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Long-term administration of inulin-type fructans has no significant lipid-lowering effect in normolipidemic humans

Fabien Forcheron[a], Michel Beylot[a,b,*]

[a]INSERM U 499, Faculté RTH Laënnec, IFR 62, Université Claude Bernard Lyon, 69008 Lyon, France
[b]Centre de Recherche en Nutrition Humaine, 69008 Lyon, France

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Abstract

Short-term studies have shown that the addition to diet of inulin-type fructans, a nondigestible carbohydrate, may have a plasma lipid-lowering effect in humans. Whether this beneficial effect persists during long-term administration has not been determined. The study was aimed at determining whether a prolonged (6 months) administration of inulin-type fructans to healthy subjects has a lipid-lowering action. In a double-blind, randomized, placebo-controlled study, 17 healthy subjects were studied before and after 6 months of daily administration of placebo (8 subjects) or 10 g of a mix of inulin and oligofructose (9 subjects). During this 6-month period, they consumed their usual diet and did not modify their everyday way of life. We measured plasma lipid concentrations; cholesterol synthesis and hepatic lipogenesis; and adipose tissue and circulating mononuclear cell messenger RNA concentrations of key regulatory genes of cholesterol metabolism. Compared with the administration of placebo, the administration of inulin-type fructans had no effect on plasma triacylglycerol concentrations and hepatic lipogenesis and induced only a nonsignificant trend for decreased plasma total and low-density lipoprotein cholesterol levels and increased high-density lipoprotein cholesterol concentration. Cholesterol synthesis was not significantly modified. Of all the messenger RNA concentrations measured, none was significantly modified by the administration of inulin-type fructans. In conclusion, contrary to what was observed in short-term studies, we observed no significant beneficial effect of a long-term (6-month) administration of inulin-type fructans on plasma lipids in healthy human subjects.

1. Introduction

Atherosclerosis is a major cause of morbidity and mortality in industrialized countries. Therefore, a reduction in risk factors for atherosclerosis, such as elevated concentrations of plasma total and low-density lipoprotein (LDL) cholesterol [1] and raised levels of plasma triacylglycerols (TAGs) [2], is an important aim in public health. These reductions can be obtained by inhibitors of cholesterol synthesis [3] or compounds activating nuclear factors, such as PPARα agonists [4], and the beneficial effects of these molecules have been clearly demonstrated. Reductions in plasma lipid levels can also be obtained, at least in part, by dietary advice [5], a less expensive approach that can be used in large populations. A usual dietary recommendation is to decrease the total intake of fat, especially of saturated fatty acids, and this indeed allows the reduction of plasma cholesterol concentration [6]. Among other possible approaches, one is to increase the amount of prebiotics such as the inulin-type fructans (inulin and/or oligofructose) in the diet [7,8]. Actually, studies in animals have consistently shown a lipid-lowering action of these nondigestible carbohydrates [9]. Studies in humans yielded more conflicting results because both beneficial actions, on plasma TAG or cholesterol levels, and no effect studies have been reported [9]. We previously found that inulin could decrease plasma TAG concentrations and hepatic lipogenesis in healthy subjects [10], thus supporting a beneficial effect of this compound. However, these effects were observed in subjects receiving a controlled moderately high-carbohydrate diet during a short-term (6 weeks) administration of inulin. Other studies in humans of the effects of inulin or oligofructose on plasma lipid levels also investigated the effects of short-term

* Corresponding author. INSERM U499, Faculté RTH Laënnec, Rue G Paradin, 69008 Lyon, France. Tel.: +33 478778749; fax: +33 478778739.
E-mail address: beylot@sante.univ-lyon1.fr (M. Beylot).

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Table 1
Main characteristics of the 2 groups of subjects

Age (y)	Placebo group (n = 8)		Fructans group (n = 9)	
	29 ± 4		34 ± 2	
Sex (M/F)	3/5		3/6	
	Initial	Final	Initial	Final
Body weight (kg)	63.9 ± 2.9	64.0 ± 2.9	63.1 ± 2.7	62.5 ± 2.5
FFM (kg)	51.9 ± 2.8	52.3 ± 3.1	50.1 ± 3.5	50.6 ± 3.3
Fat mass (kg)	12.0 ± 2.3	11.7 ± 1.8	12.9 ± 2.1	11.9 ± 1.6
Fat mass (%)	18.5 ± 3.3	18.3 ± 2.9	19.9 ± 3.3	19.2 ± 2.7
REE (kcal kg^{-1} d^{-1})	22.8 ± 0.8	22.2 ± 0.8	22.3 ± 0.7	22.5 ± 0.4

(3-8 weeks) administration [9]. If prebiotics such as inulin or oligofructose are indeed useful in reducing plasma lipid levels, and therefore one of the main risk factors of atherosclerosis, their effects should be observed on a long-term basis and in subjects consuming their usual diet. Therefore, we investigated in the present study the effects of a long-term (6 months) administration of a preparation of fructans (mix of inulin and oligofructose, 50/50, wt/wt) in healthy subjects on parameters of lipid metabolism (plasma lipid concentrations, cholesterol synthesis and hepatic lipogenesis, expression of key genes of cholesterol metabolism). These subjects consumed their usual diet and did not modify their everyday way of life throughout the study.

2. Subjects and methods

2.1. Materials

Deuterated water (99 mol% excess) was from Cambridge Isotope Laboratory (Andover, MA) or Cortecnet (Paris, France), and chemicals and reagents were from Sigma Chemical (St Louis, MO) or Pierce Chemical (Rockford, IL). The mix of inulin and oligofructose (Synergy HP, Orafti, Tienen, Belgium) was obtained from Orafti and the placebo (maltodextrin) from Avebe (Veendam, Holland).

2.2. Subjects

Twenty healthy volunteers gave their written informed consent after full explanation of the nature, purpose, and possible risks of the study. None had a personal or familial history of diabetes, obesity, or dyslipidemia; or was taking any medication. All had normal physical examination results and normal plasma glucose and lipids concentrations. Subjects with unusual dietary habits or with intensive physical activity were excluded. These subjects were randomly allocated in 2 groups of 10 (placebo or fructans group). Two subjects of one group and 1 of the other group did not complete the full study, 1 by lack of compliance and 2 because of acute illness during the study. The initial characteristics of the subjects who completed the whole study are shown in Tables 1 and 2. There was no difference in these initial characteristics between the 2 groups. No subject reported any side effect, particularly gastrointestinal discomfort.

2.3. Protocols

The protocol was approved by the Institut National de la Santé et Recherche Medicale (INSERM) and the Ethical Committee of Lyon, France, and the study was conducted according to the Hurriet law. All tests were performed in the Human Nutrition Research Centre in Lyon. All subjects were studied twice (randomized, double blind, placebo-controlled design) with 6 months between the 2 metabolic investigations. After the first (initial) investigation, they consumed either fructans (9 subjects, 5 g before breakfast and 5 g before the evening meal, as powder dissolved in water) or placebo (8 subjects, 5 g twice daily also, powder dissolved in water) until the second (final) investigation performed 6 months later. This dose (10 g daily) is the same as the one we used in a previous study of short-term effects of inulin-type fructans [10] and is near the one (9 g/d) found by Brighenti et al [11] to decrease plasma lipids in another short-term study. We checked for the amount of placebo or fructans consumed by weighting the amount of powder remaining. All subjects were instructed to consume during these 6 months and the month preceding the first study their usual diet with the only recommendation to avoid foods rich in inulin or oligofructose [12] and to continue their usual physical activity. They met with a dietician before the initial study, at 2, 4, and 6 months (before the second study) to obtain at each period a 1-week detailed report of their dietary intake and to check compliance. These intakes were calculated using the Cuqual tables. For women, the metabolic investigations were performed during the first 10 days of the menstrual cycle to take into account the known variations of lipogenesis during the menstrual cycle (there is no menstrual variation for cholesterol synthesis) [13].

The nights before the tests, the subjects consumed their last meal between 7:00 and 8:00 PM. For each subject the

Table 2
Hormonal and metabolite values measured in the postabsorptive state during the initial and final metabolic investigations in the placebo and fructans groups

	Placebo group (n = 8)		Fructans group (n = 9)	
	Initial	Final	Initial	Final
Glucose (mmol/L)	3.97 ± 0.19	3.81 ± 0.20	4.33 ± 0.12	4.03 ± 0.10
Insulin (mU/L)	6.6 ± 0.7	6.8 ± 1.1	6.2 ± 1.1	6.8 ± 1.1
Glucagon (ng/L)	175 ± 23	153 ± 30	164 ± 26	156 ± 19
NEFA (μmol/L)	349 ± 70	314 ± 51	353 ± 38	446 ± 56
TAG (mmol/L)	0.78 ± 0.16	0.64 ± 0.11	0.71 ± 0.07	0.77 ± 0.14
Total cholesterol (mmol/L)	3.91 ± 0.33	3.73 ± 0.16	4.48 ± 0.16	4.14 ± 0.16
Free cholesterol (mmol/L)	1.27 ± 0.10	1.26 ± 0.07	1.32 ± 0.07	1.41 ± 0.07
HDL-C (mmol/L)	1.03 ± 0.09	1.13 ± 0.10	1.29 ± 0.09	1.47 ± 0.11
LDL-C (mmol/L)	2.55 ± 0.33	2.31 ± 0.15	2.88 ± 0.13	2.33 ± 0.20

For converting cholesterol and TAG concentrations to grams per liter, divide the corresponding values expressed as millimoles per liter by 2.59 and 0.887, respectively. HDL-C indicates HDL cholesterol; LDL-C, LDL cholesterol.

total energy and composition of this meal were comparable between the initial and final study. Because previous studies suggested that nondigestible carbohydrates can decrease cholesterol synthesis [14] and hepatic lipogenesis [9,10], we measured these lipid synthesis rates using the administration of deuterated water. The subjects drank a loading dose of deuterated water (3 g/kg body water; one half after the evening meal and one half at 10:00 PM to reduce the risk of vertigo). From then until the end of the tests, subjects drank only water enriched with ^2H_2O (4.5 g ^2H_2O per liter of drinking water). All tests were initiated the following morning in the postabsorptive state, after an overnight fast, between 8:30 and 9:00 AM. An indwelling catheter was placed in a forearm vein, and blood was sampled for the various concentration and enrichment measurements in the basal state. Respiratory gas exchanges were then measured during 1 hour (Deltatrac metabolic monitor, Datex, Helsinki, Finland) for the determination of resting energy expenditure (REE) and respiratory quotient (RQ). Thereafter, a sample (150-250 mg) of abdominal subcutaneous adipose tissue was obtained by needle biopsy under local anesthesia and stored in liquid nitrogen until messenger RNA (mRNA) measurements. The subjects underwent then a 3-hour oral glucose tolerance test (OGTT, 1 g of glucose per kilogram of body weight).

2.4. Analytical procedures

Plasma glucose, nonesterified fatty acids (NEFA), and TAG were assayed with enzymatic methods [15,16]. Plasma insulin and glucagon concentrations were measured by radioimmunoassay. Total and free cholesterol as well as the high-density lipoprotein (HDL) fraction were measured by enzymatic assays [4,17], and the LDL cholesterol was calculated using the equation of Friedewald. Detailed methods for the measurement of deuterium enrichment in plasma cholesterol and in the palmitate of plasma TG have been published [18-20]. In short, plasma lipids were extracted using the method of Folch et al [21]. Free cholesterol and TAG were separated from other lipid fractions by thin-layer chromatography. Free cholesterol was scraped off the silica plates and eluted from silica before preparing its trimethylsilyl derivative [18,19]. The transmethylated derivatives of the palmitate of TAG were prepared as described [22]. Deuterium enrichment determinations were performed on a gas chromatograph (HP5890, Hewlett-Packard, Palo Alto, CA) equipped with a 25-m fused silica capillary column (OV1701, Chrompack, Bridgewater, NJ) and interfaced with a mass spectrometer (HP5971A, Hewlett-Packard) operating in the electronic impact ionization mode (70 eV). The carrier gas was helium. Ions 368 to 370 (cholesterol) and 270 to 272 (palmitate) were monitored selectively. Special care was taken to obtain ion peak areas comparable between standard and biological samples, adjusting the volume injected or diluting the sample when necessary. Deuterium enrichment in plasma water was measured as previously described [23]. Within- and between-assays coefficient of variations were less than 5% for measurements of enrichments in water, palmitate, or cholesterol.

2.5. Messenger RNA concentrations in circulating mononuclear cells and adipose tissue

Mononuclear cells were immediately isolated by centrifugation of whole venous blood on a Ficoll gradient at 4°C as described [24] and stored at −80°C until RNA extraction as previously described [4]. Total RNA was prepared from adipose tissue samples using the RNeasy total RNA kit (Quiagen, Courtaboeuf, France) with the addition of treatment with DNAse. Concentration and purity were verified by measuring optical density at 260 and 280 nm, and integrity was checked by agarose gel electrophoresis. Low-density lipoprotein receptor, 3-hydroxy-3-methylglutaryl coenzyme A reductase, and scavenger receptor BI (SR-BI) mRNA concentrations were measured by reverse transcriptase–polymerase chain reaction using β-actin as internal standard. ATP binding cassette A1 (ABCA1) mRNA copy numbers were determined by competitive reverse transcriptase–polymerase chain reaction [4], and the results were expressed as copy number per microgram of total cellular RNA. Sequences of the primers used are available on request.

2.6. Calculations

Fat-free mass (FFM) was calculated from the volume of the loading dose (LD) of deuterated water ingested and the deuterium enrichment in plasma water (IEw) as FFM = (LD/IEw)/0.732 [25]. The fractional contributions of cholesterol synthesis and hepatic lipogenesis to plasma free cholesterol and to plasma TAG pools, respectively, were calculated from the deuterium enrichments in free cholesterol, palmitate of TAG, and in plasma water, as described previously [19,20]. In short, the deuterium enrichments that would have been obtained if endogenous synthesis was the only source of plasma cholesterol or of palmitate of TAG were calculated from plasma water enrichment. The comparison of the enrichments observed with these theoretical values gives the contributions, expressed as the fractional synthetic rate (FSR) of endogenous synthesis to the pool of rapidly exchangeable free cholesterol and of plasma TAG during the time between the ingestion of the loading dose of deuterated water and blood sampling (12 hours). The FSR of cholesterol was then transformed in an estimate of absolute synthetic rate (ASR), expressed as milligrams synthesized during the 12-hour period of deuterated water ingestion [4]. For this calculation, we first calculated the total pool M_1 of rapidly exchangeable cholesterol using the equation of Goodman et al [26]. M_1 comprises both free and esterified cholesterol, and we found deuterium enrichment only in free cholesterol. Therefore, we calculated the pool Mf_1 of rapidly exchangeable free cholesterol, assuming that the ratio in plasma of free to total cholesterol represents the ratio in the whole pool. Absolute synthetic rate was then calculated as ASR = FSR × Mf_1. The absolute value of plasma TAG pool provided by

Table 3
Daily dietary intakes of the 2 groups of subjects during the week preceding the initial and final metabolic investigations

	Placebo group (n = 8)		Fructans group (n = 9)	
	Initial	Final	Initial	Final
kcal kg^{-1} d^{-1}	32.7 ± 2.0	31.5 ± 2.4	30.2 ± 1.7	30.0 ± 1.6
CHO (% of energy)	45.5 ± 1.7	43.8 ± 1.6	42.5 ± 2.1	40.8 ± 1.6
Lipids (% of energy)	37.5 ± 2.3	40.0 ± 2.1	39.7 ± 1.7	41.8 ± 1.4
Proteins (% of energy)	16.9 ± 0.8	16.1 ± 0.7	17.8 ± 0.7	17.4 ± 0.6
SFA (g/J)	32.2 ± 2.8	32.4 ± 4.3	31.1 ± 3.3	31.1 ± 1.7
MUFA (g/d)	27.0 ± 2.4	25.7 ± 1.4	26.2 ± 2.3	26.3 ± 1.2
PUFA (g/d)	13.0 ± 2.4	11.1 ± 1.2	10.1 ± 1.0	10.8 ± 0.8
Fibers (g/d)	16.1 ± 1.2	15.2 ± 1.6	14.3 ± 1.1	14.7 ± 1.4
Cholesterol (mg/d)	328 ± 35	315 ± 29	281 ± 44	282 ± 13
CHO (total) (g/d)	235 ± 16	218 ± 17	196 ± 15	185 ± 13
CHO (simple) (g/d)	99 ± 5	94 ± 7	84 ± 9	78 ± 9
% of total CHO	43 ± 2	44 ±	43 ± 3	41 ± 3

CHO indicates carbohydrates; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.

hepatic lipogenesis, TAG*, expressed as milligrams per kilogram of body weight, was also calculated from the corresponding FSR and the total plasma TAG pool M as TAG* = FSR × M. M was calculated from the plasma TAG concentration, in milligrams per liter, and the plasma volume estimated to 45 mL/kg in control subjects with a body mass index lower than 30 [27].

Results are shown as mean ± SEM. Initial values of the 2 groups were compared by 2-tailed Student *t* test for unpaired values. The changes observed in the 2 groups between the initial and final values (final value minus initial value) were also compared by 2-tailed Student *t* test for unpaired values.

3. Results

3.1. Body weight, fat mass, dietary intake, and energy expenditure

There was no difference in body weight, fat mass, FFM, dietary intake, REE, and RQ (data not shown) between the 2 groups during the initial tests (Tables 1 and 3). Body weights or compositions were not modified during the 6 months of placebo or fructans administration. The dietary surveys showed no modifications in dietary intakes throughout the protocol. Only the results of the initial and final surveys are shown in Table 3. Results of the intermediate surveys (at 2 and 4 months) are comparable to the initial and final surveys. Resting energy expenditure (Table 1) and RQ (data not shown) were also unchanged.

3.2. Hormonal and metabolite values

The initial values of the 2 groups were comparable (Table 2). Addition of fructans to the diet did not modify plasma glucose, insulin, glucagon, NEFA, or TAG. In the fructans group, there was a trend for a decrease in plasma total (−0.34 ± 0.13 mmol/L) and LDL cholesterol (−0.57 ± 0.17 mmol/L) concentrations and an increase in HDL cholesterol (+0.19 ± 0.09 mmol/L) level. Although the final values in this group were significantly different from the initial ones when analyzed by Student *t* test for paired values ($P < .05$ for total, LDL and HDL cholesterol), these modifications were not significantly different from those observed in the placebo group (total cholesterol, −0.18 ± 0.31 mmol/L; LDL cholesterol, −0.24 ± 0.29 mmol/L; HDL cholesterol, +0.12 ± 0.08 mmol/L) ($P < .30$ for all). There was also a nonsignificant trend for a higher increase in the HDL cholesterol–LDL cholesterol ratio in the fructans group (+0.17 ± 0.08 vs +0.09 ± 0.04, $P < .15$). The evolutions of glucose and insulin concentrations during the initial OGTT were comparable in the 2 groups and were not modified after 6 months of placebo or fructans administration (data not shown). Nonesterified fatty acid concentrations were abruptly decreased during all tests. Triacylglycerol concentrations at 180 minutes decreased moderately to final values of 0.52 ± 0.12 and 0.43 ± 0.09 mmol/L (first and second study of the placebo group) and of 0.52 ± 0.07 and 0.44 ± 0.07 mmol/L (first and second study of the fructans group) ($P < .01$ vs initial values for all OGTT series) without differences between the placebo and fructans groups nor between the first and second tests.

3.3. Lipid synthesis rates

Stable levels of deuterium enrichment in plasma water from time 0 (basal value) to time 180 minutes (end of the OGTT) were obtained in all subjects. The placebo and fructans groups had in the postabsorptive state comparable calculated FSR for hepatic lipogenesis and for cholesterol synthesis during the initial study (Table 4). These synthetic rates were again comparable during the final study and were not, despite a trend for higher values, modified relative to the initial study. The absolute values of plasma TAG pool provided by hepatic lipogenesis were not different between the 2 groups and were not modified during either placebo or fructans administration. The ASR of free cholesterol increased moderately during fructans administration, but this increase was not different from the one observed in the placebo group. At the end of the OGTT, there was in both groups and during both the initial and final study a nonsignificant trend ($P < .10$) for an

Table 4
Lipid synthetic rates during the initial and final metabolic investigations

	Hepatic lipogenesis (%)		Cholesterol synthetic rate (postabsorptive state)	
	Postabsorptive state	End of OGTT	FSR (%)	ASR (mg/d)
Placebo group				
Initial	6.6 ± 1.7	6.9 ± 1.1	3.6 ± 0.8	276 ± 62
Final	9.4 ± 1.8	9.7 ± 1.3	4.7 ± 0.4	344 ± 42
Fructans group				
Initial	5.8 ± 1.0	6.5 ± 1.0	3.0 ± 0.5	201 ± 39
Final	8.0 ± 1.5	10.1 ± 1.5	4.3 ± 0.5	305 ± 27

increase in the percentage of contribution of hepatic lipogenesis to plasma TAG pool. However, because plasma TAG concentrations, and therefore plasma TAG pools, decreased after glucose ingestion, the absolute contributions of hepatic lipogenesis to plasma TAG pool were unchanged (data not shown). Cholesterol synthetic rates were not modified during the OGTT.

3.4. Messenger RNA concentrations of key regulatory factors of cholesterol metabolism

Because studies in animals and some previous studies in humans suggested that inulin-type fructans could modify cholesterol metabolism, we measured in addition to cholesterol synthetic rates the mRNA concentrations of key regulatory genes of cholesterol synthesis (3-hydroxy-3-methylglutaryl coenzyme A reductase), cellular uptake (LDL receptor), and efflux (ABCA1 and SR-BI) in 2 tissues (adipose tissue and circulating mononuclear cells). In both tissues, the initial values of the 2 groups were comparable. No significant effects of the administration of fructans were observed in circulating mononuclear cells or in adipose tissue (data not shown) despite a trend for an increase in mononuclear cells of ABCA1 mRNA.

4. Discussion

We investigated in this study whether the long-term administration to healthy subjects of moderate amounts of a preparation of fructans could, in the absence of any dietary advice or modification of the everyday way of life, have beneficial effects on plasma lipid concentrations. We found in these conditions no effects on plasma TAG levels and only a nonsignificant trend for beneficial effects on plasma cholesterol (moderate decreases in total and LDL cholesterol and increase in HDL cholesterol).

Of the 5 previous studies investigating the effects of inulin-type fructans on healthy subjects, 3 found no significant effect on plasma lipids [28-30], whereas TAG alone [10] or TG and cholesterol [11] were decreased in 2 others. These conflicting results contrast with the consistent TAG-lowering action of inulin or oligofructose demonstrated in animals [9]. The main explanation proposed for this discrepancy between human and animal studies relates to the main mechanism of the hypotriglyceridemic effect of inulin-type fructans in animals: inhibition of hepatic de novo lipogenesis [31-33]. In humans, hepatic de novo lipogenic rate is lower than in rodents and contributes only a few percentage to the secretion of TAG by the liver [20]. Therefore, only modest effects of inulin-type fructans on hepatic lipogenesis, and plasma TAG concentrations, can be expected unless liver lipogenic activity is previously raised by nutritional or pathologic factors. This would be consistent with the more marked TAG-lowering effects of inulin on human subjects with obesity and hypertriglyceridemia [9] than in healthy subjects because the former have higher hepatic lipogenic rate than the latter [4,34]. Comparison of the present study with the one of Letexier et al [10] supports also this interpretation. Letexier et al [35] and Hudgins et al [36] investigated subjects receiving a controlled, moderately high-carbohydrate diet (55% of total energy intake), a situation stimulating hepatic lipogenesis, and observed a TAG-lowering action of inulin related, as in animal studies, to a reduction of hepatic lipogenesis. The diet spontaneously consumed by the subjects investigated in the present study contained less carbohydrate (40%-47% of total energy intake instead of 55%) and more lipids (35%-43% instead of 30%), and in this situation we observed no effects of inulin-type fructans on hepatic lipogenesis or plasma TAG levels.

In the present study, the modifications of plasma cholesterol concentrations observed during the administration of fructans or placebo were not significantly different. Cholesterol synthetic rates and the expression of key regulatory genes of cholesterol metabolism were also unchanged. Therefore, we detected no significant effect of fructans on cholesterol metabolism. However, we investigated a small number of subjects and we cannot rule out that we failed to detect a small favorable effect of fructans on cholesterol levels. Actually, based on the present data and assuming that the small difference in the evolution of plasma cholesterol levels between the placebo and fructans groups represents a true, significant effect of fructans, it can be calculated that a study with a 0.95 power to detect such difference would need more than 100 subjects in each group. Such a study would be difficult to conduct, and any effect of fructans, if actually present, would be limited. We used a low dose of fructans in the present study. Previous studies using higher doses of fructans (14-20 g) in normolipidemic humans found no effect [9]. It thus unlikely that we would have observed a significant effect if we had used a higher dose. Actually, of all previous studies in healthy, normolipidemic subjects, only the study of Brighenti et al [11], using a small dose of fructans (9 g), reported a moderate beneficial effect of fructans on plasma cholesterol level. In this study, however, the cholesterol concentrations observed at the end of the period of inulin administration, although lower than the basal values, were not different from the values observed at the end of a placebo period. The hypocholesterolemic effect of inulin reported in the study of Brighenti et al also thus appears limited.

In conclusion, we found no beneficial effects on plasma lipid concentrations of a 6-month administration of inulin-type fructans in healthy subjects consuming their usual diet and we observed no significant modifications of all the parameters of TAG and cholesterol metabolism investigated. Therefore, the beneficial effects on plasma lipids observed in previous studies during short-term administration of inulin-type fructans [10,11] do not seem to persist on a long-term basis, at least in normolipidemic subjects. Our results strongly suggest that fructans are less efficient in reducing plasma lipid levels than other dietary supplements such as other fibers or n-3 fatty acids [37,38]. However, their

possible beneficial effects in hyperlipidemic subjects remain to be investigated.

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