



INTRODUCTION

CHAPTER 1

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That foods might provide therapeutic benefits is clearly not a new concept. The tenet: “Let food be thy medicine and medicine be thy food” was embraced-2500 years ago by Hippocrates, the father of medicine.

Today, the industrialized countries are facing, among others, three major challenges i.e. to control the cost of health care, to offer to their aging population a real opportunity to live, not only longer, but also better and to provide to more and more “busy” consumers, a choice of healthy processed or ready-to-eat foods. At the same time, progress in the biosciences supports the hypothesis that, beyond providing nutrition, diet also may modulate various functions in the body that are relevant to health. The concepts in nutrition are changing from a past emphasis on the absence of adverse effects to an emphasis on the promising use of foods to promote a state of well-being, better health and reduction of the risk of diseases. These concepts have recently become popular with consumers (Roberfroid MB 1999). The growing awareness of such food that has market potential is termed as functional foods.

According to the European Consensus on “Scientific Concepts of Functional Foods”, a functional food is defined as: A food can be regarded as functional if it is satisfactorily demonstrated to affect beneficially one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either improved stage of health and well-being and/or reduction of risk of disease. A functional food must remain food and it must demonstrate its effects in amounts that can normally be expected to be consumed in the diet: it is not a pill or a capsule, but part of the normal food pattern.

The large bowel and the composition and its symbiotic microbial ecosystem are major targets for functional food development and are attracting more and more interest from the nutrition community, as shown by the most recent developments in the fields of probiotics, prebiotics, and synbiotics.

Probiotics according to the present day interpretations refers to viable microorganisms that promote or support a beneficial balance of the autochthonous microbial

population of the gastrointestinal tract (GT). Such microorganisms may not be necessarily be constant inhabitants of the GT, but they should have a “beneficial effect on the general and health status of man and animal” (Fuller R 1989). The word probiotic literally means “for life.” According to the WHO 2004 (World Health Organization), probiotics are living bacteria which, when consumed in sufficient quantities, have beneficial effects on health whereas a prebiotic is defined as a nondigestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon (Gibson and Roberfroid 1995). To be classified as a prebiotic food ingredient, it must: 1) not be hydrolyzed or absorbed in the upper gastrointestinal tract; 2) serve as a selective substrate for at least one potentially beneficial bacteria in the colon, thus stimulating growth, becoming metabolically active, or both; and 3) result in a healthier colonic microflora composition (Collins and Gibson 1999).

Claims about prebiotic ingredients reducing disease are tentative and need further scientific evaluation. These claims or potential health benefits include constipation relief, diarrhea suppression, and reduction of risks of osteoporosis, atherosclerotic cardiovascular disease due to dyslipidemia and insulin resistance, obesity, and possibly type 2 diabetes (Roberfroid MB 2000). Specific prebiotic ingredients, such as non-digestible oligosaccharides, have been shown to increase calcium absorption (Scholz-Ahrens 2001). However, the effects vary with each non-digestible oligosaccharides and the dosage consumed (Saggiro 2004).

There are three types of fructan polysaccharides that are linked in a beta 2-1 configuration. Each type of fructan polysaccharide differs with its degree of polymerization (DP) which is the number of fructose units in the chain. The first type is inulin with DP ranging from two to greater than 60 depending on the plant source. The second type is oligofructose which has a short chain length, with a DP ranging from two to twenty. The third type is fructooligosaccharide (FOS) with the shortest chain length among the three types of fructan polysaccharides. FOS has a DP ranging from three to five (FDA 2003). Among these, inulin-type fructans are relatively unique functional food components because of their chemical nature and the combination of their physiological and nutritional effects that affect gastrointestinal functions.

Inulins are linear (β -1) fructans (Roberfroid et al 1995) that are polydisperse ranging from 2 to 60 or more, present in significant amounts in several fruits and vegetables. The nutritional properties of these fructans and more specifically their indigestibility in human tract were discovered long ago. It is only recently that there is a pronounced market need for inulin as a new food ingredient (Van Loo et al 1995). Inulin is used as a prebiotic either for its nutritional advantages or technological properties but it is often applied to offer a dual benefit (Franck A 2002). The most commonly consumed inulin-containing foods are grains, cereals, bananas, tomatoes, garlic and onions.

The average intake of inulin and oligofructose in the U.S is 2.6 grams per day, compared to the estimated amount of 10 grams per day (FDA 2003). Most European countries officially recognize chicory inulin and oligofructose as natural food ingredients (Cummings JH 1997). United States granted GRAS (generally recognized as safe) status to inulin, fructooligosaccharide (FOS) and oligofructose in 2002 (FDA 2003). Inulin has a lower caloric value as compared to other forms of carbohydrate due to non-digestibility of these ingredients by human enzymes. Inulin when enters the colon is fermented by beneficial colonic microflora. The energy released is largely due to the production of short chain fatty acids and lactate, which are metabolized to contribute 1.5 kcal/g of useful energy (Niness 1999). Previously few researchers have described the presence of inulin and oligofructose in common food stuffs. Analysis of inulin becomes important due to paucity of data on the inulin content of many food plants and commonly consumed Indian foods. Also inulin is not measured by classic methods of dietary fiber analysis and consequently is often not mentioned in food tables. Their significant contribution (1 to 10 g/d/per capita) to the dietary fiber fraction (recommended at 25/g/d/per capita) is not taken into account in any nutritional recommendations (Van Loo et al 1995). In view of this inulin deserves more attention both in food composition tables and in diet or nutrition studies. Such a data base can be used by the dieticians to formulate diet for patients with special needs and thus modify the composition of food formulations. Also knowledge on inulin content of different food will help in identifying sources that can be used as sugar and fat replacers. The effects of processing on the quality of food becomes an concern, because both the content and the nutritional quality of food carbohydrates can be altered by processing in a number of ways (FAO 1998). Therefore degradation

of inulin during common food preparations procedures (cooking, baking, roasting, frying) can be determined in order to study the dietary losses of inulin during cooking.

At present commercial inulin is one of the most interested fiber ingredients. Inulin has most of the physiological effects of the dietary fiber and is considered as a functional food ingredient since it affects physiological and biochemical process in rats and human beings resulting in better health and reduction in the risk of many diseases.

Application of inulin provides unique texture modifying characteristics which can improve the rheological and textural properties of food. Inulin can form interactions with other gums and stabilizers. It is therefore an effective fat or sugar substitute in wide range of products. Combining inulin with high intensity sweeteners significantly improves the taste of products giving a more sugar-like sweetness. Owing to the high solubility of this ingredient over 'classical fibres' inulin can be used to fortify dairy products such as milk drinks, yoghurt, cheeses and desserts, which have been traditionally difficult to fortify (Niness 1999). The functionality of inulin is based on its effect on water solutions at various solid levels. At lower concentrations it causes significant viscosity increase and can be used as a rheology modifier (Franck A 1997).

Besides the technological properties, inulin also contributes from nutritional perspective being a prebiotic dietary fiber. Its high solubility, neutral taste, color and versatility makes it an ideal ingredient for wide range of applications. The physicochemical and biological properties of inulin that relates it to dietary fiber includes water dispersibility, viscosity effects, bulk absorption, fermentability and binding of other compounds. These features may lead to various physiological actions such as reducing cholesterol, attenuating blood glucose, maintain gastrointestinal health. Moreover based on their physiochemical properties inulin can help to improve organoleptic and nutritional value of foods. Therefore a need was felt to carry out the acceptability trials of inulin incorporation in various food products as a fiber enrichment or a fat replacer by substitution or addition at various levels.

Scientists have postulated that inulin has potential health benefits that include improving or maintaining colon health as a prebiotic, lowering cholesterol and glucose in blood, increasing the absorption of minerals, and improving immune function (Roberfroid MB 1999). Normalization of the properties of unbalanced

indigenous microflora of the intestinal tract by ingestion of specific strains of the healthy microflora forms the rationale of probiotic therapy (Harish and Varghese 2006). Amongst many bacteria of the intestinal microbiota considered as beneficial, *Lactic acid bacteria* and *Bifidobacteria*, normal inhabitants of human gastrointestinal tract, have raised great interest for their potential health benefits. The health promoting effects prompted by *Bifidobacteria* and *Lactic acid bacteria* is due to the growth inhibition of harmful bacteria, stimulation of immune functions, lowering of gas distention problems and improved digestion/absorption of essential nutrients and synthesis of vitamins (Gibson and Roberfroid 1995; Delzenne N 1999). Dietary consumption of probiotic LAB in a milk-based diet has been shown to offer benefit to elderly consumers to combat some of the deleterious effects of immunosenescence on cellular immunity (Gill et al 2001). In addition to lactic acid bacteria, *Bifidobacteria* produce acetic acid with a strong bactericidal action, which has been shown to suppress harmful bacteria.

New foodborne pathogens have emerged as prevalent and life threatening, including *Shigella* and *Escherichia coli* strains which can disturb intestinal functionality. *Bifidobacteria* are known to exhibit inhibitory effects on many pathogenic organisms both in vivo and in vitro. (Anand et al 1985). Acetic and lactic acids produced from catabolism of carbon sources lower intestinal pH inhibiting unfavorable bacteria such as *Escherichia coli* and *Clostridium perfringens* that produce toxins and can cause enteritis.

Lactobacillus and *Bifidobacteria* cultures are increasingly used as probiotics in pharmaceuticals and in foods (Gerhard R 2001). Many products containing *Bifidobacteria* are offered around the world, including dairy products, such as fermented milks, cottage cheese and buttermilk, and pharmaceutical preparations (Tamine AY and Marshall VME 1995).

A number of investigations have shown that inulin promotes growth of bifidobacteria (Gibson and Wang 1994 a,b) therefore, consumption of a probiotic containing food in combination with a suitable prebiotic (inulin) can result in synergistic effects by providing a readily available substrate for fermentation and increasing the establishment autochthonous *Bifidobacteria* in the gut. Probiotics and prebiotics offer attractive means where by the unfavorable changes in the aging gut can be reduced

and a more “healthy” intestinal microbiota can be maintained. This may also help to maintain normal bowel function and reduce susceptibility to infection in older adults. Synbiotics (mixture of probiotics and prebiotics) has been demonstrated to modify the composition of the microflora, restore microbial balance and therefore have a potential to provide health benefits. Probiotics in the form of fermented milk products have shown to exert cholesterol lowering properties whereas reductions in serum triglycerides have been reported in studies with rats, upon addition of fairly high (50-200 g/kg) amounts of fructooligosaccharides to the diet (Levrat et al 1995; Delzenne and Kok 1999). Lipid-lowering ability of inulin has been observed in hyperlipidemic and diabetic patients (Yamashita K 1984; Hidaka et al 1991). Inulin is rapidly and completely fermented in the colon and the most common hypothesis for a lipid-lowering mechanism is that the fermentation products, especially propionate reaching the liver by the portal vein, could modulate cholesterol synthesis (Kok et al 1996a). However in human studies using both prebiotics and probiotics there have been inconsistent findings with respect to change in lipid levels although on the whole there have been favorable outcomes.

Dietary supplement sales have shown double-digit growth in the past few years, suggesting consumers are seeking dietary sources to provide nutrition and health benefits in order to enhance their quality of life. Cultured dairy product manufacturers have believed for decades that milk is the ideal vehicle for delivering probiotics. After all, milk is a complete food and is the first form of nutrition for most mammals. There are significant nutritional benefits with consuming a whole food (vs. popping a pill). These benefits include a food’s inherent vitamin, mineral, amino acid, carbohydrate and fatty acid content. Probiotic-containing foods like yogurt and fermented milk are recognized for their health attributes, which range from enhancing lactose digestion in lactase-deficient individuals to preventing and treating diarrhea. Dairy products containing *Bifidobacteria* have been shown to improve bowel habits in adults (Bartram et al 1994). Apart from studies on constipation and transit time, where some reports indicate beneficial effects of probiotics (Ling et al 1992), the usefulness of such supplements has been investigated only with healthy younger adults or with patients with specific pathological conditions (Bianchi et al 2001). As a target group for specialized foods, the older adults have received little attention compared to other population groups particularly in India. It is likely that the net effect of probiotics,

prebiotics and synbiotics on the composition of GI microflora and ensuing GI function in the older adults differs from that observed with younger adults due to the specific status of the aged GI tract. Fermented milk is a very good medium for delivery of probiotics along with addition of inulin. Therefore, a need was felt for human intervention study to determine the efficacy of prebiotics in the older adults, particularly the application of probiotic and prebiotics, especially the inulin-type fructans, and synbiotics (prebiotics combined with efficacious probiotic strains) is studied in terms of microbiota modulation and impact on disease risk in the aged population.

Thus the present study entitled “HPLC analysis of selected Indian foods for inulin content, acceptability trials of inulin incorporated recipes and its health benefits in institutionalized elderlies” was undertaken in three phases.