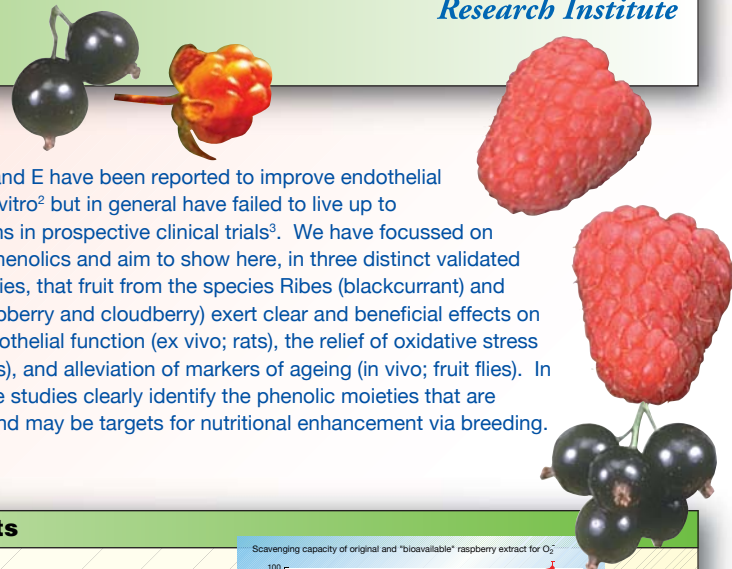


# Rubus and Ribes: Identification of nutritional breeding targets

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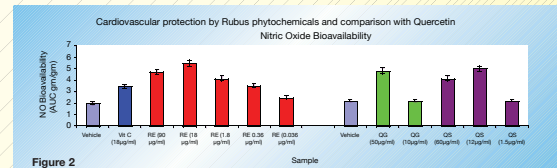
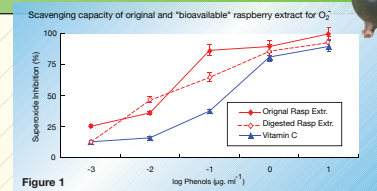
The recent joint expert report by WHO and FAO<sup>1</sup> concerning the relation between nutrition and chronic and degenerative diseases concluded that a convincing association exists relating the consumption of fruits (and vegetables) and reduced risk of cardiovascular disease (CVD) and some cancers. However, the derivation of the beneficial, protective effect remains unclear although several isolated studies point towards compounds in the plant known as antioxidants. This is a chemically diverse group and only some of these have been the subject of focussed studies into their bioavailability and bioefficacy in vivo. For example, both

Vitamin C and E have been reported to improve endothelial function in vitro<sup>2</sup> but in general have failed to live up to expectations in prospective clinical trials<sup>3</sup>. We have focussed on the plant phenolics and aim to show here, in three distinct validated model studies, that fruit from the species *Ribes* (blackcurrant) and *Rubus* (raspberry and cloudberry) exert clear and beneficial effects on arterial endothelial function (ex vivo; rats), the relief of oxidative stress (in vivo; rats), and alleviation of markers of ageing (in vivo; fruit flies). In addition the studies clearly identify the phenolic moieties that are bioactive and may be targets for nutritional enhancement via breeding.

## Study 1 - Cardiovascular-Protective Effects of Rubus extracts

A vitamin C free extract of raspberry (*Rubus idaeus*) was prepared that was almost exclusively phenolics and had an ellagitannin:anthocyanin ratio of ~2:1 (w/w). 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.

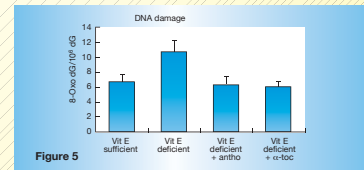
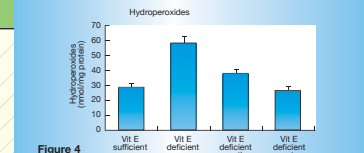
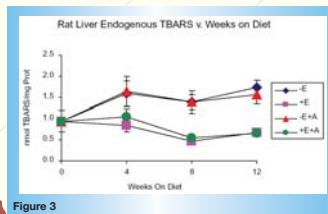
- The raspberry extract, even at remarkably low levels, exerts a significant ability to scavenge  $O_2^-$  (Fig 1) with both the original and "bioavailable" (subject to in vitro digestion) extracts performing better than Vitamin C.
- The raspberry phytochemicals also exhibit beneficial effects with respect to NO bioavailability (Fig 2). Comparison with Vitamin C and the glucuronide (QG) and sulphate (QS) metabolites of quercetin, a proposed dietary antioxidant, showed that it was more bioactive at a lower "phenol load".



## Study 2 - Relief of oxidative stress by blackcurrant phenolics

A vitamin C free extract was prepared from blackcurrants (*Ribes nigrum*) which yielded a highly enriched anthocyanins preparation. This was fed to vitamin E-deficient (oxidatively stressed) rats at 150mg/kg diet. Vit E was fed to analogous rats for comparative purposes.

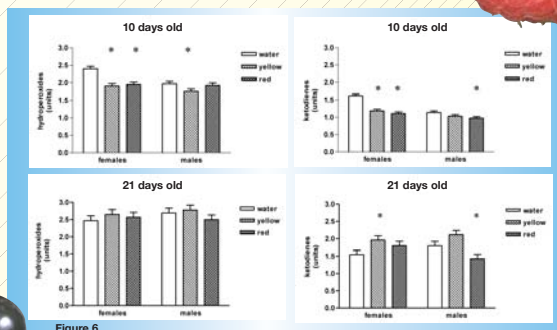
- In general, supplementation of the diet with the blackcurrant extract did not reduce the level of lipid oxidation (TBARS), unlike Vit E. (Fig 3)
- The oxidation-derived generation of hydroperoxides and DNA damage were significantly suppressed by blackcurrant extract supplementation. (Fig 4 & 5)



## Study 3 - Effects of fruit supplementation on a model system for ageing

A fruit fly (*Drosophila melanogaster*) model was used to study the effect and intervention point of dietary supplementation with juice from red and yellow cloudberry (*Rubus chamaemorus*); 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 6).

- 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.



## Conclusion

Clearly, the predominant phenolic compounds in fruit [anthocyanins (*Ribes*) and ellagitannins (*Rubus*)] exert clear biological effects on complex biochemical systems. The benefits such as reduced age-related oxidation, oxidative stress and increased NO bioavailability clearly identify these compounds for either enhancement in the fruit or more regular consumption in existing fruit. We now aim to corroborate these results in "the real world" via intervention trials.

### References

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