Phytochemical malabsorption: clinical significance

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CLINICAL SIGNIFICANCE OF PHYTOCHEMICALS

Until recent years, nutritionists have focused primarily on macronutrients and micronutrients in foods. Appreciation is now increasing that many food components, of plant origin (‘phytochemicals’) in particular, have the potential to affect human biology. Phytochemicals by definition are important components of food that may not be essential in the classical sense, and may not even be required to sustain life as vitamins or minerals do, but are likely to contribute to optimal health.

A problem in considering the place of phytochemicals in human health is that they are numerous, alongside a few known essential nutrients. Therefore, their net interactive effect ultimately requires a study of food itself and food patterns, so that food component intake may need to be subject to sophisticated mathematical modelling. However, the advent of advanced informatics may help resolve this dilemma.

Examples of phytochemicals, along with some of their food sources are listed according to their chemical structure in Table 1. The possible roles of these phytochemicals in the treatment of health conditions are rapidly unfolding[1], and the use of an index of preferred phytochemical intake has been suggested[2]. Yet limited information is available on the bioavailability of most of these compounds. With complex factors influencing the absorption and transport of phytochemicals, it is not easy to predict their bioavailability, let alone consider the implications of gastrointestinal malabsorption.

BIOLOGICAL OCCURRENCE AND RELEVANCE OF PHYTOCHEMICALS

The presence and the physiological concentration of phytochemicals in biological tissues or fluids, especially blood and urine, create the opportunity for biomarkers of the consumption of phytochemical-containing foods[4-6] (Table 2). Equally, measurements of phytochemicals reflect bioavailability, including absorption.

Table 1 Selected phytochemicals and their possible roles in health[3]

| Phytochemicals | Some important food sources | Possible roles in health |
|----------------|----------------------------|-------------------------|
| Carotenoids   | Orange pigmented and green leafy vegetables, e.g. carrots, tomatoes, spinach | Antioxidants, Antitumour, Anticarcinogen, Immuno-enhancement |
| Flavonoids, and saponins | Green and yellow leafy vegetables, e.g. parsley, celery, soy bean and soy products | Antioxidants, Anticarcinogen, Oestrogenic Immuno-modulating |
| Polyphenols   | Cranberry, raspberries, blackberries Rosemary, oregano, thyme | Antioxidants, Antibacterial Reduce urinary tract infection |
| Catechins     | Green tea | Antioxidants, Anticarcinogen, Anti-inflammatory |
| Allyl thiosulfonates | Garlic, onions, leeks | Antimutagen, Anti-inflammatory, Cholesterol lowering |
| Isoflavonoids and indoles | Cruciferous vegetables, e.g. broccoli, cabbage | Antimutagen, Anti-inflammatory, Cancer prevention |
| Phytosterols, e.g. β-sitosterol | Pumpkin seeds | Reduce symptoms of prostate enlargement |

This list is not exhaustive for phytochemicals.

Table 2 Occurrence of phytochemicals in human blood and tissues

| Phytochemicals | Where can we find them in the body |
|----------------|-----------------------------------|
| Carotenoids    | Serum (five major carotenoids) Skin |
| Lutein/zeaxanthin | Adipose tissues |
| ß-cryptoxanthin | Various tissues like prostate (lycopene) |
| Lycopene       | Lutein and macula (lutein/zeaxanthin) |
| ß-carotene     | Various tissues like prostate (lycopene) |
| ß-carotene     | |
| Flavonoids     | Serum |
| Quercetin, kaempferol | Urine |
| Isoflavones    | Serum |
| Geristein, daidzein | Serum |
| Catechins epigallocatechin gallate | Serum |
| Allyl thiosulfonates | Blood, serum, red blood cells |
| organosulfides | Adipose tissue |
| vinyl dithiins | Liver |
| Tocopherol     | Skin |

For the moment, the presence of phytochemicals in tissues, is presumptive evidence of functional
CLINICAL SIGNIFICANCE OF PHYTOCHEMICAL MALABSORPTION

Given the putative health benefits of phytochemicals, gastrointestinal malabsorption may well contribute to a loss of their protective effects. This could result in a number of clinical disorders which could be referred to as ‘phytochemical deficiency disorders’[11]. Candidate disorders are:

a. The menopause as a ‘phytoestrogen deficiency disorder’[7]

b. Cardiovascular disease because of the role of certain phytochemicals as antioxidants, others as regulators of endothelial function and others as modulators of myocardial function

c. Colorectal cancer in relation to a range of phytochemical intakes from various fruits and vegetables, and whole grain cereals[8]

d. Prostatic disease in relation to lycopene and isoflavones[9,10]

e. Maculopathy on account of the contribution to macular function of lutein and zeaxanthin[11]

Two cases of short bowel syndrome where carotenoids were undetectable in serum illustrate the potential for these orders (Case reports 1 and 2). In each case, it was possible to increase serum carotenoid concentrations by vegetable juice supplements.

Case report 1 Mrs BW (b. 1956)
Vaginal cancer (1990) treated with radiotherapy
Rectovaginal fistula - colostomy (1992)
Short bowel syndrome (1995)

| Vegetable/juice/soup | Serum concentration (nmol/L) | Reference range | Jan 96 | May 97 |
|----------------------|-----------------------------|-----------------|--------|--------|
| Lutein/zeaxanthin    | 80-850                      | 102             | 202    |
| β-cryptoxanthin      | 175-1350                    | Not detectable  | 12     |
| Lycopene             | 69-650                      | Not detectable  | 33     |
| α-carotene           | 15-300                      | Not detectable  | Not detectable |
| β-carotene           | 45-800                      | Not detectable  | 95     |

Case report 2. Mrs CM (b. 1956)
Severe road traffic accident (1976) → ruptured bowel, bowel resections
Short bowel syndrome

| V-8ceTM (glass/day) | 0 | 1×2 | 1×1 |
|---------------------|---|-----|-----|
| Serum concentration | Reference range | Nov 95 | May 96 | Nov 96 |
| Lutein/zeaxanthin   | 80-850 | Not detectable | 243 | 17 |
| β-cryptoxanthin     | 175-1350 | Not detectable | 18 | Not detectable |
| Lycopene            | 69-650 | Not detectable | 32 | 11 |
| α-carotene          | 15-300 | Not detectable | Not detectable | Not detectable |
| β-carotene          | 45-800 | Not detectable | 10 | 8 |

CONCLUSIONS

With arnergent evidence for physiological roles of phytochemicals and for their potential for disease prevention, the use of foods, which are good phytochemical sources, to prevent and manage disease will be encouraged. The malabsorption of phytochemicals is likely to be one of many pathways to so-called “phytochemical deficiency disorders”.

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