



Title	Studies on the role of fruit and vegetables in the diet
Authors(s)	Gormley, T. R. (Thomas Ronan)
Publication date	1989
Publication information	Gormley, T. R. (Thomas Ronan). "Studies on the Role of Fruit and Vegetables in the Diet." Blackwell Scientific Publications, 1989.
Publisher	Blackwell Scientific Publications
Item record/more information	http://hdl.handle.net/10197/6988

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Studies on the role of fruit and vegetables in the diet

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Fruits, vegetables and potatoes have always had a good health image and their beneficial effects on human health have been cited in numerous scientific and popular journals and in trade journals and the press. In the past much of this interest rested on vitamins (especially vitamin C) and minerals, but more recently attention has switched to the possible beneficial effects of fruit, vegetables and potato consumption in relation to coronary heart disease (CHD), certain cancers, diabetes, and other so-called diseases of affluence. This article is not a review of this extensive field, as this has been carried out elsewhere (Gormley, Downey & O'Beirne, 1987a) but is confined to a discussion of some of the issues.

Coronary heart disease

Fruits and vegetables may influence CHD through their role in reducing cholesterol and influencing blood platelet function (platelets are specialized blood cells which influence clotting). Durrington *et al.* (1976) showed that pectin and guar gum administered 'neat' reduced serum cholesterol in humans, and in an extension of this work Gormley *et al.* (1977) showed that eating two apples per day, in addition to the normal diet, reduced serum cholesterol by 8% (mean value) and raised the high-density lipoprotein cholesterol fraction (HDL) (the so-called 'good cholesterol') from 18% to 24% in 80 human volunteers. The mechanism for cholesterol lowering may be *via* bile acid binding by pectin.

Legumes also have a cholesterol lowering effect, as indicated by a mean fall of 7% in 60 subjects consuming 30 g of freeze-dried peas per day in addition to their normal diet (Gormley *et al.*, 1979); HDL cholesterol rose

from 21.5% to 24.4%. The mechanism for these effects is unclear but other authors suggest that increased bile acid excretion (thereby causing more cholesterol to break down), perhaps as a result of the effect of saponins in the legumes, may produce the cholesterol lowering (Potter, Topping & Oakenfull, 1979). Similar results to those outlined above have been obtained in a number of other studies, thus showing the beneficial effect of fruits and vegetables in relation to cholesterol reduction and hence prevention of atherosclerosis (narrowing of the arteries by lipid material).

Atherosclerosis is one factor leading to the occurrence of CHD. However, a blood clot (or thrombus) must form in the coronary arteries to actually induce a coronary, and claims have been made that certain vegetables have an anti-thrombotic effect. For example Baghurst, Raj & Trusswell (1977) showed in a dietary trial that the rate of blood platelet aggregation was significantly greater after a 'fat' meal compared with the control, but when onion was included in the meal the results were not significantly different from the control; neither the high fat nor the onion meal had any significant effect on the extent of platelet aggregation. Kinderlehrer (1978) also suggests that onions and garlic influence platelet aggregation and so may be protective against CHD.

Cancer

Frequent references are seen to the possible beneficial role of fruits and vegetables in the diet in relation to cancer development in humans. Bile acids have been linked to colon cancer, and hence their excretion, as a result of fruit and vegetables in the diet, is seen as beneficial. Fruits, vegetables and potatoes

may also help to displace other items from the diet, e.g. fatty foods, which have been linked to cancer development in humans. However, it is the possible inverse link between vitamin A status and the occurrence of certain forms of cancer (notably that of the mucous membranes) that has commanded considerable attention in recent years. Hirayama (1979) in a 10-year prospective study of over 250 000 Japanese adults found an association between frequency of green and yellow vegetable consumption and rates of mortality from cancer of different sites.

In Japan, green and yellow vegetable consumption accounts for on average 44% and 23% of the typical dietary intake of vitamins A and C, respectively. This and other studies suggested that vitamin A might be exerting a protective role. However, in all of these studies it is not clear whether it is carotene or another micronutrient which provides the protective effect. However, a currently endorsed hypothesis for a mode of action for carotenoids in cancer prevention is their ability to quench singlet oxygen and, in the absence of the latter, to act as an antioxidant. Obviously further extensive research is needed to explore and clarify these possible relationships and effects.

Energy absorption

The energy from fruit, vegetables and potatoes is absorbed slowly by the body and this confers satiety to the eater. Much of the current interest centres around the rate of absorption; complex carbohydrates in whole foods, in addition to being complex molecules which have to be broken down before absorption, are also 'packaged'. For example, in potatoes the starch grains are in cells and so are not immediately accessible for attack by digestive enzymes; energy is thus released more slowly. This has been illustrated clearly in the classic apple experiment of Haber *et al.* (1977) in which the insulin response decreased in going from apple juice to puree to whole apples. Heaton (1978) claims that any dietary change which leads to increased insulin secretion deserves to be considered fattening. On this basis, ingestion of complex carbohydrate reduces the in-

ulin response while refined carbohydrate does the opposite. This is substantiated by an experiment in Ireland (Flynn, Beirn & Burkitt, 1977) where 23 volunteers consumed 1 kg of boiled or baked potatoes daily for 10 weeks. Four gained weight (1-3 kg per person), six subjects showed no change, while 13 lost 1-5 kg. This trial clearly indicates that the potato is not fattening and that its energy value of 750 cal kg⁻¹ is not in fact high in relation to its satiety value.

Obviously the effect of cellular material (i.e. dietary fibre) on energy absorption has implications for diabetics, as shown in a study (Mayne *et al.*, 1982) where the consumption of 15 g of dietary fibre isolated from 'Golden Delicious' apples gave good diabetic control in human subjects with late maturity onset diabetes.

Natural complexity

Grimme *et al.* (1986) have stressed the importance of 'natural complexity' in food (i.e. that foods as supplied by nature may contain a subtle blend of constituents or nutrients, see below). However, there is not much scientific evidence at present to support the desirability of natural complexity in food. The lack of evidence is partly due to the difficulties in carrying out tests in this very complex field. However, the author speculates that the importance of natural complexity will be realized and much appreciated at a future date, especially in relation to the availability of trace elements, vitamins, polyunsaturated fatty acids and other constituents in foods. This may be due to the fact that many of these constituents do not occur in nature as isolated entities but as subtle co-enzymes, as parts of complex molecules, as salts or esters, or as substances loosely bonded (e.g. hydrogen bonded) to other molecules which render them more available for absorption by the human (Gormley, Downey & O'Beirne, 1987b). Both fresh and lightly cooked fruit and vegetables (including boiled potatoes) fit 'the natural complexity' mode and in the future this may be another reason for advocating an increased consumption of these items.

Natural toxicants

The discussion above highlights some of the benefits of fruits and vegetables in the diet. However, it should be noted that many plants used as food synthesize toxic chemicals, apparently as part of their defence against pests and diseases. The significance of these toxins in human health is largely unknown, but the consensus among toxicologists is that they are substantially underrated as a food hazard (Curtis, 1986). The toxins include the glycoalkaloids in potato, vicine and convicine in broad bean, psoralen derivatives in the *Umbelliferae* (celery, parsnips, etc.), a hydrazine derivative in mushrooms, conavanine in alfalfa sprouts, lupine in some legumes, theobromine in cocoa, safrole and related compounds in black pepper and oil of sassafras. Of special relevance to technical change in agriculture are possible risks (from toxicants) introduced through breeding programmes.

This comment on natural toxicants is included, not to alarm the readers, but to alert them to the need for increased research in this area. Presumably, in practice the effect of the toxicants is 'diluted out' by other constituents in the food and in the overall diet, as most of these foods have been consumed by man for centuries without apparent ill effect. However, this confirms once again the importance of the balanced diet concept, i.e. eat a wide range of foods and do not eat excessive amounts of any individual food.

Conclusions

This article highlights just some of the beneficial effects of fruit and vegetables in the diet; there are many others. The author advocates an increased consumption of these foods in the Irish diet (and also in other Northern European countries) with special emphasis on uncooked items such as coleslaw and shredded carrot. Greater efforts must also be made to encourage children to consume more fruit and vegetables.

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This article is based on a paper presented by the author at the Institute of Horticulture conference on Horticulture and Health in Dublin in March 1988.