Gastrointestinal stability of raspberry anthocyanins

G.J. McDougall, A. Blake, P. Dobson, P. Smith & D. Stewart

Anthocyanins are the polyphenol pigments responsible for the red to blue colours of plant fruits, flowers and leaves. Berry fruits are rich sources of anthocyanins providing 100-300 mg in a portion. Anthocyanins are effective antioxidants and their intake has been reported to enhance cardiovascular performance, protect against carcinogens, suppress inflammatory responses and protect against ageing-related decline in the central nervous system.

To achieve these body-wide effects, anthocyanins must be bioavailable i.e. available from digested foods, effectively absorbed from the gut into the blood and delivered to the appropriate locations throughout the body. The bioavailability of anthocyanins is open to question. Eating anthocyanin-rich fruits, extracts or pure anthocyanins has beneficial effects in preventing or suppressing disease states *in vivo*. Oral administration of anthocyanins confirmed increased blood antioxidant status but this was accompanied by very low uptake of anthocyanins into the blood (<<1% of dose). The apparent low bioavailability of anthocyanins casts doubt on their ability to exert their proposed beneficial effects.

Assessment of anthocyanin bioavailability requires complex and expensive studies on their absorption, metabolism, and excretion. In this study, we assess the stability of raspberry anthocyanins using a laboratory-based two-stage digestion procedure that mimics the physiochemical conditions encountered in the gastrointestinal tract.

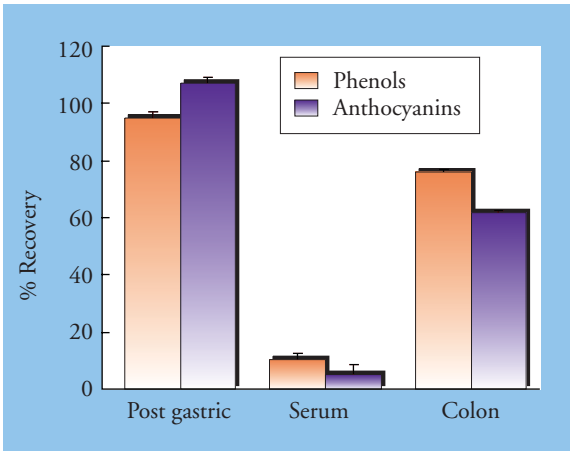

Figure 1 Recovery of phenols and anthocyanins from raspberry after gastrointestinal digestion.

Effectively all of the polyphenols in the raspberry extract survived gastric digestion and partitioned between the serum-available material and the colon-available material after pancreatic digestion. All of the anthocyanins also survived gastric digestion but only ~5% entered the serum available sample and ~65% of total anthocyanins were recovered in the colon available sample (Fig. 1).

Eight anthocyanins, composed of two anthocyanidin core molecules called cyanidin and pelargonidin linked to four different sugar structures (Fig. 2), were detected in the raspberry extract using liquid chromatography mass spectrometry (LC-MS). All eight anthocyanins were completely stable to gastric digestion. All eight anthocyanins also survived the pancreatic digestion but some such as cyanidin-3-*O*-glucoside were greatly reduced and others such as pelargonidin-3-*O*-glucoside were much more stable (Fig. 2). Differences in gastrointestinal stability did not match previous studies on the differential stability of pure anthocyanins. In particular, enhanced stability was not correlated to the anthocyanidin core or the attached sugar structures (Fig. 2). It would appear that in mixtures such as found in natural fruit extracts and juices, certain anthocyanins are sacrificially protected by oxidation of other anthocyanins. The gastrointestinal stability of anthocyanins as measured by this laboratory procedure can be related to the pool size available to transport mechanisms operating in the gut and therefore influences bioavailability. Information on the link between anthocyanin structure and the bioavailability of anthocyanins could be applied to SCRI breeding programmes to produce healthier varieties of soft fruit such as raspberry and blackcurrant.

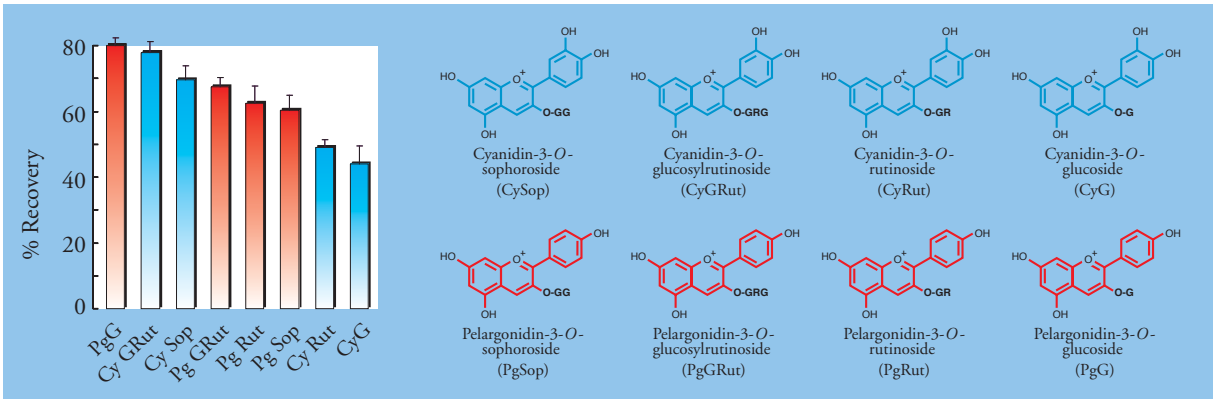

Figure 2 Recovery of individual raspberry anthocyanins after pancreatic digestion. The anthocyanidin core structures are colour coded in blue for cyanidin and in red for pelargonidin.