not well defined. The objective of this project is to assess the bioavailability and stability of carotenoids from sea buckthorn berries - a good source of these health-giving compounds (2) - using an in vitro digestion method. The long term aim is to use the information gained to select varieties with elevated levels of bioavailable forms of carotenoids in accelerated breeding programmes of soft fruit, and perhaps even in potato.

Results

Bioavailability of carotenoids

The bioavailability of carotenoids was assessed using a model system (3) that mimicked the digestive processes of the human gastrointestinal tract (Fig. 1). The recovery of carotenoids (Fig. 2) after gastric digestion was about 50% of the total content. This suggests that the carotenoids were unstable to the gastric conditions. However, around 40% of the total survived the pancreatic digestion (OUT sample values) suggesting that the carotenoids were essentially stable in the conditions of the small intestine.

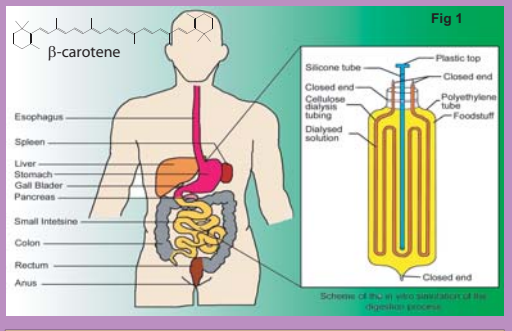
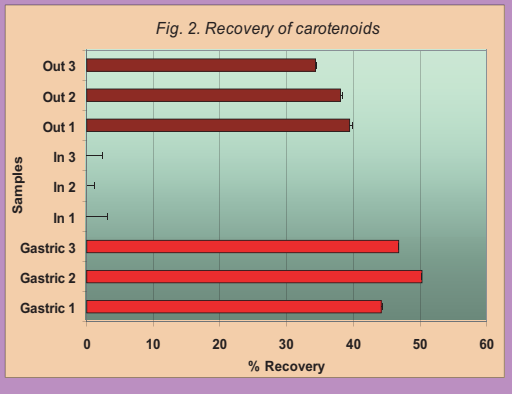
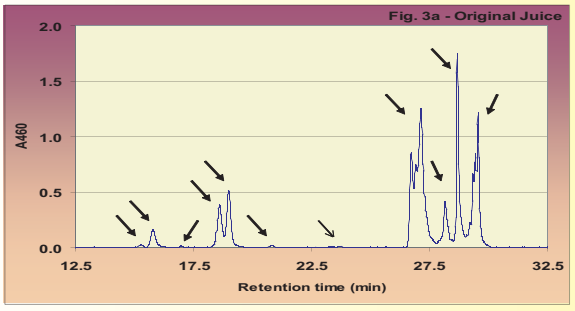


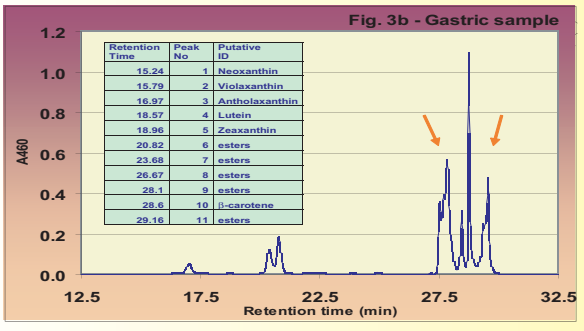
Fig. 2. Recovery of carotenoids



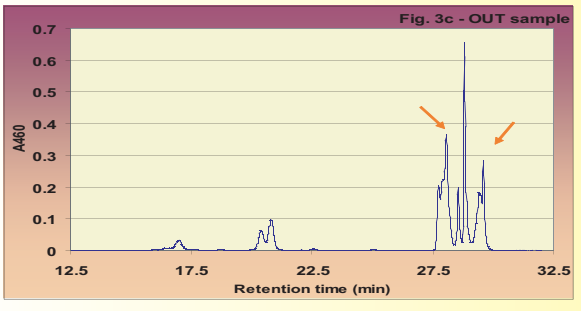
Carotenoids levels were very low in the IN samples because these hydrophobic compounds did not penetrate the dialysis membrane. Analysis of the sea buckthorn samples by reversed phase high performance liquid chromatography (HPLC) revealed the presence of eleven distinct peaks that absorbed at 460 nm (Fig 3a). These can be assigned putative identities according to the order of elution and their UV/visible absorbance spectra (see Table). The main carotene peak was β-carotene (peak 10) but there were detectable levels of violanxthin (peak 2) and large amounts of carotenoid esters (peaks 6-9 and 11). The HPLC traces of the gastric and OUT samples (Fig. 3 b-c) appeared qualitatively similar.

Identification of carotenoids by HPLC





Retention Time	Peak No	Putative ID
15.24	1	Neoxanthin
15.79	2	Violaxanthin
16.97	3	Antholaxanthin
18.57	4	Lutein
18.96	5	Zeaxanthin
20.82	6	esters
23.68	7	esters
26.67	8	esters
28.1	9	esters
28.6	10	β-carotene
29.16	11	esters



Discussion and Conclusions

The in vitro digestion procedure showed that the gastric digestion was crucial to the recovery of carotenoids. The recovery of carotenoids as assessed by HPLC analysis correlated with the total carotenoid values. There were no great qualitative differences in the HPLC traces and each carotenoid appeared equally affected by the IVD procedure. However, there were changes in the shape and levels of the carotenoid ester peaks (Fig.3, orange arrows) which suggested that the esters were differentially affected by the acid gastric conditions or the presence of lipases in the pancreatic digestion. Although the carotenoid esters were examined by saponification, it proved impossible to match the saponified carotenoids to particular ester peaks. Further work to identify which carotenoid esters are stable to IVD, perhaps using mass spectroscopic methods, is required. In conclusion, as the hydrophobic carotenoids are passively absorbed in the small intestine into the lymphatic system, any means of improving survival during gastric transit will markedly enhance carotenoid bioavailability.

References

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