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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. Kindelehrer (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 be­
tween 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 con­
sumption 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 experi­
ment of Haber et al. (1977) in which the insu­
lin response declined 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, in­
gestion of complex carbohydrate reduces the in­
sulin response while refined carbohydrate
does the opposite. This is substantiated by
an experiment in Ireland (Flynn, Beirn &
Burkitt, 1977) where 23 volunteers con­
sumed 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 indi­
cates that the potato is not fattening and that
its energy value of 750 kcal 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 con­
sumption 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 im­
portance of 'natural complexity' in food (i.e.
that foods as supplied by nature may con­
tain a subtle blend of constituents or nut­
rients, see below). However, there is not
much scientific evidence at present to sup­
port 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 ve­
etables (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, psoralein 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.

References


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.