Aspartame: in perspective

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Introduction

Aspartame (E951) is a dipeptide ester of two amino acids, phenylalanine and aspartic acid. It is an odourless, white crystalline powder which has a clean, sweet taste. It is referred to as an intense (or artificial) sweetener and is used to replace sugar in a wide range of sugar-free and low-calorie foods. It can also be used as a flavour enhancer in chewing gum. It has the same calorific value as sugar (4kcal/g), but is about 200 times sweeter than sugar and so only a small amount is needed to sweeten products. Aspartame is sometimes referred to under its original trade name of “Nutrasweet”. It appears on ingredients lists as “aspartame” and/or “E951”. The chemical structure for aspartame is shown in Figure 1.

There have been a number of reports in the press in recent months speculating about the safety of aspartame. The Food Standards Agency (FSA), whose remit includes food safety and standards issues in the UK, has received a number of enquiries from the general public resulting from these articles and similar ones appearing on the Internet. The following paragraphs provide background to the issue, including the current regulatory position in the UK and Europe, previous evaluations and research into aspartame, speculation about the safety of this sweetener, and other recent developments.

Background

The sweet taste of the compound N-L-α-aspartyl-L-phenylalanine-1-methyl ester (APM) was discovered in December 1965 by the pharmaceutical company G.D. Searle & Co. Chemist James Schlatter was synthesising the tetrapeptide gastrin when the APM intermediate spilled on his hand, and because he knew the amino acid mixture was not toxic, he did not bother to wash it off. Later, when he licked his finger to pick up a piece of paper, he discovered the sugarlike taste of the dipeptide ester (O’Brien Nabors and Gelardi, 1985). Following the discovery of the sweetness of the compound, Searle examined about 200 analogues of APM, but decided to commercialise the original discovery which became known by the generic term aspartame.

Aspartame was first approved as a sweetener and flavour enhancer by the
US Food and Drug Administration (FDA) for use as a table-top sweetener, and as an ingredient in certain dry food applications in 1974. It was first approved for use in the UK in 1982. It has been used in soft drinks and other low-calorie or sugar-free foods and as a table-top sweetener throughout the world by millions of people for over 25 years. Since 1995 its use has been governed by a European directive which permits its use in a wide range of foods in all EU member states.

Sweeteners legislation

In the UK, the use of sweeteners (including aspartame) in foodstuffs is controlled by the Sweeteners in Food Regulations 1995, as amended. These implement European Council Directive 94/35/EC and an amending directive 96/83/EC which harmonise controls on the use of sweeteners throughout the European Community. The use of aspartame is permitted in specific food categories (including soft drinks) at maximum levels set out in the regulations (e.g. 600mg per litre in non-alcoholic drinks). The regulations also list the purity criteria with which sweeteners must comply.

A new additive which requires authorisation must go through an exhaustive safety assessment process. The manufacturer of the potential new additive must not only produce evidence that there is a real need for the substance, but also commission research into that substance. The research must include toxicological tests (tests to determine whether a substance is harmful) including tests to assess the mutagenic potential of the compound, that is the ability to interfere with genetic material in the body, which could lead to the development of cancer or adverse effects in future generations. If there were any doubts about the safety of an additive, then that substance would not be authorised for use.

Like most food additives, aspartame has only been authorised for use after a careful evaluation, including rigorous safety assessments by the European Union’s (EU) Scientific Committee for Food (SCF) and those independent expert committees who advise the FSA – the Food Advisory Committee (FAC) and the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT).

Dietary intakes of sweeteners are monitored in the UK for all sectors of the population including adults in general, diabetics (whose intake of artificial sweeteners may be higher than that of the general population) and young children, to ensure that consumers are not regularly exceeding the acceptable daily intake (ADI) for each sweetener. The ADI is defined by the SCF as:

...the amount of a food additive, expressed on a mg/kg body weight basis, that can be ingested daily over a lifetime without incurring any appreciable health risk, and is based on an evaluation of available toxicological data.

Monitoring has shown that the general population and diabetics are unlikely to regularly exceed the ADIs for sweeteners. For example, the ADI for aspartame is 40mg/kg bodyweight. A person weighing 60kg (9st 6lb) would have to consume nearly 2.5g every day before breaching the acceptable limit.

By law, sweeteners are not permitted in foods for infants or young children (i.e. up to three years old). This does not mean that infants and young children should never consume sweeteners, but that sweeteners may not be used in foods specifically designed for these age groups. This is for nutritional rather than safety reasons.

Speculation regarding safety of aspartame

Aspartame is currently the subject of several campaigns by groups claiming that aspartame is linked to a wide range of serious disorders such as multiple sclerosis, lupus erythematosis, Gulf War Syndrome, chronic fatigue syndrome, brain tumours and diabetes mellitus. However, the data to substantiate these claims are anecdotal and no reliable scientific evidence is available to show that
aspartame might be responsible for these conditions.

Some reports also raise concerns about methanol, which is produced when aspartame is broken down in the body. Although large quantities of methanol can be toxic, the amounts derived from aspartame are less than those found naturally in other foods and are not considered to pose a risk.

Labelling warning for phenylketonuria sufferers

There is a small group of people who cannot safely consume aspartame. These are the sufferers of the inherited disease phenylketonuria (PKU), who are unable to metabolise the amino acid, phenylalanine effectively, leading to the accumulation of potentially harmful levels of certain breakdown products. PKU is a serious metabolic disorder which is normally diagnosed shortly after birth by a routine blood test. Sufferers need to follow a very strict diet in order to limit their intake of phenylalanine, which is a normal constituent of protein. Since aspartame is also a source of phenylalanine all food products containing aspartame are clearly labelled to indicate the presence of phenylalanine so that those people who suffer from PKU can avoid consuming these products. This labelling is a legal requirement.

Because high levels of phenylalanine can harm an unborn baby, women who have PKU and are actively planning a family follow a pre-conception phenylalanine controlled diet. Phenylalanine intake is not a problem for other pregnant women, since they are able to metabolise the amino acid effectively and do not accumulate high levels of its toxic breakdown products. In the UK, all newborn babies have been screened for PKU since 1969. It is highly improbable that anyone born prior to 1969 would have PKU and be unaware of their condition, especially if there is no family history of the disease. However, women who are actively planning a family who have concerns about PKU should contact their doctor.

Reviews on the safety of aspartame

The COT has undertaken three detailed reviews of aspartame (FACC, 1982), most recently in 1992 (COT, 1992). The advice from the committee on each occasion, which was issued after examining all the literature and data available from scientific, industrial and Government sources is that aspartame is safe in use. The international bodies who advise the World Health Organisation (JECFA, 1981) and the European Commission (SCF, 1988) have reached the same conclusion.

As is usual practice with food additive authorisations, these evaluations are subject to review, and the COT and FAC can be asked to consider any new relevant published scientific or medical data. For example, in 1996 the Committee on Carcinogenicity in Food, Consumer Products and the Environment (COC, 1996), a sister committee to the COT, reviewed a paper published in the Journal of Neuropathology and Experimental Neurology (Olney et al., 1996). The authors argued that aspartame might be associated with the increasing incidence of brain tumours documented in the USA between 1975 and 1992. The COC expressed serious misgivings about the quality of this paper and concluded that the data did not raise any concerns with regard to the use of aspartame in the UK.

Labelling of aspartame

The Food Labelling Regulations 1996, as amended, enable consumers to make an informed choice when purchasing products which may contain sweeteners such as aspartame. As well as the general requirements for the listing of ingredients under the food labelling regulations, products containing sweeteners such as aspartame must show the statement “with sweetener(s)”, and those containing both sugar(s) and sweetener(s) to be accompanied by the declaration “with sugar(s) and sweetener(s)” on the label close to the main product name. As explained earlier in this article, foods containing aspartame must also be labelled with a warning “contains a source of phenylalanine” to enable PKU sufferers to easily identify these products.

Recent press interest

Last year an article in the press (Woolf, 1999) claimed that aspartame was manufactured
from a GM source and raised concerns about the safety of the GM-derived product compared with the non-GM product which was initially tested. Although one of the starting materials, the amino acid phenylalanine, can be obtained from a GM source and is reportedly used by one manufacturing plant in the USA, the end product is chemically identical to that from conventional sources.

A three-year study by Kings College, University of London which is looking into the effect of various chemicals, including methanol, on brain tumour cells has also been the subject of media interest. This work, which commenced in autumn 1999, has been welcomed by the manufacturers of aspartame, Nutrasweet, which said there was “overwhelming scientific evidence” to prove the product was safe. The Food Standards Agency also welcomes this research and will monitor any findings from this study.

Conclusion

As explained in this article, the safety of aspartame has been extensively studied over the years and experts in the UK and internationally agree that aspartame is safe for use. In fact, in terms of types of studies and the amounts given to human subjects in controlled studies, aspartame is one of the most thoroughly tested food additives.

The Food Standards Agency welcomes any properly conducted scientific research into food safety, which can then form the basis for a rational debate. And as with all food safety issues the files remain open and the appropriate expert committees would be asked to consider any new relevant published scientific or medical data.

References

FAC (1992), Statement of Advice on Aspartame Intakes by UK Consumers.