ABSTRACT

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Inulins are plant carbohydrates that, because of the ß–(2 ← 1) configuration of the fructosyl-fructose glycosidic linkages, resist digestion in the upper gastrointestinal tract but are quantitatively fermented in the colon. In last few years they have received increasing interest because of their positive health benefits. So far, few studies are available reporting its presence in commonly consumed foods. Also, they may contribute in a significant way to a well-balanced diet by increasing the fiber content, by improving the diversity of the fiber sources and by specifically affecting several gastrointestinal functions (composition of intestinal microflora, mucosal functions, endocrine activities, mineral absorption etc) and even systemic functions (especially immune functions) as well as by reducing the risk of miscellaneous diseases. Numerous applications for inulin have been proposed but little attention has been paid to the feasibility and acceptability of using inulin in real food systems. Older adults are generally more susceptible to changes in gut physiology and diet, than are younger adults. Their gut microflora changes with growth of potentially damaging bacterial population leading to alterations in lipid and glucose metabolism.

Thus, the present study was planned in three phases 1) To determine inulin content for selected raw and cooked Indian food products, using High Performance Liquid Chromatography 2) To develop and carry out acceptability trials of inulin incorporated products and 3) To study the impact of supplementation of probiotic and synbiotic fermented milk in diets of institutionalized elderlies for a period of 6 weeks.

To determine the inulin content, popular raw food samples belonging to different food groups viz cereals and pulses were procured from the research station whereas fruits, vegetables, roots and tuber, spices and condiments and processed foods were purchased from the local market of five different zones of Vadodara. All the raw and cooked samples after drying to reduce the moisture content to 8% were powdered by grinding in the milcent mill and were analyzed using a method outlined by Dyseeler et al 1999. Inulin content was highest in garlic (12.7%), followed by onion (10.2%) and wheat (GW496 variety) (2.3%). Four percent increase in inulin content was observed in '*chapati*' prepared by roasting, followed by a loss of 17% in '*puris*' during frying

and a maximum loss of 47% in '*steamed wheat porridge*'. Vegetables and fruits like fenugreek leaves, spinach, cabbage, brinjal and apple showed occurrence of inulin in the range of 0.02 - 0.88 %. Minor amounts were detected in fenugreek seeds and rice. Inulin was not detected in various pulses and legumes namely green gram, red gram dhal, black gram, bengal gram and soyabean as well as in cereals like pearl millet, maize and oat bran. HPLC analysis was found to be useful technique for the determination of inulin content of commonly consumed Indian foods. The results will allow for the quantification of inulin in the average daily diet of Indians. The data from this study will provide added information to the current database for inulin content of commonly consumed foods as well as its contribution to health in form of reducing the risk for cardiovascular diseases. The identified sources in the present study may be further studied to recover prebiotics in their natural state to be used on a commercial scale.

The possibilities of incorporating inulin in the popular Indian foods were studied by the method of substitution and addition at various levels. The developed products included bread, *chapati, dhokla*, cookies cereal pulse porridge, *potato bonda*, orange juice and curd were studied for nutritional, physicochemical and organoleptic characteristics. Organoleptic evaluation of the standard and inulin incorporated products was carried out by a panel of selected, semi trained judges. Sensory evaluation tools selected were numerical scoring test and multiple comparison test, (ISI 1972). Results revealed that inulin enriched breads were accepted among panel members up to 20% level of incorporation. Physicochemical evaluation of bread showed decrease in water absorption, loaf weight and loaf volume with increasing level of inulin substitution. Organoleptic evaluation of cookies indicated significant difference in attributes like sweetness, texture, flavor and mouthfeel at 22% and 25% level whereas no significant difference was observed up to 20% level of inulin substitution. Results of physico chemical properties of cookies showed that there was increase in diameter, thickness and spread ratio of the cookies up to 15% of inulin incorporation thereafter a decrease in these parameters was observed. Inulin could be used as fat replacer in cookies up to 20 % without statistically significant change in sensory attributes. Inulin could be incorporated up to 10% for preparation of *chapatis* without significantly affecting organoleptic characteristics. Results of the physicochemical properties of *chapati* revealed decrease in water absorption power of

the dough and cooked weight of inulin substituted *chapatis*. Addition of inulin to *dhokla* showed increase in weight and volume as the level of inulin addition increased. Organoleptic evaluation revealed that all the *dhoklas* were quite acceptable at 20% level of inulin incorporation in the bengal gram flour batter. Adding inulin in the coating of *potato bonda* reduced oil absorption and frying temperature of the potato bondas with increasing level (0 to 20%). All the *potato bondas* were acceptable up to 20% level of inulin incorporation. The cereal pulse porridge showed no change in the water absorption properties as the level of inulin addition increased. The overall acceptability scores of porridge increased with increasing level of inulin addition. No significant differences were perceived for organoleptic properties of cereal pulse porridge under study. Addition of inulin up to 20% level to orange juice and curd showed no significant difference in overall organoleptic acceptability and scores for most of the attributes. Therefore it can be concluded that inulin can be substituted (bread, *chapati*, *dhokla*) and added as dietary fibre (cereal pulse porridge, juice, *potato bonda*, curd) in many products and as fat replacer in baked goods (cookies).

In order to study the effect of supplementation of probiotic and synbiotic fermented milk (inulin added fermented milk), 66 hypercholesterolemic institutionalized elderly subjects (age>60 yrs) were selected and a randomized, controlled clinical trial was undertaken with wherein control group (Group I) subjects (n=20) received no supplementation and the experimental I subjects (Group II) (n=20) were supplemented with probiotic fermented milk comprising *Bifidobacterium bifidum* (BB-12), *L.acidophilus, L.bulgaricus* and *Streptococcus thermophilus* and experimental group II subjects (n=26) were supplemented with synbiotic product (probiotic fermented milk +15 g inulin) for a period of 6 weeks. Probiotic and synbiotic fermented milk supplementation resulted in 3.57% and 6.9% reduction in TC, and 0.76 % and 4.1 % increase in HDL levels respectively. A significant reduction in TG (4.3%) and LDL levels (8.3%) in group III was observed. A non significant reduction was seen in serum triglyceride in group II participants (2.96%). In the control group the lipid profile remained unaltered. A significant reduction was seen in the atherogenic indices LDL: HDL, TC: HDL ratio in participants of group III whereas such reductions were not observed in group II participants. A significant reduction of 5.2 % and 7.8% was observed in fasting plasma glucose values in group II and group III respectively. There was a significant reduction in systolic and

diastolic blood pressure from 142 to 137 and 92 to 89 mm Hg in the synbiotic supplemented group respectively whereas a non significant reduction was observed in the probiotic supplemented group. As a result of intervention, a reduction in the mean BMI was seen in group II and group III participants, with a significant reduction in the synbiotic fermented milk supplemented group. The mean log values in CFU/g (wet weight) increased significantly for *Bifidobacteria* (from log 7.90 to log 8.23) and *Lactobacilli* (log 6.43 to log 6.86) in group II participants whereas the increase was higher ($p<0.001$) in synbiotic supplemented group for *Bifidobacteria* (from log 7.82 to log 8.58) and *Lactobacilli* (log 6.92 to log 7.65). Decrease in mean log counts of *E.coli* was observed from log 6.66 to log 6.28 and from log 6.51 to log 5.88 in probiotic and synbiotic group respectively. Supplementation with probiotic and synbiotic fermented milk resulted in a negative correlation between TC, LDL-C, TC:HDL-C and beneficial microorganisms. Therefore, regular consumption of 100 g of probiotic and synbiotic fermented milk (100g of probiotic fermented milk with added 15 g of inulin) by the older adults for a period of 6 weeks in daily diet with moderately raised blood lipids, significantly reduces total cholesterol. Also a significant reduction in the serum TG (4.5%), LDL levels (8.3%) and a rise in hemoglobin levels was seen only in the synbiotic fermented milk supplemented group. The colonization of beneficial bacteria (*Bifidobacterium* and *Lactic acid bacteria*) improved significantly in both the experimental groups along with a reduction in *E. coli* in the gut.