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Nutritional effects of new processing technologies*

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In this age where optimum nutrition is the goal rather than the elimination of deficiency diseases, it is important to find out what impact new food processing technologies will have on the nutritional value of foods. Food technologists and nutritionists need to start to understand each other's world more fully so that processed foods can provide the health benefits that consumers demand. This recent conference organised jointly by The Nutrition Society and the Institute of Food Science and Technology provided an insight into the link between food technology and nutrition, and highlighted a number of important areas where future collaboration between scientific disciplines is needed.

High consumer expectation

To set the scene, Professor Graham Gould, formerly of Unilever Research UK, examined how the modern consumer has very high expectations of the food supply. Consumers today want food to be fresher, to be more 'natural' with minimal packaging and of high quality in terms of flavour, texture, appearance and nutritional value. At the same time, consumers want food that is convenient, requires minimal preparation and has a good shelf life.

The food industry has responded to these expectations—for example, by developing techniques which involve milder processing, fewer additives, less fat, salt and sugar and using environmentally friendly packaging. However, in many cases this leaves products less well preserved. As food safety is top priority for all food producers much work is underway developing effective methods for the control of food pathogens that allow minimal processing and maximum food quality.

'New' preservation technology

One option is the use of natural preservatives (see Table 1). There is also a range of new technologies that offer great promise. High hydrostatic pressure can be used instead of heat for example in non-thermal pasteurisation. High voltage gradients (electric shocks) kill vegetative bacteria and laser pulses; high magnetic fields and irradiation are other options. However, much current work is examining how different methods can work synergistically to reduce the level of additives and/or processing needed. For example, natural preservatives nisin and lysozme, together with citrate, are very effective preservatives in pate and cheese spreads. Ultrasonics combined with heat also work synergistically reducing the amount of heat needed. The challenge for the future includes devising new and improved inactivation and inhibition techniques using combination treatments and multi-target interference.

Interestingly, none of the 'new' preservation methods is really that new. Some of the ideas were around well over a century ago (Table 2). The current consumer's call for a milder approach having driven their recent development.

High pressure treatment

Continuing on the theme of using high pressure treatments, Professor Dietrich Knorr from the Berlin University of Technology outlined current understanding of the impact of this technology on food safety and quality. During this process, food is put into water or oil and pressure is applied to all sides.

Curiously, even though the pressure is lethal to microorganisms, the plant cells themselves can withstand the insult and food remains intact. This was demonstrated beautifully and by chance during the salvage of a wrecked submersible from the bottom of the ocean.

When salvagers began clearing debris from the pressure capsule, they found a soggy lunch carried in the by crew on the day The Alum had sunk. The contents included a thermos full of broth, which had imploded,

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some apples and three bologna sandwiches which still tasted fresh to the intrepid engineer who too a bite. A sceptical biologist confirmed this and then took the recovered food to the lab. (R. Ballard The Eternal Darkness, 2000).

The food had survived intact despite being at 5200 m for 10 months, equivalent to 170 Mpa!

To date, most studies have focused on assessing the antimicrobial properties of high pressure techniques, but later there will be many other aspects of food quality to be considered. What happens to food allergens, nutrients and other substances like free radicals? This is where collaboration between food technologist and nutritionists will be vital.

Microencapsulation in nutrition

Moving away from preservation, Dr Peter Schrooyer of NIZO Food Research in The Netherlands examined how microencapsulation could be applied to nutrition. This process involves small particles or droplets being protected by a coating. Microencapsulation can be used to increase shelf life, perhaps by protecting against oxidation, to prevent degradation or for controlled release.

Vitamins A, C, D and K and specific fatty acids are often encapsulated for the fortification of foods. Iron and calcium salts may also be protected in this way to prevent interaction with protein. Flavouring agents can be encapsulated so that the flavour is released once in the food but not before.

The techniques used for encapsulation vary depending on whether the substance is fat or water soluble and the form of the final produce. For example, for baby food it may be necessary to convert oil into a powder. Research into new techniques and new materials is ongoing. At the moment, work is underway evaluating a plant polysaccharide that is cheap and effective and can be used instead of gelatine. For the future, Dr Schrooyer predicts that functional food ingredients may be candidates for the process.

Table 1. Major natural antimicrobial systems

Origin		
Animal	Phagosomes	Myeloperoxidases
	Serum	Transferrins
	Milk	Lactoferrin
		Lactoperoxidase
	Eggs	Lysozymes
		Avidin
	Immune system	Antibodies
Microorganisms	Lactic acid	Nisin
		Pediocin
		Other bacteriocins
Plants	Cloves	Eugenol
	Garlic	Allicin
	Mustard	Allyl isothiocyanate

Table 2. Origin of 'new' preservation technologies

Technology	Date	Authors
Bactericidal effects of high pressure	1899	Hite
Natural antimicrobial systems—Lysozme	1922	Fleming
Ultrasonication	1929	Harvey and Loomis
Food irradiation patent	1930	Wurst
Natural antimicrobial systems—nisin	1947	Mattick and Hirsch
Antimicrobial electric pulse patent	1960	Doevenspeck
Antimicrobial laser patent	1965	Klein *et al.*
Combination preservation techniques	1971	Braithwaite and Perigo
Thermosonication	1972	Burgos *et al.*
Hurdle technology	1975	Leistner and Podel

Nutrition and modern foods

But what effect does food processing have on nutritional value? Professor Jeya Henry and Dr Nick Heppell of Oxford Brooks University examined this important issue.

Figure 1 shows how the food supply has evolved over time. At each stage there has been consumer pressure to prevent it. For example, when pasteurisation was introduced there were heated debates in parliament along the lines that the process was 'taking the life out of food'. More recently, irradiation has had to be abandoned because of consumers' mistrust of the technology. Changes must be introduced slowly and consumers need to be ready to accept them.

Fabricated food

We are now at the stage where some foods are completely fabricated, i.e. they are not made from actual

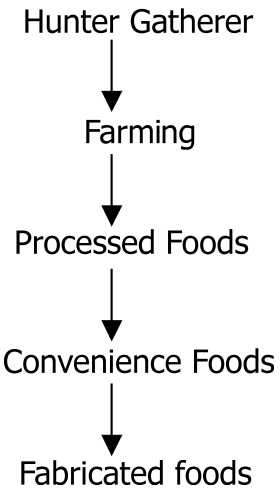

Fig. 1. Changes in the food supply over time.

animal or vegetable tissues at all. Some examples of these foods are margarines, extruded savoury snacks and some fruit flavoured drinks. Other fabricated foods have been produced in response to health concerns; for example, Olestra and Simplesse are fat replacers based on sucrose and protein, respectively. These foods throw up issues for nutritionists. What impact does using food components instead of whole foods have on nutritional quality? What is the consequence of changing the structure of the food, for example the amylose to amyloypectin ratio of starch? It is clear that better understanding of how new food technologies impact the nutritional and health qualities of foods is an area for closer study.

Positive benefits of new food components

Dr Ian Johnson from the Institute of Food Research, Norwich went on to describe an area where new food components are being developed specifically with health in mind; in particular, how foods may help protect against intestinal diseases like Irritable Bowel Syndrome (IBS), Food Poisoning and Cancer.

IBS is a distressing condition affecting about 20% of the UK population at any one time. It is of unknown cause and symptoms include abdominal pain, bloating and altered bowel habits. Fibre supplementation has been found to reduce the severity of abdominal pain and stool frequency in IBS sufferers, however not all fibres are equally effective.

Studies have shown clearly that cereal bran is no more effective than placebo. However, there is some evidence that ispaghula husk is a better option as a bulk laxative. This is probably due to its special properties of solubility and resistance to fermentation in the bowel, resulting in less bloating. If this is so, it may be possible to develop new food constituents with similar properties. Modified cellulose gums are one possibility.

Pre- and probiotics are relatively new concepts in the West, whereby altering the balance of the intestinal flora helps prevent infection from harmful microorganisms. Probiotics involves the consumption of live bacteria whilst a non-digestible food ingredient that stimulates 'good' bacteria in the colon is known as a prebiotic. Studies have shown that probiotics such as Bifidobacteria do survive in the faeces during the period of supplementation and that they may help prevent travellers' diarrhoea. It has also been shown that probiotics given at the same time as antibiotics can significantly decrease the incidence of antibiotic diarrhoea. Fructose oligosaccharide is a potential new prebiotic that has been found to increase the number of Bifidobacteria in the stools but more research is needed to determine any health benefit.

The classical approach to dietary methods of cancer prevention is the concept that increasing faecal bulk speeds up transit time which in turn decreases the exposure of the gut to potential dietary carcinogens. However, food also contains components that may be protective, helping to block or suppress the development of cancer in the gut.

Regular use of non-steroid anti-inflammatory drugs can cause the regression of precancerous polyps and prevent their reoccurrence. N3 polyunsaturated fatty acids may also provide this function and be protective against colorectal cancer. Another exciting area of research is into biologically active phytochemicals in foods. Glucosinolates are storage compounds found in brassica vegetables. When the plants are chopped up or eaten raw, the enzyme myrosinase is released which breaks down glucosinolates to yield products such as allyl isothiocyanate and benzly isothiocyanate. These compounds appear to enhance the detection and elimination of cells with DNA damage.

Why so few reduced fat bakery products?

There is more awareness now amongst consumers of current health messages to reduce fat, and the production of reduced fat foods is one way that the food industry can respond. However reduced fat bakery products are still only 5% of the market. Dr Tony Sharp from the Campden and Chorleywood Research Association described the results of a survey of bakery ingredient suppliers, producers, retailers and experts that helps to explain why this is.

A number of practical constraints were highlighted.

- Texture and flavour—Fat improves the sensory properties of baked goods. Without fat biscuits are harder and grittier, cakes are more dense and drier and pastry is less crisp and more brittle.
- Reduced shelf life—Although there may be less rancidity with lower fat products there is more checking (crumbling round the edges) of biscuits, a loss of freshness of cakes and more migration of moisture from fillings.
- Economic barriers—Fat is cheaper than the ingredients that replace them. Changing from one product to another reduces economies of scale. There will be more packaging costs and new equipment would be necessary.
- Technical knowledge—This is generally low amongst suppliers and producers of bakery products.
- Consumer attitudes—It was felt that consumer expectations of low fat products were too high. For example the quality and price must match the standard product. This means that the cost of manufacture is higher than the price achieved, as they are more difficult to produce.
- Claims criteria—It was felt the current call for 25% less fat than the standard product was too stringent and that there was no incentive for

incremental fat reduction, as they could not tell consumers about it on pack.

At the moment, there are many technical and economic barriers in the way of manufacture of reduced fat bakery products. For the future, focusing on niche markets and products that have no standard version may be the answer.

Multidisciplinary approach is Key

This Conference provided a taster of how food science and technology interact with nutrition and health, and highlighted many research areas where both disciplines need to be involved for the best outcome. As Professor Jeya Henry said, ''For the future it is clear that food technologists and nutritionists need to work together to ensure the best option for nutrition and health''.