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EFFECT OF HIGH PERFORMANCE CHICORY INULIN ON CONSTIPATION

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ABSTRACT

It is known that chicory inulin (average degree of polymerisation DP=10) and oligofructose (DP=4) affect bowel function. Whereas transit time is not affected with daily doses ranging between 4 and 15g, such doses increase stool frequency and have a faecal bulking effect in healthy volunteers.

Recently a new type of chicory inulin with higher average chain length (DP=25)has become commercially available. From a nutritional point of view this is an interesting carbohydrate, as it is fermented more slowly than the native product, giving it the opportunity to arrive in more distal parts of the colon.

In this placebo controlled study, we investigated the effect of this high performance inulin on bowel function in healthy volunteers with low stool frequency (1 stool every 2 to 3 days).

Subjects were administered 15g of the product/day for 2 weeks. Besides macroscopic observations (stool frequency, faecal bulking, etc.), or-caecal transit time, effect on intestinal permeability, amount of faecal fat, bile acids, dry solids, etc. were monitored.

There was a significant increase in stool frequency with the high performance inulin (p=0.02). The earlier observed trend to increase faecal bulk with 1.5 to 2g per g inulin ingested was observed in present study as well. There were no effects on the other measured parameters.

KEYWORDS: inulin; chicory root; constipation; bowel function

INTRODUCTION

Inulin occurs as storage polysaccharide in a variety of plants, such as onion, garlic, wheat, leek, banana, Jerusalem artichoke and chicory (1). The vast majority of inulin molecules consist of a sucrose moiety and a number of ß(2-1)-linked fructose units, the latter depending on botanical

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source and the season (2). The total number of hexoses (glucose or fructose) joined together in a chain is termed the degree of polymerisation (DP).

Inulin is extracted from chicory root with hot water, and subsequently purified by technology that is commonly used in the starch industry (3). Recently, chicory inulin devoid of its lower DP fraction (DP 2-10) has been made available commercially. This high performance inulin preparation has an average DP of 25 and is marketed as RAFTILINE HP® (ORAFTI, Tienen, Belgium).

The effects of chicory inulin (average DP 10) and its partial hydrolysate, oligofructose (DP 2-8), on human gut function have been established (4). Both substrates have a stool-bulking activity (1-2 g increase of faecal weight per gram of inulin or oligofructose ingested) and increased stool frequency when the initial stool frequency was low (5). In a study of elderly people, chicory inulin had a moderate laxative effect, relieving constipation with only mild discomfort (6).
To study the effect of high performance inulin on gastrointestinal functions, a placebo-controlled, double-blind cross-over study was performed with six, otherwise healthy, volunteers with mild constipation.

METHODS AND MATERIALS

Six healthy volunteers (one male, five females; mean age 28.5(± 11.1) years, range 20-49 years; mean body weight 59.8(± 10.3) kg; mean height 171(± 7) cm) with a low stool frequency pattern, i.e. with one stool every two or three days, participated in the study. None of them had undergone abdominal surgery. None had taken medication that can influence intestinal motility or the intestinal flora or had suffered from diarrhoea in the last three months. This study was approved by the Ethical Committee of this Institute and all participants gave informed consent.

In this double blind placebo controlled cross-over study, all participants started with a wash-out period of one week. In the second week, the subjects were randomly assigned to receive either inulin (n = 3) or placebo (n =3). The third week was a wash-out period. In the fourth week, the participants switched treatment. Both inulin (RAFTILINE HP®, sweetened with aspartame) and placebo (sucrose) were given in doses of 5 g, 3 times daily. Both substrates were combined with the normal meals.

During the 4 weeks of the study, participants followed a free but standardised diet; i.e. subjects were instructed to follow a constant diet with the exclusion of prebiotics and probiotics. Each volunteer kept a diary of food intake (28-day food record). The daily nutrient intake was calculated using the Becel nutrition program (version BNO 3A, based on the Dutch food table NEVO (7)). To check whether there was a constant diet, the mean nutritional intake of the four test weeks was compared by a Kruskal Wallis test (SAS, PROC NPAR1WAY (8)) for each volunteer and was shown to be relatively constant throughout the 4 test weeks. For 3 subjects, a difference was found in the intake of total fat, mono-unsaturated fat and/or mono- and disaccharides. These differences, however, were not considered to be of major importance for this study, since they have little influence on gastrointestinal functions.

During the 2 study weeks (inulin and placebo), the subjects kept a diary of faecal habit. The time of each defecation was noted and faeces consistency was judged as solid or soft. Urgency of defecation was described as urgent or normal. Gastrointestinal complaints were recorded. On the third day, the subjects ingested [^{3}H]PEG and started a 5-day faeces collection. Faeces were analysed for ^{3}H radioactivity and total transit was evaluated by calculation of the % dose recovery of [^{3}H]PEG after 3 days and after 5 days. For each faecal sample, the faecal weight, percentage dry weight (freeze-drying), amount of fat (Soxhlet extraction) and amount of bile acids ((9) were determined and a mean value was calculated over 5 days. On the 7th day, the subjects performed a series of tests at the laboratory. Gastric emptying was measured by the [^{14}C]octanoate breath test (10), orocaecal transit time by the lactose-[^{13}C]ureide test (11) and [^{51}Cr]EDTA was used as permeability marker (12). In practice, the subjects ingested 3 times 1 g of unlabeled lactose-ureide the day before the tests (day 6) in order to induce enzyme activity in the colonic flora. After an overnight fast, the subjects had a test meal of an omelette mixed with [^{14}C]octanoate and lactose-[^{13}C]ureide together with 3 slices of bread and a glass of water containing 50 μCi of [^{51}Cr]EDTA. Every 15 minutes during 4 hours, breath samples for $^{14}CO_2$ were obtained and measured by β-scintillation counting (Packard, model Tri-carb 2100 TR, Downers Grove, Illinois, USA). The results were expressed as the percentage of $^{14}CO_2$ excreted per hour and the half emptying time was calculated from this curve. Breath samples for $^{13}CO_2$ were collected in exetainers every 30 minutes for 8 hours. ^{13}C-enrichment in breath samples was determined with an isotope ratio mass spectrometer (ABCA, Europa Scientific, Crewe, UK). The orocaecal transit time was defined as the time-point at which a significant increase in ^{13}C-enrichment is seen. Urine was collected for 6 hours and the dose of [^{51}Cr]EDTA was determined by β-scintillation counting. Permeability was expressed as the urinary % dose excretion of [^{51}Cr]EDTA after 6 hours.

All parameters measured are presented as mean ± SEM. The effects of inulin and placebo on gastro-intestinal variables were compared by analysis of variance for repeated measurements with the treatment variable and the order of the test as dependent variables (SAS, PROC GLM (8)). Proportions (faeces consistency and urgency) after inulin and after placebo were compared by a chi^{2}-test (SAS, PROC FREQ 8).

RESULTS AND DISCUSSION

Table 1 shows the mean values for the gastrointestinal parameters for either placebo or inulin.

TABLE 1
Gastrointestinal Function Parameters for Placebo and Inulin in 6 Healthy Volunteers

	Placebo mean ± SEM	Inulin mean ± SEM	Statistics ANOVA
Half emptying time (minutes)	74 ± 8	68 ± 12	$p = 0.53$
Orocaecal transit time (minutes)	324 ± 24	362 ± 23	$p = 0.26$
Total transit:			
- % dose recovery of ^3H after 3 days	40 ± 11	34 ± 11	$p = 0.62$
- % dose recovery of ^3H after 5 days	84 ± 1	78 ± 7	$p = 0.81$
Permeability (urinary % dose excretion)	1.13 ± 0.08	0.97 ± 0.09	$p = 0.19$
Faecal frequency (number of stools per week)	4.0 ± 0.4	6.5 ± 1.0	$p = 0.02$
Faecal weight (g/day)	91 ± 107	113 ± 22	$p = 0.28$
Faecal dry solids (g/day)	24.1 ± 1.6	28.4 ± 2.7	$p = 0.28$
Faecal fat (g/day)	2.1 ± 0.3	2.0 ± 0.6	$p = 0.95$
Faecal bile acids (mmol/day)	0.52 ± 0.09	0.61 ± 0.14	$p = 0.48$
Abdominal cramps (number of days per week)	0.0 ± 0.0	1.2 ± 0.5	$p = 0.12$
Flatulence (number of days per week)	0.0 ± 0.0	0.8 ± 0.5	$p = 0.24$
	Proportion	Proportion	chi^2
Faeces consistency			
Solid	0.61	0.63	
Soft	0.39	0.37	$p = 0.68$
Faeces urgency			
Urgent	0.21	0.30	
Normal	0.79	0.70	$p = 0.66$

There was no order effect for any of the parameters, meaning that the effect of inulin was similar, independent of whether a subject started with the placebo or with inulin. The mean number of stools increased significantly, from 4.0 per week at baseline to 6.5 per week after inulin supplements ($p = 0.02$). For each individual there was an increase of at least one stool per week. Tramonte et al. reviewed the effect of different fibre preparations and drugs, such as psyllium, ispaghula, bran lactulose, lactitol and cisapride, on bowel habits and found that laxatives and fiber preparations increase bowel movement frequency by an overall weighted average of 1.4 (95 % confidence interval (CI) 1.1-1.8) bowel movements per week (13). Similarly, in this study, inulin increased bowel frequency by 1.6 times (p=0.02).

The mean increase in stool weight that was observed in this study, i.e. 22 g/day, represents a value of approximately 1.5 g stool weight increase per g inulin consumed, which, although not statistically significant, is comparable to values that were reported previously (5). The observed increase in faecal dry weight suggests that high performance inulin is, at least partly, converted to bacterial biomass.

Gastric emptying rate, orocaecal transit time and total transit time were not affected by a daily intake of 15 g of high performance inulin. Intestinal permeability, expressed as the six hour urinary % dose excretion of [^{51}Cr]EDTA, did not change after ingestion of inulin. The latter is in accord with a study where inulin was added to enteral nutrition and where no change in permeability was found (14).

Subjects ingesting inulin complained more about gastrointestinal discomfort than subjects receiving the placebo. There were no reports of flatulence or abdominal cramps following placebo, but these occurred, on average, 0.8 and 1.2 times per week, respectively, after inulin, which did not reach significance (see Table 1). And there was a large inter-individual variation for these parameters. It is possible that the spectrum of the colonic flora will adjust to this relatively new substrate and that the symptoms of discomfort may be only temporary.

APPLICATIONS

Constipation is one of the most prevalent gastrointestinal complaints in the Western world. It affects 1 in 50 people and is more prevalent in the elderly, in women and in people with low socio-economic status. Fibre supplementation is a cornerstone in the bowel management programme. In this study, we showed that inulin can be used to increase faecal frequency. As was observed in other studies, there was a trend to increasefaecal weight. Increasing inulin intake could be accomplished by ingesting its sources, such as onion, garlic, wheat, leek, banana, Jerusalem artichoke or chicory. To increase daily intake to effective levels of 4 to 5 g/day however would imply a doubling of the daily intake of these foodplants. Also, inulin has a neutral taste and can be added to the normal nutrition. Inulin is soluble in water and is therefore suitable to add to tube-feeding formulae.

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