FOOD CHEMISTRY IN NUTRITION RESEARCH AND ACTIVITIES

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ABSTRACT

The most important factor affecting the quality of life is health. Good health is in turn determined by proper nutrition and diet. Proper (good) nutrition means that the body is well-nourished with foods containing essential nutrients in the amounts needed for it to function with maximum efficiency. It is also important to ensure that foods are free from components that may be injurious to health. A comprehensive understanding of the chemistry of food is therefore indespensible to ensure a nutritious and safe food supply. This paper highlights two main aspects of food chemistry which are of direct relevance to nutrition research and activities in the country, namely the Malaysian Food Composition Programme and studies into chemical toxicants in foods. A systematic programme to develop a comprehensive food composition database was carried out as a collaborative project of the IMR, MARDI, UPM and UKM. A comprehensive database was established in 1988, with nutrient composition of over 700 foods, including some 200 cooked foods. The database is of importance in various fields of health and nutrition research and activities. In nutrition research, the quantitative assessment of the nutritional value of the diet of individuals or population groups depends mainly on the Malaysian food composition database, combined with information on food consumption. The database is also used in various nutrition activities including nutrition education, diet management and nutrition counselling, and planning of diets for feeding programmes. In the second aspect, studies into a variety of non-nutrient components in foods which may interfere with nutrient utilisation or have detrimental effects on health have been undertaken by various institutions in the country.

INTRODUCTION

The most important factor affecting the quality of life is health. Good health is in turn determined by proper nutrition and diet. Proper (good) nutrition means that the body is well-nourished with foods containing essential nutrients in the amounts needed for it to function with maximum efficiency. These nutrients are required to work together as a team, and a diet which contains all of them in the proper quantities constitutes a balanced diet. In addition to nutrients, various other food components may be injurious to health and are therefore important in determining the nutritional and health status of communites.

Nutritional imbalances result in malnutrition, namely nutritional deficiencies and excesses. Although serious undernutrition has largely been eradicated, mild to moderate nutritional deficiencies exist in various rural and urban underpriviledged communities. The major nutrient deficiencies in the country are protein-energy malnutrition, and deficiencies in several micro-nutrients namely iron, vitamin A and iodine. Thus, while the nutrition situation has improved steadily and consistently over the years, pockets of undernutrition exist in various parts of the country. On the other hand, the rapid development in the country has brought about changes in food consumption patterns and lifestyles, and resultant problems of overnutrition and associated chronic diseases which include obesity, diabetes mellitus, coronary heart disease and cancers (Tee & Cavalli-Sforza, 1993).

Nutrition research and various nutrition activities play an important role in the control and prevention of the above mentioned nutritional problems in the country. Nutrition and health promotion is one of the important strategies adopted and this focuses on the consumption of nutritious and safe foods by communities. A comprehensive understanding of the chemistry of food is therefore indespensible to ensure that these strategies can be implemented effectively. This paper highlights two main aspects of food chemistry in the country which are of direct relevance to nutrition and good health, namely the Malaysian Food Composition (MafComp)

Programme and studies into chemical toxicants in foods.

Development and Utilisation of the Malaysian Food Composition Database in Nutrition Research and Activities

Development of the Malaysian Food Composition Programme

A systematic programme to compile a comprehensive food composition table for use in Malaysia was initiated by the Institute for Medical Research (IMR) in 1980. It later developed into a collaborative effort among the IMR, the Malaysian Agricultural Research and Development Institute (MARDI), Universiti Pertanian Malaysia (UPM) and Universiti Kebangsaan Malaysia (UKM). To execute the Programme, a Working Group was formed, comprising scientists from the participating institutions. A preliminary table was published in 1982, followed by an update in 1985 and a comprehensive publication of Nutrient Composition of Malaysian Foods in 1988 (Tee et al., 1988).

With the publication of this Food Table, the systematic food composition programme in Malaysia has achieved an important stage of development. Work on the programme continued, and current activities emphasize on providing further input and refinement to the database established. These included analyses of selected nutrients which have not been given sufficient attention, selected groups of foods for which information is lacking, as well as studies on analytical methodologies. Effort was also made to improve the management, storage and retrieval of the large amount of data that has become available.

Two groups of foods which the government was encouraging their consumption, but for which compositiond data were lacking were studied. In the first group, 19 types of local vegetables, used mainly as ulam-ulam, were studied. The nutritional value of 20 species of fresh-water fishes were compared with that of 50 species of marine fishes from 31 families. In response to the great interest generated on the consumption of snack foods, the nutritional value of these foods was also examined. Studies into analytical methodologies placed emphasis on several nutrients, including vitamin C, calcium and iron.

Studies on several specific nutrients were carried out. In response to increasing interest in the dietary fibre content of foods, a study of this "neglected nutrient" was initiated.. The cholesterol content of foods was re-analysed, to meet increasing demand for these data in the control and prevention of cardiovascular disease. In response to the increasing interest in vitamin A and carotenoids in foods in relation to their importance to vitamin A deficiency as well as their possible roles in the prevention of cancers, an HPLC method was developed for simultaneous analysis of retinol and carotenoids in a variety of fruits and vegetables as well as foods of animal origin.

Utilisation of Food Composition Data in Nutrition Research and Activities

The Malaysian food composition database is of importance in various fields of health and nutrition research and activities. One of the most common use of the data in health care is in nutrition education. The use of these data enable the identification of foods rich in various nutrients, as a strategy to overcome nutrient deficiencies. For instance, nurses rely on food composition data to identify foods rich in iron to help prevent iron deficiency anaemia amongst pregnant women and young children. Teachers use these data to encourage children to consume vegetables and fruits so as to prevent vitamin deficiencies. To encourage communities to follow a healthy dietary pattern, health educationists need to identify foods with appropriate amounts of energy, salt and fibre.

In the hospital setting, dieticians rely mainly on this database in diet management and nutrition counselling. Dietary counselling is recognised as a complementary approach to medical treatment in various disease conditions, whereas in other conditions, it is the main approach in therapy. For instance, patients at greater risk to coronary heart disease need to be advised to consume foods low in cholesterol, fat, sugar and fat. Dietary management are also important strategies

for renal patients, as well as diabetics. In addition, dietary advice plays an important role in improving the nutritional status of undernourished patients.

Planning of diets for institutions and feeding programmes also depend on information on the composition of foods. Some examples of these programmes are the school feeding programme implemented by the Ministry of Education, feeding of inmates in welfare homes, and various other institutions such as the armed forces. There is also increasing demand for these data from individual consumers, with greater awareness that what people consume is the basic determinant of their health. Malaysians are becoming more health conscious and more consumers are demanding to understand their dietary intakes and the effects of nutrients on their health.

In nutrition research, the quantitative assessment of the nutritional value of the diet of individuals or population groups depends mainly on the Malaysian food composition database, combined with information on food consumption. These studies into nutrient intake of communities are important in the assessment of nutritional adequacy of diets of communities. Food composition data are also used in studies into the effects of variations in nutrient intake on reproduction, growth and development and in studies of the relation between diet and health or disease. Particularly at the present time, there is increasing interest in epidemiologic studies investigating the relationship between nutrition, diet and the development of various chronic diseases such as coronary heart disease, diabetes, hypertension and cancer.

Non-nutrients in Foods and Their Role in Nutrition and Health

Foods contain large numbers of constituents, some of which are of little nutritive value. Some of these constitutents may even interfere with nutrient utilisation, while others have detrimental effects on the health of consumers. These constituents can be either natural constituents of food (e.g. anti-enzyme factors, goitrogens, mineral binders, and antivitamins) or natural constituents of natural contaminants in food such as bacteria and fungi (e.g. mycotoxins). Other toxicants in food can arise as a result of contamination introduced by agricultural practices (e.g. pesticides), industrial pollution (e.g. heavy metals) and food processing (e.g. packaging contaminants). Some of these constituents that are more relevant to nutrition and health are summarised in the following paragraphs.

Enzyme Inhibitors

There are several ways in which enzyme inhibitors can affect enzyme reactions, the most common of which appear to be by acting as substrate or cofactor analogues. They may also form strong bindings to the active sites of the enzyme, giving rise to enzymatically inactive compounds. Many enzyme inhibitors are proteins, and their activities are usually lost during denaturation. For example, the nutritive value of many legumes can be improved by heating to denature the enzyme inhibitor. Trypsin inhibitors are probably one of the most widely distributed inhibitors of proteolytic enzymes. Thus many inhibitors have been shown to have activity against -chymotrypsin as well as aginst trypsin. The presence of these inhibitors in various legumes have also been studied by some local investigators, including studies into the properties of these inhibitors and various detoxification procedures (Tee, 1993).

Specific Antinutrients and Antimetabolites

The goitrogens comprise some of the most common toxicants in human food. These antithyroid compounds have long been recognized and include the glucosinolates found in a variety of plants, especially those of the Crucifers family, e.g., cabbage, rapeseed, mustard seed, brussels sprouts, and cauliflower. These goitrogenous compounds may produce thyroid enlargements, presumably through competitive inhibition of the iodization of thyroxine. Goitre is confined to selected inland communities in Peninsular Malaysia, but poses a much greater problem for communities in Sarawak and Sabah. Endemic goitre problem in the country is primarily caused by the lack of iodine in the diet, but the importance of goitrogens in the diet should also be investigated.

Other antinutrients include cynogenetic glycosides are compounds that occur in plant foods and are potentially poisonous because they can decompose and release hydrogen cyanide. Some common examples of cyanogenetic glycosides are amygdalin in bitter almond seeds, dhurrin in sorghum species and linamarin in cassava and some varieties of lima bean. Haemagglutinins or lectins are compounds of glucoprotein origin that affect the red blood cells ultimately resulting in agglutination. Lectins have been found mostly in plants, and it has been assumed that they are responsible for a number of the toxic effects from the consumption of raw legumes. The extent of these toxicants among local communities is not well studied, except for a few isolated studies (Tee, 1993).

Two other antinutrients of nutritional significance are oxalic acid and phytates. These represent compounds that interfere with mineral metabolism as they form chelates with, for example, calcium, iron and zinc resulting in possible deficiencies of these minerals. The significance of these compounds in the diet of Malaysians have not been extensively studied (Tee, 1993).

There has been a great deal of interest in the vitamin A and carotenoid contents of foods in recent years, in relation to their importance to vitamin A deficiency as well as to their possible roles in the prevention of cancer (Tee, 1991a). Much progress has been made in the development of analytical methods for more accurate determination of these two groups of closely related nutrients (Tee and Lim, 1991a). A systematic project to develop an improved method for the analysis of retinol and carotenoids was thus initiated. The HPLC method developed was found to be suitable for the simultaneous analysis of retinol and carotenoids in a variety of fruits and vegetables (Tee and Lim, 1991b), as well as foods of animal origin (Tee and Lim, 1991c). Besides making available an improved methodology, the project has also resulted in making available the carotenoid composition of these foods, to provide more accurate estimations of the vitamin A values of foods.

Further to the above-mentioned completed project on the development of a HPLC method for more accurate analysis of retinol and carotenoids in foods, two other studies were carried out. In the first study, the HPLC method developed was successfully adapted for the simultaneous determination of retinol and carotenoids in blood sera. For the first time, the carotenoid composition of a sample of "normal" sera of Malaysians has become available. The method would be useful for more accurate determination of these nutrients in human subjects, e.g. in the assessment of vitamin A status. In order to provide more accurate data on the vitamin A value of foods, the biological utilization of carotenoids in selected plant sources was investigated using experimental rats in the second study.

Antivitamins

Antivitamins are substances that act on the availability of vitamins. There are two major types of antivitamins, viz (a) substances that are structurally similar to vitamins and therefore can compete with the vitamins in various metabolic reactions; and (b) substances that can modify the structure of a vitamin or form a complex with the vitamin, thereby destroying or decreasing the effect of the vitamin.

Most of the antivitamins occurring in the food seem to belong to the latter group. The biotin antagonist, avidin, occurs in raw egg white and represents a classical example of an antivitamin. One of the first antivitamin to be described is thiaminase and occurs in viscera of various fishes. But a thiamin inactivity effect has also been described in some fruits and vegetables, e.g. blueberries, black currants, red beets, brussels sprouts, and red cabbage. Antivitamins directed toward other vitamins have also been reported, for example, the niacin inhibitors that occur in some cereals. A pyridoxine antagonist, linatine, was described a few decades ago in flax seed and a pantothenic acid inhibitor has been isolated from pea seed lingers (Hambreaus, 1982).

Mycotoxins

Fungal toxins are a group of important naturally occurring toxicants in foods. Over 45 mycotoxins are now known to be either carcinogenic and/or mutagenic, most of which have been

discovered only in the last 25 years or so. The best known of these fungal toxins is aflatoxin, although it was not the first to have been recognized. Originally discovered as a veterinary problem in the 1960's, involving principally turkeys, today aflatoxin has caused great concern as a possible health hazard to humans. In Malaysia, studies into the aflatoxin problem were carried out as early as in the 1960's (Tee and Siti Mizura, 1984). Aflatoxin is the generic term of a series of metabolites produced by the common yellow mould Aspergillus flavus. The most common member of this family of complex lactones is aflatoxin B1 which has been extensively and intensively studied. Based on all available data, the International Agency for Research on Cancer (IARC) listed aflatoxin B1 as one of the 26 chemicals or industrial processes associated with or are strongly suspected to be associated with the occurrence of human cancer.

Since the aflatoxins have been found to be harmful to a wide variety of animal life and to isolated human cells and creating problems of health as well as social and economic significance, it is clear that all efforts should be made to reduce the level of this mycotoxin in our foods, if not to eliminate them entirely. The laws regulating the sale of foods in many countries have already included provisions aimed at controlling aflatoxins content in foods. In the Malaysian Food Regulations 1985, the maximum level of mycological contaminant permitted in food is 35 g per kilogram of aflatoxin or other mycotoxin (Government of Malaysia, 1992).

Concluding remarks

There is a need for continuing efforts in the two activities highlighted. Work on nutrient composition of foods is continuing, as new foods are continuously being introduced into the market. Even for raw foods, there are various foods which have not been analysed, especially foods specific to particular regions or communities. There is also a need to keep abreast with developments in methodologies and continue to develop and adapt improved methods of analysis. The Institute is also looking into improved methods of storage and retrieval of food composition data. There is also a great deal to be done in the area of non-nutrient components of foods as work in this area by local investigators has not been extensive.

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