JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY

Dietary Fiber Intake in Two European Diets with High (Copenhagen, Denmark) and Low (Murcia, Spain) Colorectal Cancer Incidence

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Contradictory results have been reported in studies associating dietary fiber (DF) intake and the incidence of colorectal cancer. Most studies focused mainly on the amount of total DF, but DF is a heterogeneous complex and its components are generally ignored. The aim of this work was to compare the amount and composition of DF intake in Murcia (Spain) and Copenhagen (Denmark). Total dietary fiber intake was a 31% higher in Murcia than in Copenhagen, the ratio of insoluble DF/soluble DF being similar in the two diets. DF in Murcia contains major amounts of nonstarch polysaccharides and polyphenolic compounds, mainly derived from the high consumption of fruits and vegetables (6.7 servings). Resistant starch intake was of the same order in the two regions while resistant protein intake was higher in Murcia. The quantitative and qualitative differences in DF intake may contribute to understand the differences in colorectal cancer incidence in Mediterranean and Scandinavian areas.

KEYWORDS: Dietary fiber; Mediterranean diet; Scandinavian diet; colorectal cancer; indigestible polysaccharides; indigestible protein

INTRODUCTION

Considered globally, colorectal cancer (CRC) is second in terms of cancer-related deaths (*1*). Locally, North America, Australia, Japan, and Europe are the geographical areas where the incidence and mortality rate from CRC are the highest. Within Europe, the Mediterranean countries have a lower incidence of CRC while the highest rates are found in the Scandinavian countries and the United Kingdom (*2*). The lowest rate of incidence in the year 2000 in Europe was found in Greece (European age standardized rate 24.2) while Denmark had the highest rate (European age standardized incidence rate 51.8). European countries with a Mediterranean coastline like France (*3*) and Spain (*4*) exhibited regional variations in the incidence of CRC, with lower incidence in the southern (Mediterranean) areas. Murcia, a region of Spain located on the Mediterranean coast, presented the lowest mortality rate of CRC in the Spanish peninsular area (European age standardized rate 17.74). The CRC incidence rate was in the same order to that reported in Greece (27.6 for men and 26.3 for women).

It has been estimated that as many as 70% of the CRC may be due to dietary and lifestyle factors (*5*) and that an optimal dietary approach might prevent the occurrence and development of that disease. Therefore, local CRC incidence differences may be related to dietary patterns, among other factors. Citizens of Murcia tend to be strict followers of the Mediterranean diet (*6*), and the inhabitants of Copenhagen tend to follow a diet which could be considered typically Scandinavian.

Dietary fiber (DF) was selected as one of the main dietary factors for primary CRC prevention (*7*). From the initial protective hypothesis based on the bulking effect of DF (*8*), numerous studies have added more value to the colorectal anticarcinogenic and antiinflammatory effects of DF (*9*). Nevertheless, nonsubstantial evidence has been obtained in prevention of adenoma recurrence trials (*10*), and contradictory results have been described by epidemiological studies when potential protective effects are associated with a specific source of DF, mainly cereals, fruits, and vegetables (*11–14*).

These contradictory results could stem from methodological and conceptual mistakes concerning DF analysis. Most trials generally only consider the total amount of DF, ignoring its components. However, DF is a heterogeneous complex, and its potential physiological effects are derived from its components. The ratio of soluble and nonsoluble nonstarch polysaccharides present in DF determines its fermentation characteristics; for example, resistant starch increases butyrate production (*15*) whereas oligosaccharides modulate functions of the gut immune system (*16*). Minor components associated with DF as well as their fermentative derivates may exhibit protective effects as antioxidants (*17, 18*) and antimutagenic compounds (*19*). On the other hand, when fermentative substrates are scarce, resistant protein is fermented by microbiota, resulting in potentially harmful fermentation products such as ammonia, amines, *p*-cresol, and phenyl and indole derivates (*20*). Therefore, it has

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10.1021/jf072146o CCC: $37.00
Published on Web 10/12/2007

Table 1. Daily Intake of Plant Foods in Diets from Murcia and Copenhagen

		daily intake	
		Murcia (g/day per person)	Copenhagen (g/day per person)
(a) Starchy Foods			
starchy foods		318.28	373.84
cereals	bread	111.84	156.66
	crisp bread	6.02	2.97
	sweet buns	43.43	32.08
	sweet biscuits	10.39	5.73
	breakfast cereals	0.53	19.50
	snacks	42.36	32.98
	pasta and rice	1.30	3.36
potatoes		75.15	83.03
legumes	beans, chickpeas, and lentils	27.25	1.14
(b) Nonstarchy Foods			
nonstarchy foods		651.66	291.28
leafy vegetable	borage, chard, endive, lettuce, spinach, and thistle	29.71	11.10
fruity vegetable	aubergine, cucumber, pepper, pumpkin, and tomato	151.33	53.04
root vegetable	beetroot, carrot, celery, radish, salsify, and turnip	11.72	25.10
brassicaceae	broccoli, Brussels sprouts, cabbage, cauliflower, and kale	15.42	18.24
allium	onion and garlic	39.39	12.07
fruits	high consumed (orange, pear, banana, apple)[a]	233.01	83.97
	low consumed (apricot, cherry, fig, grape, kiwi, melon, nectarine, peach, tangerine, pineapple, plum, and strawberry)	168.73	80.68
chocolate		2.35	7.14

[a] Based in EPIC (*23*), highly consumed fruits in Spain were apple, orange, and pear (26%, 20%, and 12% of the total fruit intake, respectively) and apple, banana, and orange in the Danish diet (29%, 12%, and 10% of the total fruit intake, respectively).

been proposed that individual contributors of DF should be described (*21*).

The aim of this work was to compare the amount and composition of daily ingested DF in the diets from Murcia and Copenhagen.

MATERIALS AND METHODS

Samples and Dietary Information. Estimates of plant food consumption in the selected diets, Murcia and Copenhagen, were based on the European Prospective into Cancer and Nutrition (EPIC) (*22, 23*). This interlaboratory study, designed to look at the relationship between diet and incidence of cancer, summarizes food intake data in 10 European countries. During 5 years and using 24 h recalls, the dietary habits of 13031 men and 22924 women from 35 to 74 years of age were collected. Dietary intake included in **Table 1** corresponds to the plant food intake in the diets from Murcia and Copenhagen calculated as an average of the intake data of men and women of starchy (**Table 1a**) and nonstarchy foods (**Table 1b**).

Plant foods were locally acquired in Danish and Spanish markets, and the edible portion of each plant food as eaten (raw or cooked) was freeze-dried and milled. In the fruits and cereals groups, portions were kept as described by the intake data (*22, 23*) using brown bread (“Schwarzbrot”; Bolderslev, Denmark/Kohberg Brod A/S) for Copenhagen and refined wheat flour bread (“Pan rustico”; S.L. Madrid) for Murcia. Fruits were divided in two groups according to the country intake data described by the EPIC. Highly consumed samples in Denmark were apple (29%), banana (12%), and orange (10%), while the most consumed in Spain were apple (26%), orange (20%), and pear (12%). These ratios were maintained to prepare the samples, and the rest of the fruits classified as low consumed fruits were prepared using equal amounts of fresh produce. Due to the lack of detailed intake information, the vegetable and legume groups were prepared using the same amount of edible food portion.

As the digestibility of starch may be altered due to interaction with other compounds such as protein, fat, and enzymatic inhibitors (*24*), plant food components were grouped as starchy (**Table 1a**) and nonstarchy foods (**Table 1b**) in the diets of Murcia and Copenhagen.

Estimation of Dietary Constituents. Food consumption data reported by the EPIC (*22, 23, 25–28*) were used to estimate the energy and nutrient intake in both diets. Dietary evaluation and nutritional characteristics were analyzed using the DIAL software system (*29*).

Total phenolic content in both diets was measured in aqueous–organic extractions of the plant food constituents by Folin–Ciocalteu assay (*30*).

Dietary Fiber Determination. The DF of starchy and nonstarchy foods consumed in Murcia and Copenhagen was measured on the basis of the procedure described by Saura-Calixto et al. (*31*) with some modifications to analyze DF components. This method combines enzymatic treatments and separation of digestible compounds by dialysis using physiological conditions (temperature and pHs), obtaining the fraction of food that is not digested and reaches the large intestine where it is susceptible to fermentation by colonic microbiota.

Total DF was calculated as the sum of insoluble DF components (resistant starch, insoluble nonstarch polysaccharides (iNSP), Klason lignin, insoluble resistant protein, ash, proanthocyanidins, and hydrolyzable phenols) plus soluble DF components [soluble nonstarch polysaccharides (sNSP), soluble protein, and soluble polyphenolic compounds].

Samples (300 mg) were incubated with pepsin (EC 3.4.23.1; 0.2 mL of a 300 mg/mL solution in 0.2 M HCl–KCl buffer, pH 1.5, 40 °C, 1 h, Merck 7190), pancreatin (1 mL of a 5 mg/mL solution in 0.1 M phosphate buffer, pH 7.5, 37 °C, 6 h, Sigma P-1750), lipase (EC 3.1.1.3; 2 mL of a 7 mg/mL solution in 0.1 M phosphate buffer, pH 7.5, 37 °C, 6 h, Sigma L-3126), bile extract porcine (2 mL of a 17.5 mg/mL solution in 0.1 M phosphate buffer, pH 7.5, 37 °C, 6 h, Sigma B-8631), and α-amylase (EC 3.2.1.1; 1 mL of a 120 mg/mL solution in 0.1 M Tris–maleate buffer, pH 6.9, 37 °C, 16 h, Sigma A-3176). Samples were centrifuged (15 min, 3000*g*) and supernatants removed. Residues were washed twice with 5 mL of distilled water, and all supernatants were combined. Each supernatant was incubated with 100 μL of amyloglucosidase (EC 3.2.1.3; Roche, 102857) for 45 min at 60 °C before being transferred to dialysis tubes (12000−14000 molecular weight cutoff, Visking dialysis tubing; Medicell International Ltd., London, U.K.) and dialyzed against water for 48 h at 25 °C to eliminate digestible compounds.

Soluble resistant protein contained in the retentate was measured by the Bradford assay (*32*) using bovine albumin as a standard and soluble indigestible phenolic content by the Folin–Ciocalteu method (*30*), and results were expressed as gallic acid equivalents (GAE). sNSP were hydrolyzed with 1 M sulfuric acid at 100 °C for 90 min and

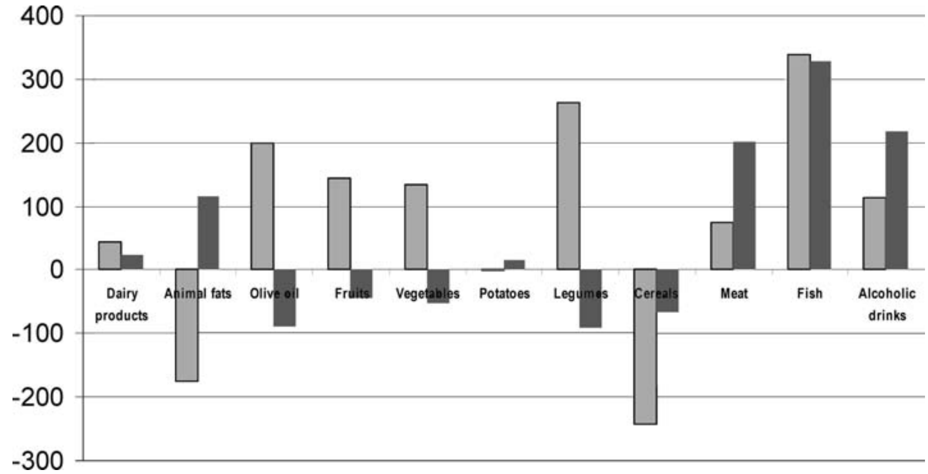

Figure 1. Comparison of the diets from Murcia and Copenhagen with the European average food intake. Average food intake data from 10 European diets (point 0) based in the EPIC data. Diet from Murcia (light gray bars). Diet from Copenhagen (dark gray bars).

spectrophotometrically measured after alkalinization with NaOH (3.9 M) and reaction with dinitrosalicylic acid (*33*).

The residues were dried and stored for resistant starch, iNSP, Klason lignin, insoluble resistant protein, ash, proanthocyanidins, and hydrolyzable phenol analysis.

Resistant starch was analyzed according to the method described by Goñi et al. (*34*) measuring the glucose released after a basic treatment with KOH. iNSP and Klason lignin were determined according to the method described by the AOAC (*35*). The insoluble dietary fiber was treated with sulfuric acid (12 M H_2SO_4, 20 °C for 3 h; dilution to 1 M H_2SO_4; and refluxing for 2 h, 100 °C), and iNSP were determined spectrophotometrically as sugars and uronic acid with dinitrosalicylic acid (*33*). Klason lignin was determined gravimetrically.

Proanthocyanidins (condensed tannins) and hydrolyzable phenols associated to insoluble dietary fiber were analyzed. Proanthocyanidins were measured at 555 nm after hydrolysis with HCl (5%) in 1-butanol (3 h, 100 °C) (*36*). Results were compared with carob pod (*Ceratonia siliqua*) proanthocyanidin standard (Nestlé, Ltd., Vers-Chez-les Blanes, Switzerland). Hydrolyzable phenols were measured according to the method described by Hartzfeld (*37*) by hydrolysis with methanol and sulfuric acid for 20 h at 85 °C. Concentration was estimated by the Folin–Ciocalteu method (*30*) and expressed as GAE.

Insoluble resistant protein was determined using an automated nitrogen analyzer (FP-2000; Dumas Leco Corp., St. Joseph, MI) as described in the literature (*18*). Protein was calculated as $N \times 6.25$. Ash was analyzed gravimetrically after a burning treatment (550 °C) of the insoluble dietary fiber (*18*).

Results were expressed as percentage terms of the edible portion dry matter.

Statistic Analysis. Determinations were performed in triplicate for each sample. Results are expressed as mean values with the corresponding standard deviation (SD). Comparison of the means of three measurements using a significant level of $P < 0.05$ was performed by Student's *t*-test analysis using the Statgraphics Computer System version 5.1.

RESULTS AND DISCUSSION

Diets from Murcia and Copenhagen. Of the five Spanish centers interviewed during the EPIC data collection, Murcia was the one which most strictly adhered to the Mediterranean diet (*6*). As **Figure 1** shows, the intake of fruits, vegetables, legumes, fish, and vegetable oil (principally, olive oil) was higher than the European average. Alcoholic beverages were also highly consumed; nevertheless, cereal and animal fat were consumed in lower amounts than the European average. In the Danish diet, sources of lipids were cream, margarine, and mayonnaise, the intake of olive oil was lower than the European average, as was the daily intake of fruits and vegetables. The intake of alcoholic beverages, fish, and meat was notably high.

Table 2. Nutritional Value of the Diets from Murcia and Copenhagen

	Murcia	Copenhagen
energy (kcal/day)	2171	2339
carbohydrates (g/day)	242	247
vegetal protein (g/day)	30.2	24.25
animal protein (g/day)	44.4	58.25
fats (g/day)	82.6	89.7
monounsaturated/saturated lipids	1.5	0.8
alcohol (g/day)	16	23.7
vitamin C (mg/day)	142	105
vitamin E (mg/day)	8.1	6.5
calcium (mg/day)	822	1055
selenium (μg/day)	95.5	126
carotenoids (μg/day)	1590	1007
polyphenolic compounds (mg/day)	1666	1304
dietary fiber (g/day)	16.3	18.5

Several dietary factors were related in assessing the risk of CRC, and as summarized in **Table 2**, intake in both diets was estimated using specialized dietary evaluation software (*29*). Total energy intake consumed did not differ substantially (2339 kcal in Copenhagen and 2171 kcal in Murcia). However, lipid profile intake was different for the two populations, the Copenhagen diet being rich in saturated and polyunsaturated fatty acids, while monounsaturated fatty acids were the most abundant in the Murcia diet. A monounsaturated/saturated lipid ratio of around 1.7 has been related with a low mortality due to chronic diseases (*38*).

The Murcia diet contains 6.7 servings of fruits and vegetables daily while the amount consumed in Copenhagen was 3.6 servings per day. Animal protein intake is twice that of vegetal protein in Copenhagen, while in Murcia these two protein sources are similar. Antioxidant intake (carotenoids, polyphenols, and vitamins) was higher in the Murcia diet. A substantial amount of dietary antioxidants were associated with DF, thus becoming available for bacterial metabolism in the colon (*17, 18*). The antioxidant environment created in the colon and metabolites from colonic fermentation may be key factors in the prevention of CRC. Calcium and selenium, which reduce the recurrence of adenoma in voluntaries (*10*, *39*), were more abundant in the diet from Copenhagen.

DF intake estimated by food composition tables was lower in the case of the diet from Murcia (soluble DF 6.4 g/day and insoluble DF 9.9 g/day) as compared to the diet from Copenhagen (soluble DF 5 g/day and insoluble DF 13.5 g/day). It has been reported that traditional methodology used in measuring

Table 3. DF Composition of Starchy Foods (mg/100 mg Dry Weight)

starchy foods	Murcia (mg/100 mg)	Copenhagen (mg/100 mg)
insoluble DF	8.79 ± 0.30	9.14 ± 0.36
resistant starch	1.24 ± 0.05	1.60 ± 0.08
iNSP	0.75 ± 0.07	1.63 ± 0.08
resistant protein	4.78 ± 0.11	4.24 ± 0.09
Klason lignin	0.61 ± 0.26	0.42 ± 0.27
ash	1.07 ± 0.04	0.92 ± 0.15
hydrolyzable phenols	0.20 ± 0.01	0.33 ± 0.02
proanthocyanidins	0.14 ± 0.01	nm
soluble DF	3.67 ± 0.18	4.85 ± 0.20
sNSP	2.73 ± 0.17	4.03 ± 0.20
soluble protein	0.76 ± 0.01	0.64 ± 0.01
polyphenols	0.17 ± 0.01	0.18 ± 0.01
total DF	12.46 ± 0.35	13.99 ± 0.41

Table 4. DF Composition of Nonstarchy Foods (mg/100 mg Dry Weight)

nonstarchy foods	Murcia (mg/100 mg)	Copenhagen (mg/100 mg)
insoluble DF	17.86 ± 0.88	17.16 ± 0.62
resistant starch	0.50 ± 0.02	0.14 ± 0.01
iNSP	7.68 ± 0.48	6.75 ± 0.52
resistant protein	3.15 ± 0.23	3.41 ± 0.10
Klason lignin	2.27 ± 0.67	3.14 ± 0.30
ash	2.63 ± 0.19	1.87 ± 0.05
hydrolyzable phenols	0.38 ± 0.01	0.45 ± 0.02
condensed tannins	1.25 ± 0.11	1.40 ± 0.02
soluble DF	5.44 ± 0.33	2.59 ± 0.37
sNSP	5.01 ± 0.33	2.10 ± 0.37
soluble protein	0.22 ± 0.02	0.29 ± 0.02
polyphenols	0.21 ± 0.02	0.20 ± 0.03
total DF	23.29 ± 0.94	19.75 ± 0.72

DF may underestimate it (*40*). The methodology, and therefore the composition tables, probably overestimates the DF content of nonrefined cereals while underestimating the DF content of fruits and vegetables. Epidemiological and interventional studies relating CRC incidence and DF intake are frequently based on these composition tables, and therefore contradictory conclusions could be linked to the methodology behind these data.

As was already mentioned, in this work the DF as the portion of plant food that escapes digestion and reaches the large intestine (*41*) was analyzed using the indigestible fraction method (*31*), which is performed using physiological temperatures and pH, minimizing gelatinized starch and degradation of bioactive compounds.

Dietary Fiber Components. Starch digestibility may be altered by interaction with food compounds (gastric enzymatic inhibitors like tannins) and conditions of moisture and heat (by retrograded amylase). In order to minimize interactions, starchy and nonstarchy foods were analyzed separately, grouping the freeze-dried foods as described in **Table 1**. Subsequently, four samples were obtained: starchy foods from Murcia, starchy foods from Copenhagen, nonstarchy foods from Murcia, and nonstarchy foods from Copenhagen.

As **Table 3** shows, the total DF was higher in starchy foods from Copenhagen than in starchy foods from Murcia, as well as the insoluble and soluble DF, resistant starch, sNSP, and iNSP. The predominant food in both starchy samples was bread, which was made with nonrefined cereals in starchy foods from Copenhagen and refined wheat flour in starchy foods from Murcia. Soluble and insoluble protein content was significantly higher in the DF of starchy foods from Murcia. The high values of resistant protein and the presence of proanthocyanidins may be due to the intake of legumes in the Mediterranean diet (*42*). sNSP are rapidly fermented in the proximal colon while iNSP and lignin are slowly fermented and are the sole source of available carbohydrates in the distal colon. Soluble DF/insoluble DF ratios were high in both samples (30/70 in starchy foods from Murcia and 35/65 in starchy foods from Copenhagen), and therefore swift fermentation of both DF would be expected.

There were no significant differences between total DF from nonstarchy foods from Copenhagen and nonstarchy foods from Murcia (**Table 4**). Nevertheless, a difference in the soluble DF/insoluble DF ratio was observed (10/90 in nonstarchy foods from Copenhagen and 25/75 in nonstarchy foods from Murcia). Nonstarchy foods from Murcia contain higher amounts of pectin-rich foods such as fruits and fruity vegetables which may increase the portion of soluble DF of this sample and therefore its fermentability.

Total DF content was higher in nonstarchy foods than in starchy foods, mainly insoluble DF, iNSP, Klason lignin, ash, and associated polyphenols. Resistant starch content was higher in starchy samples than in nonstarchy samples. Resistant starch may have beneficial intestinal effects due to its high fermentability and its effect of increasing butyrate production (*15*).

It has been described that when carbohydrates are readily available, resistant protein could be used constitutively by the microbiota (*43*) contributing to an increase in bacterial biomass. It has been estimated that the human large intestine contains more than 100 g of bacterial biomass (*44*) from which 15 g is excreted daily (*45*); taking into account that bacteria composition is very rich in protein (comprising 55% of their dry matter) (*44*), approximately 8.25 g of resistant protein (dietary and host

Table 5. Daily Intake of DF in the Diets from Murcia and Copenhagen

	Murcia			Copenhagen		
	starchy foods, daily intake 318.3 (g/day per person)	nonstarchy foods, daily intake 651 .7 (g/day per person)	total, daily intake 969.95 (g/day per person)	starchy foods, daily intake 373.8 (g/day per person)	nonstarchy foods, daily intake 291.3 (g/day per person)	total, daily intake 665.1 (g/day per person)
insoluble DF	21.81	24.06	44.85	22.58	11.30	33.88
resistant starch	3.07	0.67	3.74	3.95	0.09	4.04
iNSP	1.85	10.35	12.20	4.03	4.45	8.47
resistant protein	11.88	4.24	16.12	10.47	2.44	12.91
Klason lignin	1.52	3.06	4.58	1.04	2.07	3.11
ash	2.65	3.54	6.19	2.27	1.23	3.50
hydrolyzable phenols	0.50	0.51	1.01	0.82	0.30	1.11
condensed tannins	0.35	1.68	2.03	0.00	0.92	0.92
soluble DF	9.10	7.33	16.44	11.98	1.71	13.69
sNSC	6.77	6.75	13.52	9.95	1.38	11.33
soluble protein	1.89	0.30	2.20	1.58	0.19	1.77
soluble phenols	0.43	0.28	0.71	0.45	0.13	0.59
total DF	30.91	31.39	62.30	34.56	13.00	47.56

derived) per day is needed to maintain the ecosystem turnover. Nevertheless, when fermentative substrates are scarce, resistant protein used as the energy source by microbiota results in potentially harmful fermentation products like ammonia, amines, *p*-cresol, and phenyl and indole derivates (*20*). On the basis of that assumption we use the relationship between milligrams of potentially fermentable carbohydrates versus milligrams of resistant protein (pfc/rp) as an index to estimate the quality of DF. The amount of dietary daily available carbohydrates and protein was estimated by Cummings and Macfarlane, which range between 22 and 82 and 6–18 g per day, respectively, resulting in a pfc/rp ratio of 3.6–4.6 (*44*).

On the basis of the results from **Tables 3** and **4**, the starchy foods from Copenhagen (pfc/rp = 1.32) would produce less protein fermentation metabolites than starchy foods from Murcia (pfc/rp = 0.75).

DF derived from nonstarchy foods could be considered as healthier than that derived from starchy foods, based on its higher ratios, pfc/rp = 3.67 (nonstarchy foods from Murcia) and pfc/rp = 2.25 (nonstarchy foods from Copenhagen). Additionally, concentrations of polyphenolic compounds associated to DF were higher in nonstarchy foods (around 2 mg/100 mg dry weight sample) than in starchy foods (0.5 mg/100 mg dry weight sample). These compounds may be released from the DF matrix by the action of microbiota metabolism counteracting the oxidative environment of colonic lumen (*46*). Moreover, metabolites derived from the fermentation of that compound exhibit antioxidant and antiproliferative properties (*19*).

Dietary Fiber Intake. On the basis of the daily intake data reported by the EPIC (**Table 1**), the daily DF intake was estimated for the Murcia and Copenhagen diets (**Table 5**) according to the results obtained through the indigestible fraction method.

The total daily DF intake was 31% higher in the diet of Murcia than in Copenhagen while the insoluble/soluble DF ratio was similar in the two diets (72/28). The estimate of DF intake may be slightly higher if oligosaccharides are included. The daily intake of nondigestible oligosaccharides has been estimated between 2 and 10 g per day (*44*).

The main sources of DF in Copenhagen were starchy foods (72.5% of the total) while in the Murcia diet both samples contributed equally. Similar results, as well as the daily intake of iNSP, were previously reported for the Copenhagen diet (*47*). It has also been estimated that around 60 g of fermentable nondigestible material is needed to maintain intestinal bacterial turnover (*44*). The total amount of nondigestible compounds provided by the Murcia diet is close to this value.

Potentially fermentable carbohydrates (29.5 g) and resistant protein (22.5 g) are provided on a daily basis by the Murcia diet, 5 and 6 g more respectively than provided by the Copenhagen diet. The daily intake of antioxidants (proanthocyanidins and polyphenols) associated with DF from Murcia is 1 g higher than that of the Copenhagen diet. Only the daily intake of resistant starch was slightly higher (0.3 g/day) in the Copenhagen diet as compared with the Murcia diet. These differences may be related to the role played by fruits and vegetables as sources of DF and which are potentially healthier than cereals and are more abundant in the diet from Murcia.

In conclusion, the quantitative and qualitative differences in DF intake between Murcia and Copenhagen may contribute to understand the differences in CRC incidence in Mediterranean and Scandinavian areas. Further research in this topic is needed.

ABBREVIATIONS USED

DF, dietary fiber; CRC, colorectal cancer; EPIC, European Prospective into Cancer and Nutrition; iNSP, insoluble nonstarch polysaccharides; sNSP, soluble nonstarch polysaccharides; GAE, gallic acid equivalents; SD, standard deviation; pfc/rp, potentially fermentable carbohydrates/resistant protein.

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Received for review July 18, 2007. Revised manuscript received September 10, 2007. Accepted September 13, 2007. The present research was performed under the financial support of the European Commission by the Marie Curie Action Number FP6-510585.

JF072146O