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Investigating the bioavailability of phytochemicals and minerals from broccoli soups

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Cruciferous vegetables such as broccoli are associated with a reduced risk of different types of cancers[1], cardiovascular diseases[2] and other chronic diseases. This is attributed to the active phytochemical sulforaphane (SF) hydrolysed from glucoraphanin, a glucosinolate found in broccoli[3]. SF is a potent inducer of Nrf2, a transcription factor which upregulates anti-oxidant genes and has lately been shown to modulate central metabolic pathways[4]. We have developed broccoli varieties with allelic variation in Myb28, a key transcription factor in glucosinolate biosynthesis, and are using these to deliver increasing levels of glucoraphanin in human dietary intervention studies. The aim of the current study is to assess bioavailability of SF and other minerals from soups containing these novel varieties.

The study was designed to recruit ten healthy participants (male and female) aged 18–65 years old into a randomized, double-blinded, three-phase crossover intervention trial. Plasma and urine samples are collected at various timepoints after consumption of one of the three types of soup (standard [Myb28$^{-/-}$], Beneforte® [Myb28$^{vill/-}$] and Beneforte Extra broccoli [Myb28$^{vill/vill}$]). Total SF, free SF, and its conjugates (SF-glutathione, SF-cysteine-glycine, SF-cysteine and SF-N-acetyl cysteine) was measured using liquid chromatography-mass spectrometry method stated by Gasper et al[3] and cyclocondensation based on the method of Ye et al[5]. Inductively coupled plasma mass spectrometry was performed according to the method used by Hurst et al[6] to analyse total sulphur and other minerals in the broccoli soups, urine and plasma.

	Standard broccoli and stilton		Beneforte broccoli and stilton		Beneforte Extra broccoli and stilton	
Micronutrients	Mean	SD	Mean	SD	Mean	SD
Glucoraphanin (μmoles/100 g Fresh Soup)	14·17	0·78	53·26***	18·12	147·47***	6·53
Total sulphur (g/100 g dry wt)	287·33	11·93	442·33***	8·96	556·33***	14·01
Iron (mg/100 g dry wt)	0·99	0·02	2·07***	0·05	3·63***	0·14
Potassium (mg/100 g dry wt)	0·90	0·05	1·30***	0·03	1·50***	0·40

Glucoraphanin values are a mean of 10 independent soup batches. Total sulphur, iron, potassium values are a mean of 3 independent soup batches. ***$p < 0·001$ vs standard broccoli using ANOVA.

Mineral analysis of the three soups is outlined in the table which shows that Beneforte® and Beneforte extra soups have significantly higher concentrations of glucoraphanin, total sulphur, iron and potassium compared to standard broccoli. These results confirm that the Beneforte Extra and Beneforte® broccolis are able to deliver 10 times and 3 times more glucoraphanin respectively compared to standard broccoli ($p < 0·001$). Analysis of SF and metabolites in plasma and urine sample are undergoing. In conclusion, the results from this study provide valuable information on SF metabolism for other future studies.

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