Non-nutrients in foods: implications for the food industry

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Food as such

There is increasing evidence, for physiological and pathaphysiological reasons, that food needs to be considered as such and not only as nutrients.

One of the more important lines of evidence for this view comes from the work on food memory by Taketoshi Ono and his colleagues (29). This work, in non-human Japanese primates, has painstakingly revealed that there are food-specific neurons in the central nervous system, particularly in the amygdalar and lateral hypothalamic neurons. In the first place, the amygdalar neurons provide a mechanism for the distinction between food and non-food. Then, from now-extensive work of this group, it would appear that the sum total of the visual, tactile, smell, taste, texture and other inputs allow the recruitment of food-specific neurons. It is also possible that these neurons may be extinguished. This central mechanism presumably accounts for our ability to make fine distinctions between different cheeses or different wines and also what is biologically, organoleptically and probably emotionally acceptable as food.

A most convincing example has come from the study of neuronal recognition of foods not ordinarily accessible to wild Japanese monkeys; these creatures ordinarily do not have access to bananas, but feeding them leads to the development of banana-specific memory, which can, however, be extinguished by the use of combinations such as bananas and salt (personal communication). In the grey area between food and medicine, which some of us are describing as 'medical foods', this knowledge of primate physiology will assume increasing importance.

Non-nutrients in foods

Texture and food physico-chemistry (42)

For the same chemical composition, food may have a wide range of physico-chemical properties. These may be evidenced in, for example, particle size and viscosity. To some extent, the ability for food to assume these wide-ranging characteristics depends on the presence of certain components, such as dietary fibre, its amount and type. But the presence of the chemical components of dietary fibre does not itself ensure these characteristics. This is nowhere more in evidence than where fibre is extracted from plant foods and reintroduced at some other point in the food chain, such as with wheat bran (41).

Colour

The colours in food may themselves have biological effects aside from creating interest in food, yet ordinarily they are dismissed as nutritionally irrelevant (6,7,10,11).

The brown products of the Maillard reaction are, of course, sugar-amino acid complexes and have the potential for physiological effects as recent data suggest (15,15a,15b). Again, lycopene which accounts for most of the colour of tomatoes has been largely ignored from a nutritional point of view because it is not a vitamin A precursor, although it is a carotenoid. However, recent evidence indicates that it is a powerful agent to trap singlet oxygen, potentially damaging to tissues. The flavonoids in various fruits and vegetables are also responsible for some of their colour and their biological actions include some which are oestrogen-like (44,44a). Even more recently, the anthocyanins which account for colour in berry fruits have been shown to have LDL-cholesterol lowering properties (15,15a,15b).

Taste and smell

The food chemistry which accounts for taste and smell depends on literally hundreds of compounds. For example, the flavours of various fruits usually depend on a dozen or more compounds. For the olfactory contribution to flavour alone, this means that there are many different receptors in the olfactory apparatus. It seems unlikely that these compounds, in the gut or post-absorption, will not find, to some extent, representation in receptors elsewhere than in the olfactory apparatus. Of course, the teleological argument that they will then have physiological effects elsewhere does not necessarily follow, but the possibility certainly exists. A great deal more work is justified in this area.

Coffee is a good example of the extent to which a range of volatile constituents can form during progressive roasting (7,8). These constituents of the aroma of coffee include a range of furfuryl and pyrrole-type compounds. It is therefore of interest that, amongst these compounds in coffee itself or its aroma, there are those which are opiate receptor ligands (4,46). Exactly what this means in terms of human nutritional physiology remains uncertain.

It has also become clear that there is a lipid-rich coffee fraction, not including caffeine, which will elevate serum LDL cholesterol and triglycerides in humans (23).

Compounds of physiological importance

Defined chemically

While by no means exhaustive, the examples given in Table 1 and the source references will provide some insight as to the extent to which these compounds have been neglected and might be of importance in human physiology.

Defined physiologically

Likewise, Table 2 is an effort to categorise non-nutrient compounds in food from the point of view of human physiological effects. The plant physiology of substances in food is, of course, another matter (1,31,44,44a).

One of the most interesting classes of physiologically active compounds is the phytooestogens. Recently work from our group indicates that foods such as soya flour, clover sprouts, and linseeds significantly improve vaginal cytology and decrease serum FSH levels in post-menopausal women, in much the same way as hormone replacement therapy (44,44a). The agent tamoxifen does much the same and yet it is actually anti-oestrogenic at the breast and used in the management of breast cancer. Thus, compounds found in plants with oestrogen activi-

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ties may have a hierarchy of oestrogenic effects at different tissues ranging from the anti-oestrogenic to the pro-oestrogenic. A particularly important question is what trace compounds do to bone and what they do to cardiovascular risk. In the meantime, it is noteworthy that the work of Lee and colleagues in Singaporean women shows that soya products (mainly of the tofu kind) appear protective against breast cancer in women (20).

However, oestrogenic effects from foods may be achieved not only by way of oestrogenic compounds themselves, but by stimulation or alteration of endogenous oestrogen secretions. It is therefore interesting that amounts of boron given to post-menopausal women in quantities similar to those obtainable from fruits like apples (about 3mg) significantly increase serum oestradiol, especially where magnesium intake is low (26). At the same time, women fed these amounts of boron decrease their urinary calcium excretion.

Dietary factors which affect lipoproteins other than dietary fat include: energy balance, amount and quality of fat, cholesterol, protein, dietary fibre (of various types), alcohol, coffee factor and other non-nutrients (allicin, anthocyanins, saponins)

Although reduction in saturated fat intake is of paramount importance in dealing with abnormal serum lipoproteins in individuals at risk of coronary heart disease, a broader and more integrated nutritional approach to food, not only from the point of view of lipoprotein control but also of macrovascular disease protection, is highly desirable (25,19,43).

Thermogenic effects have been seen with the combination of mustard and chilli at breakfast where the increment in the thermogenic response to a meal attributable to these spices can be almost a doubling (13,14).

Potential therapeutic or pharmacological properties

From what has been documented already, it will be clear that non-nutrient components of food have potential therapeutic or pharmacological properties. This might apply in the management or, indeed, prevention of obesity, lipid disorders, diabetes, Parkinsonism, gut motility disorders and motion sickness (24).

Recent data from our own group (3,39) indicate that a broad bean extract, in conjunction with carbidopa (an enzyme inhibitor which decreases the loss of L-dopa) is at least as useful as the combination of carbidopa and L-dopa in commercial pharmaceutical preparations. Moreover, there is a prolongation of the therapeutic effective period in those with Parkinsonian motor fluctuations with the oral broad bean mixture as a single meal in the morning.

Of considerable interest is the way in which ginger preparations have been used in traditional oriental medicine and are used in contemporary Western cancer medicine for their anti-nauseant properties. A study (24) where ginger powder (derived from *Zingiber officinale*) was compared with placebo and dimenhydrinate as an anti-motion sickness agent revealed it to be superior to dimenhydrinate.

The dichotomy in occidental thought between food and medicine is less in evidence, if at all, in oriental thought. If this is appreciated, the advent of a new dynamic in Japanese food technology, which is leading to the production of an array of so-called 'functional foods' is much more understandable. It may also help food legislators in countries like Australia to deal more effectively with the positioning of such foods however they might be described, as 'food analogues', 'functional foods' or 'medical foods'.

Table 1. Non-nutrients of physiological importance defined chemically

Ajoene/Allicin (2,18,19,27,28)
Caffeine (34,35,36,37)
Coumestans (44,44a)
Flavonoids (7,8)
Salicylates (40)
Saponins (33,38)
L-Dopa (3,39)
Capsaicins (5)
Lectins (16,16a,30)
Trace Elements (26)
Peptides (12)
Novel Amino Acids and Fatty Acids (23,43)
Peppermint Oils (21,31)

Table 2. Non-nutrients defined physiologically

Opioids or exorphins (4,46)
Other neuro-endocrine factors (12,22)
Digestive enzyme inhibitors (45)
Glycaemia altering (16,16a)
Lipid lowering (15,15a,15b,43)
Satiating (37)
Thermogenic (13,14)
Behaviour modifying (22)

The future

The need for food technology to take account of the broad nutritional dimensions of food in the development of 'functional foods' or food analogues is evident through a consideration of the non-nutrient components of food. There are also opportunities for extended therapeutic uses over and above those of the present.

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Corrigenda

The review of Toledo's **Fundamentals of food process engineering** (Food Australia 1992, 44(9): 432) incorrectly identified this book's Australian distributor. 'This valuable contribution to the food engineering literature' is available from Thomas Nelson Australia, 102 Dodds St, South Melbourne, Victoria 3205. We apologise for any inconvenience this error caused our readers and the two book distributors concerned.

Professor M.J. Gurr sincerely regrets the error which crept into his paper **Health and nutrition aspects of dairy products** (Food Australia 1992, 44(9): 421-6). The second sentence of the first paragraph in the section headed "Cancer" (page 423) should read:

> Amongst cancer patients there was a much higher percentage of people who never drank milk than among the healthy control subjects (Table 4).