British Journal of Nutrition (2007), **97**, 1051–1052
doi: 10.1017/S0007114507709121

Invited Commentary

Further evidence that food fortification improves micronutrient status

The paper by Hannon *et al.*[1] in this issue of the *British Journal of Nutrition* documents the significant contribution of voluntary food fortification to micronutrient intakes in Ireland. One reason for the growing interest in micronutrients is the realization that micronutrient malnutrition contributes substantially to the global burden of disease. In 2000, the *World Health Report*[2] identified I, Fe, vitamin A and Zn deficiencies as being among the world's most serious health risk factors, while a recent report from the World Health Organization[3] examines, described below the potential impact of food fortification with micronutrients.

The best way of preventing micronutrient malnutrition is to ensure consumption of a balanced diet that is adequate in every nutrient. Unfortunately, this is far from being achievable everywhere since it requires universal access to adequate food and appropriate dietary habits. From this standpoint, food fortification is a good alternative strategy, since it has the advantage of being able to deliver nutrients to large segments of the population without requiring radical changes in food consumption patterns. In fact, fortification has been used for more than 80 years in industrialized countries as a means of restoring micronutrients lost by food processing, in particular some of the B vitamins, and has been a major contributory factor in the eradication of diseases associated with deficiencies in these vitamins. Because of the increased awareness of the widespread prevalence and harmful effects of micronutrient malnutrition, and in consideration of changes in food systems (notably an increased reliance on centrally processed foods), and successful fortification experiences in other regions, increasing numbers of developing countries are now committed to, or are considering, fortification programmes.

With so much accumulated experience, the conditions under which food fortification can be recommended as a strategic option for controlling micronutrient malnutrition are now better understood. Its limitations are also well known: food fortification alone cannot correct micronutrient deficiencies when large numbers of the target population, either because of poverty or locality, have little or no access to the fortified food, when the level of micronutrient deficiency is too severe, or when the concurrent presence of infections increases the metabolic demand for micronutrients. Various safety, technological and cost considerations can also place constraints on food fortification interventions. Thus, proper food fortification programme planning not only requires assessment of its potential impact on the nutritional status of the population, but also of its feasibility in a given context.

As a response to micronutrient insufficiency, food fortification can take several forms. It is possible to fortify foods that are widely consumed by the general population (mass fortification), to fortify foods designed for specific population subgroups, such as complementary foods for young children or rations for displaced populations (targeted fortification) and/or to allow food manufacturers to voluntarily fortify foods available in the market place (market-driven fortification). The term marketdriven fortification is applied to situations whereby a food manufacturer takes a business-oriented initiative to add specific amounts of one or more micronutrients to processed foods. Although voluntary, this type of food fortification usually takes place within governmentset regulatory limits and it is this type of fortification whose benefits in Ireland are assessed by Hannon *et al.*[1].

Marketdriven fortification can play a positive role in public health by contributing to meeting nutrient requirements and thereby reducing the risk of micronutrient deficiency. In the European Union fortified processed foods have been shown to be a substantial source of micronutrients such as Fe and vitamins A and D[4]. Marketdriven fortification can also improve the supply of micronutrients that are otherwise difficult to add in sufficient amounts through the mass fortification of staple foods and condiments because of safety, technological or cost constraints. Examples include certain minerals (e.g. Fe, Ca) and sometimes selected vitamins (e.g. vitamin C, vitamin B_2).

Marketdriven fortification is more widespread in industrialized countries, whereas in most developing countries the public health impact of marketdriven food interventions is still rather limited. However, their importance is likely to be greater in the future, because of increasing urbanization and wider availability of such foods.

Mandatory fortification is usually prompted by evidence that a given population is deficient or inadequately nourished, such as clinical or biochemical signs of deficiency and/or unacceptably low levels of micronutrient intake. In some circumstances, a demonstrated public health benefit of an increased consumption of a given micronutrient might be considered sufficient grounds to warrant mandatory fortification even if the population is not considered to be seriously at risk according to conventional biochemical or dietary intake criteria. The mandatory addition of folic acid to flour to reduce the risk of birth defects is a case in point.

Fortification is described as voluntary when a food manufacturer freely chooses to fortify particular foods in response to permission given in food law, or under special circumstances, is encouraged by government to do so. The impetus for voluntary fortification usually stems from industry and consumers seeking to obtain possible health benefits through an increase in micronutrient intakes. Occasionally, however, government provides the driving force. Given this diversity in the circumstances that drive voluntary fortification, it is

not surprising that the public health impacts range from negligible to substantial. Indeed, depending on the nutritional quality of their basic diet, those individuals who regularly consume fortified foods might well gain discernible benefits.

However, it is important that governments exercise an appropriate degree of control over voluntary fortification through food laws or other cooperative arrangements, such as industry codes of practice. The degree of control should at least be commensurate with the inherent level of risk. Regulatory controls of this nature should also ensure the safety of fortified foods for all consumers, as well as provide opportunities for industry to produce fortified foods that offer consumers nutritional and/or other health benefits. The potential benefits may be demonstrable, or indicated as potential or plausible by generally accepted scientific data.

When instituting voluntary fortification arrangements, governments have a duty to ensure that consumers are not misled or deceived by fortification practices and may also wish to be satisfied that market promotion of fortified foods does not conflict with, or compromise, any national food and nutrition policies on healthy eating. This could be achieved through regulations on the range of foods eligible for voluntary fortification and on the permitted combinations of particular micronutrients and foods.

Currently many countries permit voluntary fortification, but the range of foods that may be fortified varies considerably from country to country. Some Scandinavian countries allow only a narrow range of foods to be fortified, whereas the range of products that can be fortified is much greater in the United States. Similarly, the permitted fortificants range from a select few to almost all micronutrients that are considered essential.

Voluntary fortification tends to be used when there are lower order risks to public health, i.e. when the risks to public health are not as serious or demonstrable as to warrant mass fortification. Inadequate micronutrient intakes that arise because of changes in lifestyles that tend to follow changing social and economic circumstances are more likely to be associated with lower order public health risks than inadequate intakes that arise because of significantly modified eating habits and dietary behaviour. In addition, for certain nutrients, dietary requirements have been reappraised in light of evolving scientific knowledge about their physiological role and the beneficial effects on certain physiological processes and health conditions.

Because of uncertainty about the level of industry uptake of fortification within each food product category, and the fact that regular consumers of a given fortified food may vary over time and thus do not constitute a readily identifiable group, voluntary fortification is less likely than mandatory fortification to deliver a guaranteed favourable outcome in terms of increased intakes of micronutrients across a target population. Apart from the extent to which a given food category is fortified, the public health impact of voluntary fortification depends on the contribution of that food category to the diet of the population as a whole, and also whether or not those individuals who would benefit most from fortification regularly consume and have access to that food category.

Despite these inherent difficulties, a consistent supply of appropriately regulated, voluntarily fortified foods, produced under freemarket conditions and widely and regularly consumed by a given population group, can have a beneficial impact on public health by positively contributing to micronutrient balance and thereby reducing the risk of deficiency. For example, in the European Union where fortification of margarine is voluntary, it is estimated that the addition of vitamins A and D to margarine and spreadable fats contributes about 20 % of the reference nutrient intake for vitamin A and 30 % of that for vitamin D[4]. It has also been reported that by the 1990 s fortified breakfast cereals had become the principal source of Fe for young children in the United Kingdom[5] and according to Hannon *et al.*[1] now also in Ireland.

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