

Berry Polyphenols: Bioactivities and Health Benefits

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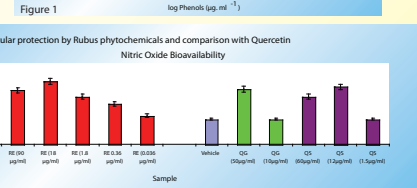
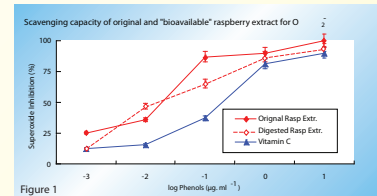


The recent joint expert report by WHO and FAO (1) concerning the relation between nutrition and chronic and degenerative diseases concluded that a convincing association exists relating the consumption of fruits (and vegetables) and reduced risk of cardiovascular disease (CVD) and some cancers. However, the derivation of the beneficial, protective effect remains unclear although several studies point indicate that plant antioxidants could be important. In this poster, we show four examples in which polyphenols from berries have bioactivities that could have beneficial effects on key health issues.

Study 1 – Cardiovascular-Protective Effects of Raspberry extracts

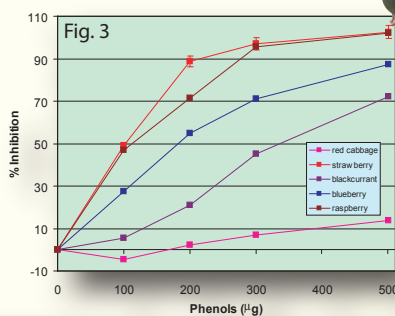
A polyphenol-rich but vitamin C free extract of raspberry (*Rubus idaeus*) was prepared that had an ellagitannin:anthocyanin ratio of ~2:1. This was used in serial dilution organ bath studies to determine their effect on the suppression of superoxide (O_2^-) in rat abdominal and thoracic arteries and NO bioavailability in carotid arteries. O_2^- is accepted as an endothelial dysfunction agent whilst NO is a mediator involved in several endothelial functions including relaxation and vessel flexibility.

- The raspberry extract, even at remarkably low levels, exerts a significant ability to scavenge O_2^- (Fig 1) with both the original and "bioavailable" (subject to in vitro digestion) extracts performing better than Vitamin C.
- The raspberry extracts also exhibit beneficial effects on NO bioavailability (Fig 2). They were more effective than Vitamin C and quercetin glucuronide (QG) and sulphate (QS) - known effective dietary components - at lower concentrations. Therefore, the raspberry polyphenols have the potential to beneficially influence CV performance.

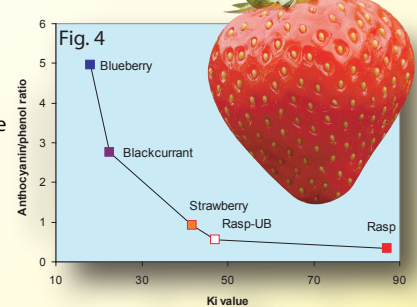


Study 2 – Inhibition of Starch Digestion by Berry extracts

Berry extracts inhibited α -amylase activity with strawberry and raspberry being the most effective (Fig. 3). The concentration for half maximal inhibition was in the range that could be encountered in the small intestine after ingestion of berries. The most active components appeared to ellagitannins.



The berry extracts also inhibited α -glucosidase activity but the order of effectiveness was different (Fig. 4). The most effective extracts appeared to be anthocyanin-rich. There is considerable potential for synergy between different berry polyphenolic components to inhibit starch digestion and thereby modulate blood glucose levels in vivo (2).

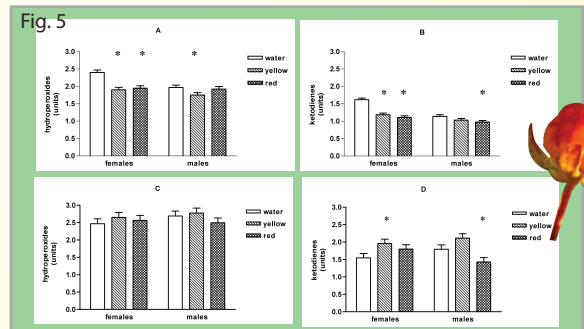


Study 3 – Effects of Berry Supplementation on a Model System for Aging

A fruit fly (*Drosophila melanogaster*) model was used to study the effect of dietary supplementation with red and yellow cloudberry juices (*Rubus chamaemorus*) with high and low anthocyanin respectively. Primary (conjugated hydroperoxides) and secondary (ketodienes) products of lipid peroxidation (age-related oxidative damage) was measured at different age points and in both sexes (Fig. 5). There were age-related and sex related differences (3).

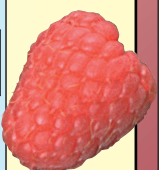
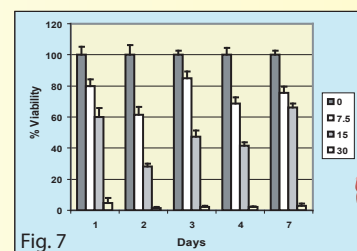
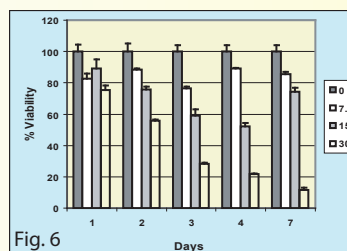


- Young females experienced significant reductions in primary and secondary oxidation with both juices.
- Young males experienced significant reductions in primary and secondary oxidation following supplementation with yellow and red juices, respectively.
- Older flies only experienced benefits with red juice and only then on secondary oxidation products (ketodienes) in males.



Study 4 - Effects of Raspberry Extracts on Cancer Cell Proliferation

Raspberry extracts inhibit the proliferation of cancer cells in a dose-responsive manner (Fig. 6). The inhibition is not caused by anthocyanins as their complete removal potentiated the effectiveness of the extract (Fig. 7). Ellagitannins seem to be the most effective anti-proliferative agents and initial studies suggest that they break down in the presence of the cancer cells to form ellagic acid, which may be the key antiproliferative agent (4).



Conclusions

Polyphenolic components of berries exert clear bioactivities such as reduced age-related oxidation, increased NO bioavailability, reduced cancer cell proliferation and control of blood glucose levels which have direct relevance to major health problems such as aging, cardiovascular disease, cancers and diabetes. We have begun to identify structure activity relationships for these bioactivities and we now aim to corroborate these results under in vivo conditions through suitably designed trials.

References

- anon. (2002). Diet, nutrition and the prevention of chronic diseases. World Health Organisation, Geneva, Switzerland.
- McDougall et al. J Agric Food Chem. 53, 2760. 3. Mylnikov et al. (2005) J. Agric Food Chem. 53, 7728. 4. Ross et al. (2006) Phytochemistry, in press.

Acknowledgements

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