Food patterns in intake of dietary fibre in small group of Croatian adults

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Summary

The aim of this study was to determine the intake of total dietary fibre, soluble and insoluble dietary fibre, as well as their food sources. Additionally, a relationship between dietary fibre intake and intake of foods that do not contain dietary fibre was examined. Forty-five adult subjects (22-52 yr; 28 women and 17 men) took part in the study. A method of 7-day weighed dietary records was used. An average daily total dietary fibre intake for the whole group was 21.0 g, i.e. 2.6 g/MJ. The mean soluble dietary fibre intake was 7.5 g. Cereals and products made the greatest contribution to daily dietary fibre intake (45% total, 53% soluble and 40% insoluble dietary fibre). This group of subjects had a mean daily consumption of fruits and vegetables of 482 g, and 241 g of cereals. Aside to an expected higher intake of fruits, vegetables and cereals, subjects with high intake of total dietary fibre (4th quartile), also had a higher intake of meat and products and fats and oils, as opposed to subjects from the lowest quartile of total dietary fibre intake. Daily intake of total dietary fibre is best correlated with intakes of vegetables (without potatoes) and cereals.

Keywords: daily intake, dietary fibre, eastern Croatia, food groups, weighed dietary records

Introduction

Inadequate provision of dietary fibre (DF) is one of the most important factors in a noticeable rise in nutrition-related disorders over the last few decades (Jansen et al., 1999; Le Marchand et al., 1997; Aldoori et al., 1998; Meyer et al., 2000; Wolk et al., 1999; Rimm et al., 1996). Most experts recommend between 20 and 35 g DF per day i.e. 2.4-3.1 g/MJ (Position of ADA, 1997) for adults. The lowest DF intake believed to prevent chronic diseases is 25 g/day (Shikany et al., 2000). In 2002, the Food and Nutrition Board of the American National Academy of Sciences Research Council issued Dietary Reference Intakes (DRI) for fibre. Their recommendations range between 21 and 38 g/day for adults depending on gender (www.nap.edu, 2003). Main food sources of DF are vegetables, fruits and cereals, primarily whole-grain products. At the same time, these foods deliver antioxidants and minerals which are also implicated in the protection against carcinogenesis (Shikany et al., 2000). Croatian food-based dietary guidelines recommend at least 400 g of fruits and vegetables (without potatoes) i.e. five or more servings per day in order to reach an adequate DF intake (Antonić Degač et al., 2002).

There are only sporadic data on intake of DF and contribution from foods in Croatia. A household survey determined intakes at the lower margin of recommendations (Cummings and Frólich, 1993). Contribution from cereals was very high, mainly above 60%, while vegetables contributed around 30%, and fruits up to 10%. The results of a questionnaire within the First Croatian Health Project showed that only 36% and 25% of subjects consumed fresh and cooked vegetables daily, respectively (Turek et al., 2001). Similar results were obtained for fruits.

The aim of this pilot study was to determine the daily dietary intake of DF and foods which are sources of DF using the method of weighed dietary records in a small-size adult population sample from eastern Croatia. In addition to this, the origin of the DF in food as well as the connection between DF intake and intakes of food groups not contributing to DF intake (meat, fish, eggs, milk and dairy products, fats, and sugar and confectionery), was examined.

Materials and Methods

Subjects

A total of 45 volunteers (students and staff of the Faculty of Food Technology in Osijek) (28 women and 17 men; mean age 34.3 yr; range 22-52 yr), were recruited. 29 of them were of normal weight (mean BMI 22.0 kg/m^2) and 16 participants were overweight (mean BMI 27.3 kg/m^2). The highest number of participants had academic education, and those of lowest education were at least with high school level. Investigation was carried out over a

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period of seven subsequent days during August and September.

Methods

Seven-day weighed dietary records were used to estimate daily intake of energy, DF and different food groups. Following initial instructions, the weighed dietary records were carried out by the subjects who were in close contact with trained interviewers for any further information. Subjects were asked to weigh or measure and record on provided forms all they ate (only the edible part) and drank over the course of a day during a 7-day period. The amounts were expressed as grams (e.g. steak, bread, sauce, salad), or decilitres (e.g. milk, juice), and the subjects were asked to give details (recipes) on the preparation of composite meals (e.g. cooked beans with or without meat or cake). Estimation of food consumed outside the house involved use of standard kitchen measures like coffee cup (1 dl), 2 dl glass, slice, etc. Subjects were also instructed not to change their usual nutritional habits during the study period. Following collection of all 7-day records, the forms were checked and any uncertainties were cleared with the subjects. Types and quantities of consumed foods were entered into a computer program NP-2 (KPS), on the basis of which were calculated daily intakes of DF, energy and different food groups (vegetables, fruits, cereal products, meat, fish, eggs, milk and dairy products, fats, and sugar and confectionery). The program is mainly based upon the Croatian food tables (Kaić-Rak and Antonić, 1990) which contain data for nutritional composition of 580 items, and partly from the data of some other national food tables. Content of insoluble (IDF) and soluble (SDF), as well as total dietary fibre (TDF), was calculated using German food tables (Souci et al., 1989). In addition to nutritional composition of foods, the computer program enables entering recipes for composite meals. Most of the recipes were taken from Croatian cookbooks (Brodarec, 1975), but some (for specific meals) were also obtained from the subjects, as already mentioned above.

Data analysis

Data analysis was performed using computer programs Microsoft Excel 2003 (Microsoft Corp.) and Statistica 8.0 (Statsoft Inc.). Means and range values for daily intake of DF, energy and food groups, were calculated. Contribution of different food groups (vegetables, legumes, fruits, and cereals) to DF intakes was examined as well. Subjects were classified according to quartiles of TDF intake (g/day), and difference between subjects in highest and lowest quartile (calculated using formula $(Q_4 - Q_1)$ x 100 / Q_1) was evaluated. Pearson correlation coefficients were used to examine relationship between daily intake of energy, certain food groups and daily intake of DF. Values were previously log-transformed to improve normality of distribution.

Results and Discussion

Table 1 shows daily intake of DF (total, soluble and insoluble) and energy, as determined by 7-day weighed dietary records. Great individual variations in results could be ascribed to the heterogeneity of the study group. Men had significantly higher ($p<0.01$) intakes of IDF and SDF and TDF ($p<0.05$), compared to women. Moreover, a significant difference was noted between normal weight and overweight (BMI≥25) subjects (19.8 vs. 23.1 g/day, $p<0.05$). Average daily intake of TDF for the whole group was 21.0 g (Table 1), which is similar to the above mentioned Croatian household survey (Cummings and Frólich, 1993). Workers from other countries, using similarly methodology (mostly non-weighed dietary records), reported either comparable (Germany (Mensink et al., 2001), Ireland (Galvin et al., 2001), UK (Brunner et al., 2001), Denmark (Haraldsdóttir, 1999)), or lower (Canada (Jain and Mclaughlin, 2000), US (Patterson et al., 1999)) results. In Italy and France the TDF intake was way below recommended values (Cummings and Frólich, 1993; Saba et al., 1995). If TDF intake is expressed in g/MJ, the provision in this group of subjects might be considered satisfactory, contrary to studies from Denmark (Haraldsdóttir and Andersen, 1994; Haraldsdóttir, 1999), Ireland (Galvin et al., 2001) or Sweden (Becker, 1999). A satisfactory intake of at least 20 g/day was established in 77% of male and 39% of female subjects. Better insight is given if absolute DF intake is looked together with the determined energy intake for the subjects, than 75% of women and 88% of men had an adequate (i.e. above recommendations; 2.4 g/MJ) intake.

The recommendations for TDF intake are based on their disease preventing properties (Johnson and Southgate, 1994). Such diseases include colorectal cancer (Jansen et al., 1999; Le Marchand et al., 1997), diabetes (Meyer et al., 2000; Salmerón et al., 1997), and coronary heart diseases (Wolk et al., 1999; Rimm et al., 1996; Jenkins et al., 2001). However, the numerous compounds implied under the name DF have different physiological actions in the organism (Oku, 1992; Read and Eastwood, 1992), which stresses the importance of awareness of the intake of SDF and IDF (Shikany et al., 2000;

Nishimune et al., 1996). According to the recommended SDF intake by the American Dietetic Association of 5-10 g/day (www.eatright.org, 2001), most of the present subjects had an adequate intake, only 14% women consumed <5 g/day SDF. Almost all major food sources of DF have a bigger fraction of insoluble fibre, resulting in IDF fraction of up to ¾ TDF in a mixed diet (Position of ADA, 1997). The mean fraction of IDF in this group was 64%, which gives an IDF/SDF ratio of 1.8.

Table 1. Mean daily intake of energy and dietary fibre

Nutrient	Women (n = 28)		Men (n = 17)		Overall (n = 45)		p-values
	Mean	Min. – Max.	Mean	Min. – Max.	Mean	Min. – Max.	
Energy (MJ)	7.6	4.8 – 10.8	8.9	6.0 – 12.3	8.1	4.8 – 12.3	<0.05
SDF (g)	6.9	3.6 – 11.0	8.5	5.5 – 11.8	7.5	3.6 – 11.8	<0.05
IDF (g)	12.3	6.5 – 18.2	15.3	8.8 – 21.3	13.5	6.5 – 21.3	<0.01
TDF (g)	19.2	11.0 – 28.1	23.9	15.0 – 32.3	21.0	11.0 – 32.3	<0.05
TDF (g/MJ)	2.6	1.8 – 3.5	2.7	1.8 – 4.3	2.6	1.8 – 4.3	ns
IDF/SDF	1.8	1.4 – 2.6	1.8	1.1 – 2.4	1.8	1.1 – 2.6	ns

SDF - soluble dietary fibre; IDF - insoluble dietary fibre; TDF - total dietary fibre

p-values - differences between women and men obtained by Mann - Whitney test; ns difference not significant

Contribution of different food groups to TDF, SDF and IDF intakes are presented in Fig. 1. Cereals contributed the greatest share to TDF intake (45%) which is a consequence of their common occurrence in the diet in Croatia, but also due to their comparatively high content of DF. The present findings corroborate previous studies. However, there are considerable region-specific variations. For example, in Scandinavian countries cereals make around 60% TDF intake, while around Mediterranean the contribution from cereals is around 40% (Cummings and Frólich, 1993). Furthermore, our results indicate that cereals had a greater share in daily SDF compared to IDF intake (53% vs. 40%). The ratio of IDF and SDF from cereals of 1.4 points to a prevalent consumption of refined products in this group.

Vegetables including potatoes were the second best source of TDF (28%) (Fig. 1). Most of the vegetable DF comes from potato, i.e. 25%, 29% and 24% of TDF, SDF and IDF, respectively. Fruits make 21% of TDF intake and the contribution is similar in SDF and IDF intake. Comparing contribution to TDF intake by food groups in this study, with data obtained in the Croatian household survey (Cummings and Frólich, 1993), different nutritional habits were noted. A smaller fraction of TDF from cereals, and more fibre from fruits characterised the present group of subjects.

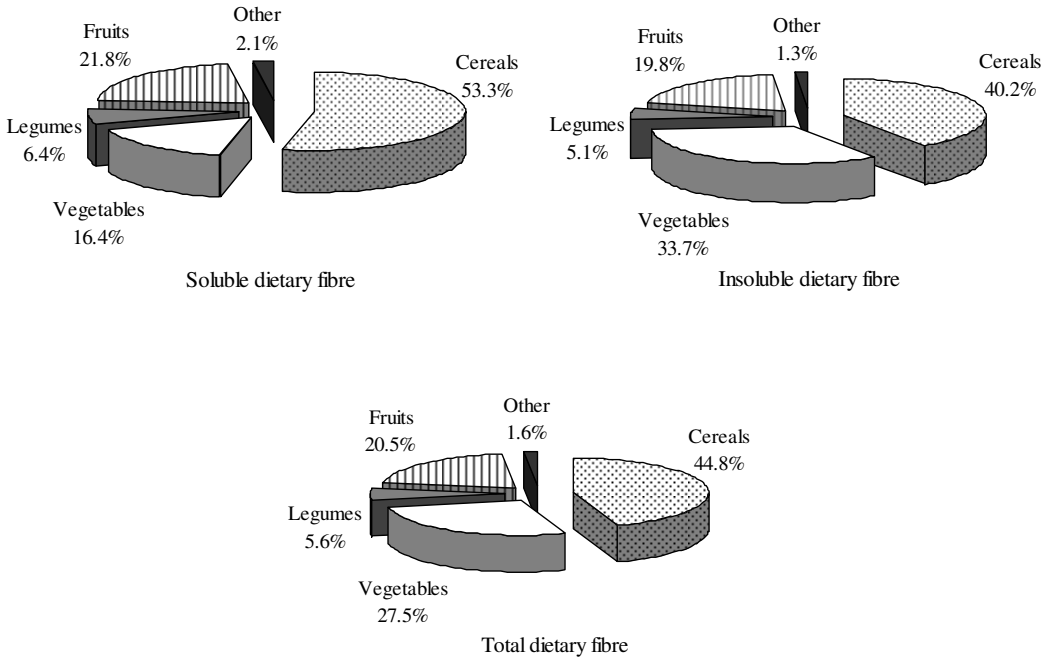

Fig. 1 Contribution of different food groups to total, soluble and insoluble dietary fibre intake

Daily intake of foods which are sources of DF is presented in Table 2. Men had higher intakes of all food groups but the difference was only statistically significant for legumes ($p<0.001$) and cereals ($p<0.05$). Bakery products were the greatest contributor (74%) to cereal intake (g/day) (value obtained from the row dietary intake data by calculation). Altogether, daily intake of cereal products in this group is within the range of values established in several European countries (Haraldsdóttir, 1999; Turrini and Lombardi-Boccia, 2002; Winkler et al., 1992). On the other hand, Spain and Baltic countries had a considerably lower intake (Aranceta et al., 1998; Pomerleau et al., 2001). Whole grain cereals, aside to being an indispensable source of TDF, and especially IDF, also contain many other phytochemicals some of which are thought of as capable of reducing incidence of chronic diseases (Jacobs et al., 1999; Jones et al., 2002; Mckeown et al., 2002). The identified prevalent share of refined cereals in this group of subjects most probably reduces protective effect of such products, as has been suggested before (Jones et al., 2002; Slavin et al., 2001).

Table 2. Mean daily intake of selected food groups

Food groups (g)	Women (n = 28)		Men (n = 17)		Overall (n = 45)		p-values
	Mean	Min. – Max.	Mean	Min. – Max.	Mean	Min. – Max.	
Vegetables	193	59 - 357	228	51 – 516	206	51 – 516	ns
Potatoes	55	14 - 120	65	12 – 139	58	12 – 139	ns
Legumes	10	0 - 40	27	10 - 59	17	0 – 59	<0.001
Fruits	253	6 – 742	268	32 - 586	259	6 – 742	ns
Cereals	221	104 - 403	272	121 - 357	241	104 - 403	<0.05

p-values - differences between women and men obtained by Mann - Whitney test; ns difference not significant

Mean intake of vegetables (without potatoes) and fruits of 482 g (women: 456 g, men: 523 g) is in agreement with recommendations. Percentage of subjects with mean intake of vegetables (without potatoes) and fruits of <400 g/day was 46% in the female, and 29% in the male subgroup. Supply of fruits and vegetables in the present study group, although not as desirable as in the Mediterranean countries, is still higher than in most other European countries. The World Health Survey (WHS) which was administered in 70 countries in 2002–2003 estimated that nowadays only a small number of people from low- and middle-income countries consume the recommended intake of fruits and vegetables (Hall et al., 2009). Data Food Networking (DAFNE) Project, carried out between 1987 and 1995 in ten European countries, determined an insufficient intake of vegetables (<250 g/day without potatoes) in most countries (Naska et al., 2000), while only three countries having a fruit intake below recommended 150 g/day. In 1998, only 6 of the 14 WHO regions had an availability of fruits and vegetables equal to or greater than the recommended intake of 400 g per capita per day (Report of Joint FAO/WHO Expert Consultation, 2003).

Present subjects of both sexes consumed more fruit than vegetables, although the intake of fruit was below recommended 150 g/day in 36% female and 29% male subjects. It is in agreement with a study on a sample of Croatian adolescents, which showed a similar pattern in fruit and vegetables consumption, in addition to an unsatisfactory mean overall intake (Colić Barić et al., 2000). A body of epidemiological evidence indicates protective role of fruits and vegetables against diabetes, cancer and cardiovascular disease (Ford and Mokdad, 2001; La Vecchia et al., 2001; Bazzano et al., 2002; John et al., 2002), and they might also be an important factor in the lesser incidence of chronic diseases around the Mediterranean (Bes-Rastrollo et al., 2006; Kushi et al., 1995).

Relationship between daily intakes of different food groups and TDF intake (g) (quartiles of TDF intake) is given in Table 3. Apparently, subjects consuming more DF simultaneously consume more meat, fats and oils and certain food groups which are sources of DF. Comparison of extreme quartiles of TDF intake showed that subjects in the high-fibre quartile had higher intake of meat (by 79%), fats and oils (by 52%), cereals (by 69%), vegetables (by 108%), potatoes (by 35%), legumes (by 211%), fruits (by 102%). These results may be explained by a significantly higher mean BMI-value of the subjects in the fourth quartile compared to the subjects in the first quartile (25.2 vs. 21.5 kg/m^2, $p<0.05$). Additionally, an association between subjects BMI and food intake was established ($r=0.30$, $p<0.05$).

The results of the correlation analysis are presented in Table 4. Very good correlation was established between daily TDF intake and intake of vegetables without potatoes. Intake of cereal products is less well correlated, presumably because most of the

consumed foods from this group were produced from refined cereals. Relationship between intakes of fruits and TDF was probably affected by the high average intake of watermelon (21% total fruit intake), on account of their low fibre content (Souci et al., 1989). SDF intake is best correlated with cereal intake, as opposed to IDF, the intake of which shows similar association with the intake of vegetables without potatoes (Table 4).

Table 3. Mean daily intake of selected food groups by the quartile of consumption of dietary fibre

	Total dietary fibre intake (g)			
	Quartiles			
Food groups (g)	1 cut-off < 16.0	2 16.0 – 20.6	3 20.7 – 25.3	4 cut-off > 25.3
Vegetables	131	170	257	272
Potatoes	48	57	62	65
Legumes	9	14	14	28
Fruits	169	197	342	342
Cereals	182	241	215	308
Meat (products)	80	96	100	143
Fish	5	18	9	11
Milk (products)	221	250	315	285
Eggs	19	16	12	22
Fats and oils	25	31	32	38
Sugar and sweets	23	23	33	26

Table 4. Pearson correlation coefficients between intake of selected food groups and intake (g/day) of dietary fibre

Food groups (g /day)	SDF	IDF	TDF
Vegetables	0.40 [b]	0.70 [c]	0.61 [c]
Potatoes	0.25 [ns]	0.30 [a]	0.29 [ns]
Legumes	0.21 [ns]	0.24 [ns]	0.24 [ns]
Fruits	0.35 [a]	0.40 [b]	0.39 [b]
Cereals	0.64 [c]	0.44 [b]	0.54 [c]

SDF - soluble dietary fibre; IDF - insoluble dietary fibre; TDF - total dietary fibre; a $p<0.05$; b $p<0.01$; c $p<0.001$; ns difference not significant

Conclusions

The mean daily intake of TDF in this group of subjects is in accordance with recommendations. The mean intake of SDF is completely satisfactory. Still, since the obtained values are not much higher than the recommendations, these results should be taken with the caution due to the fact that there are many factors (level of education, sex, study period) which could contribute to the higher intake of TDF as well as SDF. To obtain a better insight into DF intake wider study, with higher number of participants, which will be repeated in different seasons, is needed.

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