



Revisión

Consumption of functional foods in Europe; a systematic review

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Abstract

Objective: To assess differences in functional foods consumption between European countries.

Design: Systematic review. The literature search was conducted in Medlars Online International Literature (MEDLINE), via PubMed® and Scopus. Twenty two studies were identified to examine the differences in functional food consumption between European countries.

Results: Figures on consumers of functional foods reveal differences across European countries. Functional foods are popular in most of European countries like Finland, Sweden, the Netherlands, Poland, Spain and Cyprus, but not so in other countries like Denmark, Italy and Belgium. A high percentage of adolescents in the European Mediterranean countries (Spain and Cyprus, but not Italy) consume functional foods. Evaluation of functional foods consumption according to gender is difficult, because results differ from one study to another.

Conclusions: Functional foods have become very popular in Europe in recent years, but still huge differences exist between Europeans on consumption of functional foods. Further research is needed to find out the reasons behind these differences and to understand consumers' needs for functional foods.

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Keywords: *Functional foods. Food fortification. Food consumption. Europe. Systematic review.*

Introduction

Diet-related diseases such as obesity, cancer, diabetes and cardiovascular disease have been increasing¹ and in this view, functional foods play an important role by

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CONSUMO DE ALIMENTOS FUNCIONALES EN EUROPA; UNA REVISIÓN SISTEMÁTICA

Resumen

Objetivo: Evaluar las diferencias en el consumo de alimentos funcionales entre los países europeos.

Diseño: Revisión sistemática. La búsqueda bibliográfica se realizó en Medlars Online International Literature (MEDLINE), vía PubMed®, y Scopus. Se identificaron veintidós estudios que examinaron las diferencias en el consumo de alimentos funcionales entre los europeos.

Resultados: Existen diferencias en la proporción de consumidores de alimentos funcionales entre los países europeos. Así, mientras los alimentos funcionales son muy populares en la mayoría de los países europeos como Finlandia, Suecia, Países Bajos, Polonia, España y Chipre, en algunos países como Dinamarca, Italia y Bélgica no lo son tanto. Un elevado porcentaje de adolescentes europeos mediterráneos (España y Chipre, pero no Italia) consume alimentos funcionales. La evaluación del consumo de alimentos funcionales en función del género es difícil, pues los resultados varían de estudio a estudio.

Conclusiones: En los últimos años se ha extendido el consumo de alimentos funcionales en Europa, pero dicho consumo muestra grandes diferencias entre los europeos. Más investigaciones serán necesarias para averiguar las razones subyacentes tras estas diferencias y entender las necesidades de los consumidores de alimentos funcionales.

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Palabras clave: *Alimentos funcionales. Alimentos fortificados. Consumo de alimentos. Europa. Revisión sistemática.*

reducing or preventing risk of diseases.² Regarding to health message of functional foods, markets for these products has been growing steadily.^{3,4} The biggest functional foods markets are in Japan and the USA; however, European markets far behind them,^{3,5} and in European functional food market, Germany, France, the United Kingdom and The Netherlands have higher consumption of functional foods than other European countries.³

Consumer's acceptance and attitude towards functional foods determine the markets size and success. While Americans accept and consume functional foods more easily, Europeans' approaches are more critical⁶ and questioning of functional foods.⁷ It has

been reported that Danish consumers have more negative attitudes toward functional foods than American and Finnish consumers.⁸ By contrast, Finnish consumers have the most positive attitudes toward functional foods⁽⁵⁾. In addition to consumer's acceptance, the study for comparison between European and American consumer's awareness of functional foods also shows the differences between Europe and the USA. Labrecque et al.⁹ reported that awareness of functional foods among French consumers is lower than Americans and Canadians.

In the literature, there are studies comparing consumers acceptance and awareness of functional foods between Europeans and Americans;^{5,9} however, studies evaluating the differences in the functional food consumption of European countries are scarce. The aim of the present study is to systematically review the functional food consumption in European countries.

Methods of this review

The literature search was conducted through September 2013 in Medlars Online International Literature (MEDLINE), via PubMed[®] and Scopus. The MeSH dictionary in PubMed was used to identify search terms for this review. The keywords used in the search were “functional food”[Major] AND (“intake”[Mesh] OR “consumption”[Mesh] OR “food habits”[Mesh], OR “diet” [Mesh]) AND (“Mediterranean”[Mesh], OR “Europe”[Mesh], OR “adults”[Mesh], OR “child”[Mesh], OR “elder”[Mesh], OR “age groups”[Mesh], OR “demography”[Mesh], OR “socioeconomic factors”[Mesh]).

The selection process for the articles is shown in figure 1. In total, 425 articles (403 via PubMed, and 22 via Scopus) were selected by reading the title or abstract (by AEO). Among the latter, review articles, systematic reviews, articles in other language rather than English, articles that are not conducted in Europe,

articles that are not included a validated method for assessing dietary intake at the individual level and articles which are not included the number and percentage of the functional food consumer in the population were excluded (n = 402). Finally, a total of twenty three articles were chosen for the present review. Author and year of publication, age range of the population, number and gender of participants, sampling size, country in which the study was carried out and methods were collected from these articles. In addition to these data, number and percentage of the functional food consumers in each study were found. Full-text articles were assessed by 2 authors (AEO and JAT). Any matter of doubt was discussed by at least two of the reviewers (AEO, MMB, AP, and JAT).

Twelve articles¹⁰⁻²¹ represented the functional food consumption of the population; however other studies gave information about the food consumption²²⁻²⁵ or dietary patterns²⁶ or consumption of specific food group²⁷⁻³³ of the study population. In these studies functional foods were determined according to the definition of Diplock et al.:² *A food can be regarded as 'functional' if it is satisfactorily demonstrated to affect beneficially one or more target functions in the body, beyond adequate nutritional effects, in a way which is relevant to either the state of well-being and health or the reduction of the risk of a disease. The beneficial effects could be either maintenance or promotion of a state of well-being or health and/or a reduction of the risk of a pathologic process or a disease.*

Results

The characteristics of studies selected for this systematic review are shown in table I. In these studies the number of participants varied from 395³¹ to 48763.²⁷ The range of the response rate was 33%²⁷-99%.¹³ In two studies the response rate^{17,20} and in one study¹⁷ the

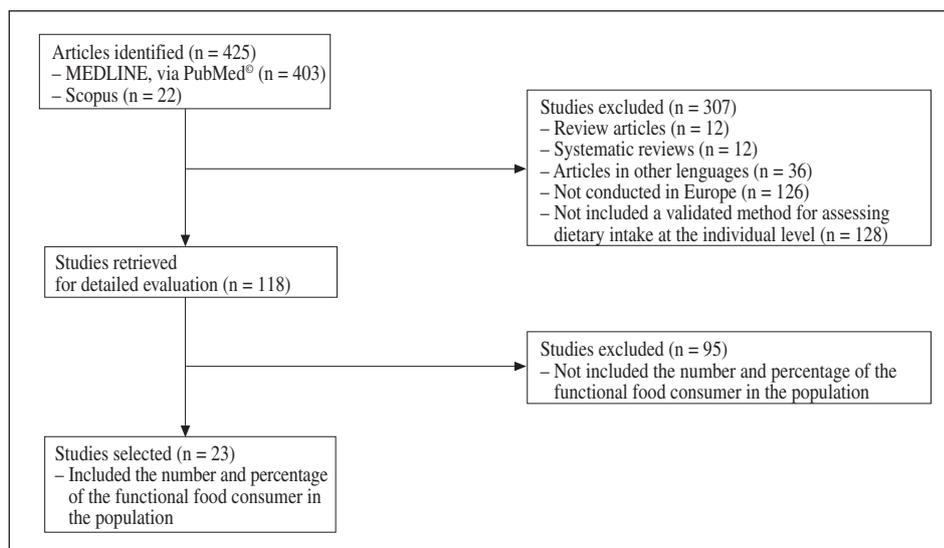


Fig. 1.—Flow chart for selection of articles for the present review.

Table I
Description of the studies included in this review

Author(s)	Method	Country	Study year	Sample size (Response rate, %)	Age range
Schätzer et al. ³³	Self-administered questionnaire	Austria	2006	2704 (52.7)	19-64 y
Mullie et al. ¹⁵	Semi-quantitative food-frequency questionnaire (FFQ)	Belgium	2007	1852 (37)	20-59 y
Mullie et al. ¹⁹	Semi-quantitative food-frequency questionnaire (FFQ)	Belgium	2007	1852 (37)	20-59 y
Lazarou et al. ²⁶	Semi-quantitative food-frequency questionnaire (FFQ)	Cyprus (The CYKIDS)	2004-2005	1140 (72)	9-13 y
Tjønneland et al. ²⁷	Food frequency questionnaire (FFQ)	Denmark	1993-1997	48763 (33)	50-64 y
Lahti-Koski et al. ²⁴	Self-administered questionnaire	Finland (FINRISK)	1982-1997	24604 (79)	25-64 y
Anttolainen et al. ¹⁰	Questionnaire (Health-lifestyle)	Finland	1996-1998	23657 (79)	35-84 y
Hirvonen et al. ¹⁸	24-hour dietary records	Finland (FINDIET)	2007	981 (90)	25-64 y
Urala et al. ¹¹	Special questionnaire	Finland	1999	958 (n.d.)	17-81 y
Lukasiewicz et al. ³⁰	24-hour dietary records	France	1994-2002	2323 (86)	35-60 y
Annunziata and Vecchio ¹⁷	Special questionnaire	Italy	n.d.	400 (n.d.)	18-75 y
Ferraroni et al. ²¹	Food frequency questionnaire (FFQ)	Italy	1990-1991	395 (87%)	>35 y
Trevisan et al. ²⁹	Special questionnaire	Italy	1978-1987	15649 (83%)	30-59 y
de Jong et al. ¹²	Self-administered questionnaires	Netherlands	2000	1183 (76)	19-91 y
de Jong et al. ¹³	Food frequency questionnaire (FFQ)	Netherlands	2003	2379 (99)	28-76 y
van de Vijver et al. ³²	Food frequency questionnaire (FFQ)	Netherlands	2006	4237 (85)	55-69 y
Aranceta et al. ²²	Food frequency questionnaire (FFQ)	Spain (Basque Country)	1990	2348 (73)	25-60 y
Ciprián et al. ²¹	Food frequency questionnaire (FFQ)	Spain (Valencia Comm)	1994	1863 (74)	>15 y
Serra-Majem et al. ^{23,25}	24-hour dietary records	Spain (EnKid)	1998-2000	3850 (70)	2-24 y
Núñez-González et al. ²⁰	Special questionnaire	Spain (Canary Islands)	2009-2010	1112 (n.d.)	>18 y
Landström et al. ¹⁴	Food questionnaire	Sweden	2005	972 (48)	17-75 y
Lindström et al. ²⁸	Cross-sectional study	Sweden	1994	11834 (39)	45-64 y
Wadolowska et al. ¹⁶	Closed-question questionnaire	Poland	2005	1005	15-75 y

n.d.: no data.

year of the study was not mentioned. While two studies involved only men,¹⁵ and one study involved only adolescents,²⁶ most of the studies showed an age range of 2-91 y.

Food consumption of respondents was determined by different questionnaires. In total, five food frequency questionnaires (FFQ), one of them was validated, three validated semi-quantitative food frequency questionnaires (s-FFQ), three self-administered questionnaires (two of them were validated), one cross-sectional study, one food questionnaire, three 24-h dietary recalls, four special questionnaires and one validated closed question questionnaire were used to assess food consumption.

The functional food consumption was reported in twelve studies,¹⁰⁻²¹ and eight of them showed different functional food consumption,^{4,12,14-17,20,21} whereas two of them presented consumption of stanol-enriched margarines.^{10,13} In one study low-fat food consumption was reported¹⁹ and in another study fortified food consumption was presented.¹⁸ Two studies showed functional foods consumption only in men.^{15,19}

Nine articles reported different food group consumption like fruits and vegetable, whole grain, or alcohol. While two studies reported fruit and vegetable intake,^{28,33} one study reported tea and coffee con-

sumption³¹ and two studies reported alcohol consumption.^{29,37} One study reported relationship between body mass index and food choices.²⁴ One study assessed the association of whole-grain intake with BMI,³² and another one reported alcohol intake and BMI relation.³⁰ Rest of the studies reported food pattern of the study population.^{21,22,23,25,26}

Milk and dairy products

Six studies reported consumption of low-fat/skimmed milk, milk with n-3 fatty acid or milk fortified with Ca or with vitamins A and D. In Finland while 42.3% of respondents consumed low-fat milk only 8.8% of them consumed skimmed milk;²⁴ however in Belgium only 7.4% of the respondents consumed low-fat milk¹⁹ (table II). Total percentage of the adults who consumed low-fat/skimmed milk in Finland was higher than those in Spain in where only ≤ 30% of the adults consumed functional milk products like milk low in lactose, milk products low in fat or milk enriched with vitamins and/or minerals.^{20,21} In Italy functional milk products consumption (milk with n-3 fatty acids) was lower than in Finland, Belgium and Spain, only 5% of

Table II
Number and percentage of the functional food consumers in different European countries

Country	Functional food	Men		Women		Total	
		n	%	n	%	n	%
<i>Austria</i> ³³	Fruits and vegetables	290	27.2	694	43.0	984	36.4
<i>Belgium</i> ¹⁵	Fortified margarines	488	26.3	n.d.	n.d.	488	26.3
	Fermented dairy products	87	4.7	n.d.	n.d.	87	4.7
	Nuts	259	14.0	n.d.	n.d.	259	14.0
	Black tea	551	29.8	n.d.	n.d.	551	29.8
	Red wine	190	10.2	n.d.	n.d.	190	10.2
	Fatty fish	228	12.3	n.d.	n.d.	228	12.3
	Fruits	354	19.1	n.d.	n.d.	354	19.1
	Vegetables	492	26.6	n.d.	n.d.	492	26.6
<i>Belgium</i> ¹⁹	Low-fat mayonnaise	93	5.0	n.d.	n.d.	93	5.0
	Low-fat yogurt	320	17.3	n.d.	n.d.	320	17.3
	Low-fat milk	137	7.4	n.d.	n.d.	137	7.4
	Low-fat cheese	65	3.5	n.d.	n.d.	65	3.5
	Low-fat cottage cheese	95	5.1	n.d.	n.d.	95	5.1
	Low-fat meat	401	21.7	n.d.	n.d.	401	21.7
<i>Cyprus (The CYKIDS)</i> ²⁶	Semi skimmed milk	352	66.0	422	69.5	774	67.9
	Yogurt	240	45.1	256	42.2	496	43.5
	Whole grain bread	113	21.2	118	19.5	231	20.3
	Breakfast cereals	273	51.2	293	48.2	566	49.7
<i>Denmark</i> ²⁷	Red wine	12973	55.7	13891	55.5	26864	55.1
<i>Finland (FINRISK)</i> ²⁴	Low-fat milk	5065	42.7	5339	41.9	10404	42.3
	Skimmed milk	875	7.4	1287	10.1	2162	8.8
	Sour milk	10697	90.2	11846	92.9	22543	91.6
	Coffee	11740	99.0	12675	99.4	24415	99.2
	Tea	10455	88.2	11573	90.8	22028	89.5
<i>Finland</i> ¹⁰	Plant sterol ester margarine	577	5.1	518	4.2	1095	4.6
<i>Finland (FINDIET)</i> ¹⁸	Voluntarily fortified foods ¹	305	74	315	65	620	67.5
<i>Finland</i> ¹⁰	Probiotic juice and yoghurt	n.d.	n.d.	n.d.	n.d.	287	30.0
	Cholesterol lowering products	n.d.	n.d.	n.d.	n.d.	169	18.0
	Products with added calcium	n.d.	n.d.	n.d.	n.d.	451	47.0
	Products with added fibre	n.d.	n.d.	n.d.	n.d.	465	49.0
	Low-salt products	n.d.	n.d.	n.d.	n.d.	670	70.0
<i>France</i> ³⁰	Wine	954	90.4	984	77.6	1938	83.4
<i>Italy</i> ¹⁷	Milk with n-3 fatty acids	n.d.	n.d.	n.d.	n.d.	20	5
	Probiotic yoghurt	n.d.	n.d.	n.d.	n.d.	48	12
	Vitamin enriched juices	n.d.	n.d.	n.d.	n.d.	21	7
	Enriched breakfast cereals	n.d.	n.d.	n.d.	n.d.	60	15
	Low cholesterol butter	n.d.	n.d.	n.d.	n.d.	12	3
	Spread with added calcium	n.d.	n.d.	n.d.	n.d.	16	4
<i>Italy</i> ³¹	Coffee	80	61.5	161	60.8	241	61.0
	Decaffeinated coffee	120	92.3	243	91.7	363	91.9
	Tea	93	71.5	183	69.1	276	69.9
<i>Italy</i> ²⁹	Red wine	5650	62.9	4090	61.3	9740	62.2
<i>Netherlands</i> ¹²	Yogurt with lactic acid bacteria	n.d.	n.d.	n.d.	n.d.	383	32.4
	Cholesterol lowering margarine	n.d.	n.d.	n.d.	n.d.	78	6.6
	Lemonade or sweets with extra vitamins and minerals	n.d.	n.d.	n.d.	n.d.	435	36.8
	Foods with extra Ca	n.d.	n.d.	n.d.	n.d.	324	27.4

Table II (cont.)
Number and percentage of the functional food consumers in different European countries

Country	Functional food	Men		Women		Total	
		n	%	n	%	n	%
Netherlands ³²	Whole grain (all grain without bran and germs)	727	35.0	938	43.5	1665	39.3
	Total brawn bread (sum of brown, wholemeal and rye bread)	1913	92.1	2018	93.5	3931	92.8
	All grain (bran, germs, muesli, porridge, brown rice and cooked grains)	765	36.8	1051	48.7	1816	42.9
Netherlands ¹³	Phytosterol/-stanol-enriched margarines	48	4.0	67	5.7	115	4.8
Spain (Basque Country) ²²	Red wine	793	69.4	470	39.0	1263	39.5
Spain (Valencia Community) ²¹	Low-fat milk	151	18.1	313	31.9	464	25.0
	Vitamins A+D enriched milk	65	7.9	125	12.8	190	10.6
	Calcium enriched milk	28	3.4	68	7.0	96	5.3
	Fibre enriched foods	146	17.5	269	27.6	415	23.0
	Two yoghurts	107	12.9	159	16.2	266	14.3
	Coffee	344	41.3	399	40.7	743	39.9
	Red wine	177	21.3	68	6.9	245	13.2
	Iodized salt	239	29.4	335	34.8	574	32.3
Spain (EnKid) ^{23,25}	Cereal or cereal product for breakfast	1380	84.7	1669	87.6	3049	86.3
	Two yoghurts and/or 40 g cheese	850	52.2	897	47.1	1748	49.5
Spain (Canary islands) ²⁰	Milk products ²	n.d.	n.d.	n.d.	n.d.	331	29.8
	Cereals ³	n.d.	n.d.	n.d.	n.d.	341	30.7
	Drinks ⁴	n.d.	n.d.	n.d.	n.d.	463	41.6
	Eggs ⁵	n.d.	n.d.	n.d.	n.d.	75	6.7
	Fats ⁶	n.d.	n.d.	n.d.	n.d.	197	17.7
Sweden ¹⁴	Probiotic fruit-drinks	169	39.5	276	50.7	445	45.8
	Probiotic milk-products	217	50.8	326	59.9	543	55.9
	Portion-sized yoghurt with muesli	20	4.7	47	8.6	67	6.9
	Juice with added vitamins or minerals	208	48.6	265	48.7	473	48.7
	Cholesterol-lowering products	112	26.3	162	29.7	274	28.2
	Fibre-rich bread with n-3 fatty acids	157	36.7	256	47.1	413	42.5
	Egg with n-3 fatty acids	14	3.3	23	4.2	37	3.8
Sweden ²⁸	Fruit Juice	2987	55.5	2925	45.3	5912	50.0
Poland ¹⁶	Cholesterol lowering spreads or drinks	n.d.	n.d.	n.d.	n.d.	201	20.0
	Energy drinks	n.d.	n.d.	n.d.	n.d.	70	7.0
	Food with added vitamins and/or minerals	n.d.	n.d.	n.d.	n.d.	201	20.0
	Fruit and/or vegetables	n.d.	n.d.	n.d.	n.d.	834	83.0
	High fibre foods	n.d.	n.d.	n.d.	n.d.	382	38.0
	Probiotic yoghurt drinks	n.d.	n.d.	n.d.	n.d.	372	37.0
	Weight loss products	n.d.	n.d.	n.d.	n.d.	40	4.0

n.d.: no data.

¹Yogurts fortified with vitamins or minerals, juice fortified with vitamins or minerals, Ready-to-eat breakfast cereals fortified with vitamins or minerals, Energy and wellness drinks fortified with vitamins or minerals, Quarks fortified with vitamins or minerals

²Milk products: easily digestible milk (or milk low in lactose), milk enriched with vitamins and/or minerals, skimmed milk with soluble fiber, milk with royal jelly, milk with modified fatty acids (omega 3), milk products low in fat, pro-biotic foods (yoghurt and fermented milk) and yoghurt with phytosterols.

³Cereals: fortified breakfast cereals, whole-meal cereals and energy bars.

⁴Drinks: juices and enriched drinks, stimulating drinks and isotonic drinks.

⁵Eggs: Docosahexanoic acid-enriched (DHA), low in cholesterol eggs.

⁶Fats: enriched margarine, margarine rich in phytosterols and sunflower oil rich in oleic acid.

the adults consumed milk with n-3 fatty acids.¹⁷ In one study, semi-skimmed milk consumption of adolescents was investigated, and reported that 66% of boys and 69.5% of girls consumed low fat milk in Cyprus.²⁶

Consumption of fermented milk products was reported in ten studies. Finland had the highest consumption percentage of fermented milk products, 91.6% of the respondents consumed sour milk.²⁴ Also in Sweden probiotic milk products were consumed in high ratio (55.9%), while yogurt with muesli was consumed by only 6.9% of the respondents.¹⁴ De Jong et al.¹² reported that 32.4% of the Dutch respondents consumed yogurt enriched with lactic acid bacteria and Wadolowska et al.¹⁶ reported that 20% of the Polish respondents consumed probiotic yogurt drinks; however in Spain,²¹ Italy¹⁷ and Belgium,¹⁵ fermented dairy products were not popular. While in Spain 14.3% (12.9% of men and 16.2% of women) and in Italy 12% of the respondents consumed probiotic yogurt, in Belgium less than 5% of the respondents consumed these products. In Belgium, 17.3% of the respondents consumed low-fat yogurt.¹⁹ Lazarou et al.²⁶ reported that 43.5% of the children consumed yogurt in Cyprus, while in Spain almost 50% of the children consumed yogurt.^{23,25}

Infusions

Coffee and/or tea consumption was reported in four studies. In Finland coffee and tea consumption was higher than in other countries and no gender difference was reported.²⁴ Coffee consumption, especially decaffeinated coffee, also in Italy was high. Coffee with caffeine consumed by 61% of Italian respondents, almost 92% of them consumed decaf coffee.³¹ Spanish people also show high coffee consumption (39.9%), higher in men (41.3%) than among women (40.7%). While almost 70% of male respondents consumed tea in Italy,³¹ 29.8% of the male respondents in Belgium consumed black tea.¹⁵

Cholesterol-lowering products

Consumption of cholesterol lowering products (phytosterol/stanol-enriched foods) was reported in six studies. Cholesterol lowering margarine/drink was a popular functional food in Belgium, Sweden, Poland and Spain where the percentage of consumption were 26.3%,¹⁵ 28.2%,¹⁴ 20%¹⁶ and 17.7%²⁰ respectively; however, in Finland and The Netherlands cholesterol lowering products were consumed by 4.6%¹⁰ and 6.6%¹² of the respondents. In Finland, 18% of the respondents consumed cholesterol lowering products.¹¹

Red wine

Five studies reported consumption of red wine. France had the highest proportion for red wine consumption

with 83.4% of the respondents.³⁰ In Italy (62.2%) and Denmark (55%) more than half of the respondents consumed red wine,^{27,29} while in Spain 13.2%-39.5% of the respondents consumed red wine.^{21,22} In France and Spain there was a gender difference in the consumption of red wine, male respondents more likely to consume red wine in these countries; however, in Denmark and Italy no gender difference was observed. In Belgium red wine consumers was reported as 10.2% of the respondents;¹⁵ since this study represented functional foods consumption of military men, comparison of genders for red wine consumption was not possible.

Cereals

Breakfast cereals or fibre rich bread consumption was reported in six studies. In Cyprus and Spain breakfast cereal consumption of adolescents was investigated. In these two Mediterranean countries children had similar and high percentage of breakfast cereal consumption, 49.7%²⁶ and 49.5%^{23,25} respectively, and boys had slightly higher consumption proportion than girls.

Landström et al.¹⁴ reported that 42.5% of Swedish respondents consumed fibre rich bread with n-3 fatty acid, while 92.8% of the Dutch respondents consumed total brown, wholemeal or rye bread.³² Whole and all grain consumption of Dutch respondents were also reported as 39.3% and 42.9% of respondents, respectively.^{16,32} Wadolowska et al.¹⁶ reported that high fibre foods were consumed by 38% of the Polish respondents. In Italy only 15% of the respondents consumed enriched breakfast cereals.¹⁷

Fruit and vegetables

Fruit and vegetables consumption was reported in three studies. In Austria 36.4% of the respondents consumed fruits and vegetables and it is clearly seen that females more likely to consume these products.³³ In Poland 83% of the respondents consumed fruits and vegetables.¹⁶ In Belgium consumption of fruits and vegetables were investigated separately. While 26.6% of the respondents consumed vegetables 19.1% of them preferred to consume fruits.¹⁵

In five studies consumption of fruit juice were investigated. In Sweden almost half of the respondents (48.7%) consumed juice with added vitamins or minerals.¹⁴ In another study reported that 50% of the Swedish respondents consumed fruit juice.²⁷ Another common functional food among Swedish respondents was probiotic fruit drinks which was consumed by 45.8% of the respondents.¹⁴ Consumption of vitamin enriched juices was not popular in Italy, only 7% of the respondents consumed these products;¹⁷ however in Spain juices and enriched drinks were consumed almost 42% of the respondents.²⁰

Other functional foods

Consumption of other functional foods like eggs with n-3 fatty acids, spread with added Ca, low-fat mayonnaise, low fat cheese, low cholesterol butter, nuts, energy drinks, vitamin or mineral enriched foods, fibre enriched foods, iodized salt, and weight loss products was also investigated among European citizens. While fatty fish was consumed by 12.3% of the Belgium respondents, nuts were consumed by 14% of them.¹⁵ Low-fat products like mayonnaise and cheese were consumed by 5% of the Belgium respondents; however, low fat meat was consumed 22% of them.¹⁹ Consumption of low cholesterol butter and spread with added calcium in Italy were investigated and reported that less than 5% of the respondents consumed these products.¹⁷ Consumption of different functional foods (yogurts fortified with vitamins or minerals, juice fortified with vitamins or minerals, ready-to-eat breakfast cereals fortified with vitamins or minerals, energy and wellness drinks fortified with vitamins or minerals, quarks fortified with vitamins or minerals) were investigated in Finland and it was reported that total 67.5% of the respondents consumed these products.¹⁸ Probiotic juice and yogurt, products with added fibre and low-salt products were also commonly consumed by Finnish.¹¹

Consumption of functional eggs was mentioned in two studies. While in Sweden only 3.8% of respondents consumed eggs with n-3 fatty acids,¹⁴ in Spain 6.7% of the respondents consumed eggs with n-3 or low in cholesterol.²⁰ Vitamin enriched foods like lemonade or sweets were popular in The Netherlands, almost 40% of the respondents consumed these products.¹⁵ In the same study it was reported that almost 30% of the study population consumed foods with extra calcium.¹⁵ Products with added calcium were also popular in another north European country, almost half of the study population consumed calcium fortified products in Finland.¹¹ However, in Poland 20% of the respondents consumed vitamin and/or mineral enriched foods, whereas energy drinks and weight loss products were consumed by only 7% and 4% of the respondents respectively.¹⁶ In Spain, 32.3% of respondents consumed iodized salt, and 23.0% of them consumed fibre enriched foods.²¹

Discussion

While in most of the north European countries like Finland, Sweden and The Netherlands, functional foods are consumed by a high percentage of the population,^{10,12,13,18,24,32} in Belgium percentage of functional foods' consumers is not as high as in the north European countries.^{15,19} On the other hand, in most of the other European countries, fortified margarines were consumed by less than 10% of the populations,^{10,12,13,17} but in Belgium 26% of the study population consumed these products.¹⁵ It is also surprising that fermented dairy

products, one of the most popular functional foods,³⁴ is consumed by less than 5% of the study population in Belgium. The studies conducted in Belgium represented only specific group of population, military men, it might be the reason that results from this north European country differs from other northern countries.

Results from Mediterranean countries, like Spain, Italy and Cyprus, also show differences. Spanish and Cypriots are more likely to consume functional foods than Italians. Functional foods, except coffee, tea and red wine, are not as popular in Italy as in other European countries.^{17,29,31} When the functional food consumption of young population in Mediterranean countries was investigated, results show that in Spain and Cyprus a high percentage of adolescents consumed functional foods.^{23,25,26}

It is clearly seen that there are differences between functional food consumers' percentage across the countries. Menrad³ reported that functional foods are more popular in the Central and Northern European countries than in Mediterranean countries; however, it is not possible to make a generalization between northern and southern countries. Furthermore, in East Europe functional foods consumption has become popular,¹⁶ and functional food market has been growing in Poland.³⁵ European countries differ in their nutrition and health claims of functional foods³⁶ and also popularity of functional foods differs from country to country.

Bech-Larsen and Grunert⁸ reported that Finnish consumers have positive attitudes toward functional foods, whereas Danish consumers have negative attitudes toward functional foods. High acceptability of functional foods in Finland might be the result of the government's support of functional foods.¹⁴

It is difficult to evaluate functional food consumption according to gender, because results varied from study to study. In some studies, it was reported that females were more interested in functional food,^{14,37,38} however, some studies reported that different products might be attractive for one or the other gender.^{12,39} In fact, results of some studies conducted in same country represent different outcomes. According to Lathi-Koski et al.²⁴ females were more likely to consume functional foods than males in Finland; in contrast Anttolainen et al.¹⁰ and Hirvonen et al.¹⁸ reported that male consumers were more interested functional foods than females. Similarly, Landström et al.¹³ pointed out that Swedish women more likely to consume functional foods than men, but another study conducted in Sweden reported that males consumed functional foods more than female did.²⁸

Functional foods offer a new kind of health message due to the specific effects of functional components,⁴⁰ and consumer aspects of functional foods lay on the grey area between food and medicine.⁷ The lack of legal definition and regulation for functional foods could affect the consumer attitude to functional foods.¹⁴

Lately, it has been evaluated the knowledge of, interest in and predisposition towards FFs in Spanish di-

eticians and experts in human nutrition, and how these professionals rate the potential benefits and risks associated with consuming functional foods. This study yielded that functional foods are generally accepted by nutritional professionals. However, further study is required into the discrepancies between dieticians and experts in human nutrition regarding the view that it is “dangerous” to consume certain functional foods and regarding their evaluation of whether the public know in which situations certain functional foods should be consumed.⁴¹

Conclusions

Functional foods have become very popular in Europe in recent years, but still huge differences exist between Europeans with consumption of functional foods. Further researches are necessary to find out reasons behind the differences and understand consumers' needs for functional foods.

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Authors' contributions

AEO and JAT contributed to the design of the strategy for the literature search, double screened and selected the retrieved documents. AP and MMB provided previous literature searches and analysis. AEO and JAT prepared the main outline of the manuscript, and all authors contributed to the preparation of the manuscript.

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