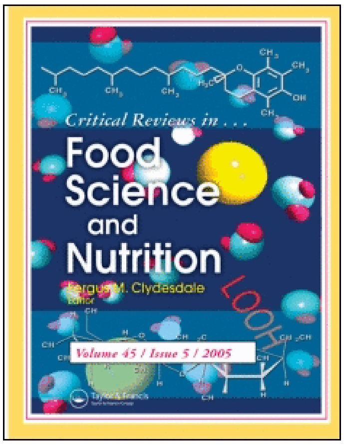

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Definition of the Mediterranean Diet Based on Bioactive Compounds

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Antioxidant (polyphenols and carotenoids) and nonantioxidant (phytosterols) bioactive compounds and dietary fiber may have a significant role in health. The intake of these compounds is strongly linked with the high consumption of fruits, vegetables, and unrefined cereals. A whole-diet approach to these food constituents is intended to render the current definition of Mediterranean diet based on food consumption more comprehensive.

The Mediterranean dietary pattern can be characterized by the following four essential dietary indicators: 1) Monounsaturated to saturated fatty acid ratio (range: 1.6 to 2.0); 2) Intake of dietary fiber (41 to 62 g/person/day); 3) Antioxidant capacity of the whole diet (3500 to 5300 trolox equivalent/person/day); 4) Phytosterols intake (370 to 555 mg/person/day). The contribution of foods and beverages to these parameters is described. Spanish National Food Consumption Data for the years 2000 and 1964 were used to quantify the lowest and highest range values. The occurrence of these indicators in the Mediterranean diet has specific characteristics and there is sufficient scientific evidence to support the beneficial health effects.

Keywords Mediterranean diet, bioactive compounds, antioxidant capacity, dietary fiber, phytosterols

INTRODUCTION

Nowadays we possess a good understanding of metabolism and daily macronutrient and micronutrient requirements. But plant foods also contain hundreds of nonnutrient microconstituents with significant biological activity, generally called bioactive compounds or phytochemicals, which appear to play a role in the maintenance of human health. The main groups of these substances are polyphenolic compounds, carotenoids, and phytosterols. The current knowledge of their bioavailability, metabolism, and dietary intakes is incomplete or nonexistent, and there are consequently no recommended daily allowances for bioactive compounds. The traditional approach in this field has focused on the physiological properties associated with the ingestion of single compounds or specific food extracts, generally involving doses well in excess of those contained in common diets (Bjelakovic et al., 2004). This may be of only relative value as it is generally thought that what really produces an effect on human health is the synergistic and cumulative action of these substances in the diet. To assess the real significance of bioactive compounds for human health, the diet needs to be approached as a whole (Martinez-González et al., 2004). In adopting a whole-diet approach to bioactive compounds it may be useful to look at diets in connection with which observational and epidemiological studies have shown low rates of morbidity and mortality by chronic disease. The Mediterranean diet (MD), the Japanese diet, or other specific diets rich in fruits and vegetables may all be good models. Here we focus on the Mediterranean dietary pattern.

Over 500 journal articles have addressed the Mediterranean diet in the last ten years; of these, 76 are clinical trials and 136 are reviews (MEDLINE, National Library of Medicine, Bethesda, MD). A systematic review of studies reveals a significant association between the MD and a lower rate of mortality from all causes, and favorable effects of the MD on lipoprotein levels, endothelium vasodilatation, insulin resistance, antioxidant capacity, and metabolic syndrome (Serra-Majem et al., 2006). Recent prospective investigations have reported that adherence to the MD was associated with lower arterial blood pressure, (Psaltopoulou et al., 2004), increased survival among older people (Trichopoulou et al., 2005; Knoops et al., 2004) and significantly lower total mortality, mortality from coronary heart disease, and mortality from cancer (Trichopoulou et al., 2003; Vincent-Baudry et al., 2005; Cottet, et al., 2005). Trichopoulou

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and Lagiou (2001) and Trichopoulou et al., (2003) included in the commonly-reported definition of MD, the following nine components:

(a) High monounsaturated-to-saturated lipid ratio (derived from high olive oil consumption)
(b) Moderate ethanol consumption (mainly as wine)
(c) High consumption of legumes
(d) High consumption of cereals (mainly unrefined cereals and bread)
(e) High consumption of fruits
(f) High consumption of vegetables
(g) Low consumption of meat and meat products
(h) Moderate consumption of milk and dairy products
(i) High consumption of fish and fish products

A health pyramid for the general adult population based on the Mediterranean dietary pattern provides a guide to the relative proportions and frequency of consumption of the respective food groups and it is used to give advice on healthy food choices. The Mediterranean dietary pattern is nowadays considered highly appropriate for public health objectives, and consumer trends globally indicate growth in demand for mediterranean products, (Regmi et al., 2004).

MEDITERRANEAN DIET: A NEW COMPLEMENTARY DEFINITION

The definition of the MD is mainly based on consumption of foods. However, despite the robust inverse association between MD and mortality found in observational and epidemiological studies, no appreciable associations have been identified with any individual foods, including olive oil (Trichopoulou et al., 2003; Hu, 2003). The only single food item whose role in the beneficial effects of the MD is widely considered and discussed is olive oil. Trichopoulou et al. (2003) described inverse associations with mortality but only found in connection with high intakes of food groups rich in bioactive compounds, comprising dozens of individual foods such as fruits and vegetables (over 500 g/person day) or fruits and nuts (over 300 g/person day).

It is not yet clear which food constituents of the MD contribute most to its apparent health effects. The intake of energy and nutrients in the MD is similar to that in diets of North European countries where there is a higher prevalence of chronic diseases and an excess of total energy provided to a large extent by fat and protein at the expense of carbohydrates. However, there are differences between Mediterranean and Northern European countries in relation to fat consumption. Mediterraneans recorded high availability of olive oil and unprocessed red meat, while Central and Northern Europeans preferably consumed meat products (Naska et al., 2006).

As far as micronutrients are concerned, to our knowledge, clear significant differences in the intake of vitamins and minerals in Northern and Southern European countries have not been reported, (Elmadfa et al., 2004) and therefore the role of bioactive compounds or phytochemicals as a key factor in the health effects of the MD is an attractive hypothesis. The plant foods in the MD, of which there is a considerable amount and variety, contribute a large proportion of the overall dietary intake of dietary fiber (DF) and bioactive compounds and a small proportion of the overall dietary intake of energy. In this connection, a complementary definition of the MD was recently proposed by Saura-Calixto and Goñi (2005), based on the following dietary indicators: monounsaturated/saturated lipid ratio, intake of DF, antioxidant capacity of the whole diet, and the intake of phytosterols. These indicators were selected for two reasons: first, there is sufficient scientific evidence to support their beneficial health effects, and second, their occurrence in the MD has specific characteristics (Table 1).

Table 1 Essential dietary indicators in the Mediterranean diet

Indicator	Associated health effects	Diferential features in Mediterranean diet
Monounsaturated fatty acid to saturated fatty acid ratio	Inverse correlation with cardiovascular disease and total mortality	High ratio derived from consumption of olive oil (high) and animal fat (moderate)
Dietary fiber intake (as total indigestible fraction)	Prevention of coronary heart disease and colon cancer	High consumption of fresh fruit and vegetables (fiber with associated bioactive compounds)
Antioxidant capacity of the whole diet	High serum antioxidant capacity Prevention of oxidative damage	High variety of antioxidants from plant foods and beverages
Phytosterols intake	Lower total and LDL-cholesterol	High intake from vegetable oils

Monounsaturated to Saturated Fatty Acids Ratio (derived from High Olive Oil Consumption)

There is general consensus among scientists as to the significant role of the monounsaturated to saturated fat ratio (MUFA/SFA) in disease etiology. This ratio is predictive of total mortality and is the first point in the definition of the MD (Trichopoulou et al., 2003; Gibney and Roche, 2001; Fernandez and West, 2005). A high MUFA/SFA ratio is a common feature in Mediterranean countries; it is much higher than in other parts of the world including northern Europe and North America (Naska et al., 2006).

Intake of Dietary Fiber (as Total Indigestible Fraction)

Nowadays the importance of DF in nutrition and health is well defined. Numerous clinical and epidemiological studies have addressed the role of DF in intestinal health, prevention of cardiovascular disease and cancer, obesity, and diabetes (Krichevsky and Bonfield, 1995; Cho and Dreher, 2001). The daily intake of

DF is quantitatively similar in Mediterranean and non- Mediterranean European countries (around 20 g per capita) (Goñi, 2001; Elmadfa et al., 2005). However, there are qualitative differences arising from the fact that a large proportion of the DF intake in Mediterranean countries comes from fresh fruit and vegetables, while in Northern European countries it comes more from cereals (Saura-Calixto and Goñi, 1993; Goñi, 2001). This suggests that the composition and properties of the DF in the MD may have specific characteristics. Fruits and vegetables possess a higher soluble fiber to insoluble fiber ratio than cereals. On the other hand, it is well known that DF, especially from fruits and vegetables, is a carrier of bioactive compounds. DF transports a significant amount of polyphenols, carotenoids, and other bioactive compounds linked to the fiber matrix through the human gut. (Goñi et al., 2007; Saura-Calixto et al., 2007). A part of the postulated benefits of the Mediterranean diet might then be attributable to the intake of fiber. It is important to note at this point that the use of food DF data in nutrition may be subject to some limitations arising from the concept of DF itself and from the methodology used to determine DF in foods. The concept of DF was first developed 40 years ago. DF was defined as plant polysaccharides and lignin which are resistant to hydrolysis by the digestive enzymes of man (Trowell et al., 1976). However, knowledge has increased since then. On the basis of bacterial growth, it has been calculated that up to 60 g of carbohydrates have to reach the colon to maintain the bacterial cell turnover on a daily basis. Nevertheless, the intake of DF in European countries only accounts for 20 g of carbohydrate/day, which leaves what was called a "carbohydrate gap" of 40 g/d (Cumming and Macfarlane, 1991; Stephen, 1991). The general tendency among nutritionists nowadays is to extend the concept of DF to include all major food constituents that are resistant to hydrolysis by digestive enzymes.

In this context the American Association of Cereal Chemists (2001) recently defined DF as the edible part of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. That includes polysaccharides, oligosaccharides, lignin, and associated plant substances. Nevertheless, the analytical methodology for determination of DF in food (Prosky et al., 1992) focused on non-starch polysaccharides and lignin has not been adapted to the new concept but is still widely used. Therefore, most DF values recorded in food composition tables and databases are defined by the traditional concept, which may cause errors in nutritional and epidemiological studies addressing the health effects of DF. In the same context, DF as total indigestible fraction was recently defined as the part of plant foods that is not digested or absorbed in the small intestine and reaches the colon, where it serves as a substrate for the fermentative microflora, (Saura-Calixto et al., 2000). As such, it comprises not only the non-starch polysaccharides plus lignin (traditional concept of DF), but also other compounds of proven resistance to the action of digestive enzymes such as a fraction of resistant starch, protein, certain polyphenols, and other associated compounds. A significant part of dietary starch, called resistant starch, is not digested in the human gut. The resistant starch fraction is a major component of the indigestible fraction of cereals. Resistant starch is an insoluble substrate largely fermented by the colonic bacteria (Asp et al., 1996). A specific methodology has been developed to determine DF as the total indigestible fraction (Saura-Calixto et al., 2000) which may provide data that reflect the amount of substrates available in the human colon more accurately than traditional DF values. A recent report (Saura-Calixto and Goñi, 2004) concluded that DF intake determined as traditional DF underestimates a major part of the dietary substrates that enter the colon, while DF intake determined as total indigestible fraction more closely matches the amount of substrates needed to maintain a typical human colonic microflora. Therefore, in order to avoid the limitations of the traditional DF data, we have used values of DF determined as total indigestible fraction as a dietary indicator of the Mediterranean dietary pattern, (Saura-Calixto and Goñi, 2004).

Antioxidant Capacity of the Whole Diet

Ongoing research aims to elucidate the role of dietary antioxidants in disease prevention. The main approach was based on the hypothesis that the chronic disorders common in many industrialized societies are related to cumulative oxidative damage to DNA, proteins, and lipids in body tissues. Even at very low concentrations, dietary antioxidants protect against oxidative damage and may also have a greater impact than realized hitherto on the regulation of gene expression, profoundly affecting metabolism (Beckman and Ames, 1998). Vitamins (C, E, and A), polyphenolic compounds, and carotenoids are recognized as the main groups of antioxidants present in beverages and plant foods. Vitamins are single molecules, but polyphenols (flavonoids, phenolic acids, stilbenes, tannins) and carotenoids (carotenes and xanthophylls) are made up of hundreds of compounds with a wide range of structures and molecular masses. Recent reviews have addressed the role of these bioactive compounds in nutrition and health, (Manach et al., 2005; Williamson and Manach, 2005; Tapiero et al., 2004; Cooper, 2004). There is abundant literature on the antioxidant capacity of single compounds and food extracts, but as mentioned earlier, there is a lack of comprehensive data on the antioxidant capacity of whole diets. The antioxidant capacity of a whole diet is derived from the accumulative and synergistic antioxidant power of vitamins, polyphenols, carotenoids, and other minor food constituents such as Maillard compounds and trace minerals. The fact that dietary antioxidants come from a wide variety of sources is a specific feature of the MD. The consumption of a large variety of fruits and vegetables, legumes, nuts, cereals, red wine, citrus juices, and other beverages supply the MD diet with a considerable range of lipophilic and hydrophilic antioxidants. The total antioxidant capacity of the MD is probably higher than in other countries with a higher incidence of chronic diseases, especially cardiovascular disease, such as Northern Europe and the United States.

There is growing scientific evidence that dietary antioxidants may be a critical mediator of the beneficial effects of the MD. There are a number of recent studies supporting this. The work of Pitsavos et al. (2005) on the effects of the MD on total antioxidant capacity, performed with a random sample of over 3000 adults, concluded that greater adherence to the MD is associated with high total antioxidant capacity levels in serum. Serafini et al. (2003) found that the dietary antioxidant intake, measured as total antioxidant capacity, was inversely associated with both cardia and distal cancer risk in a population based case control. Brighenti et al. (2005) reported that total antioxidant capacity is inversely and independently correlated with plasma concentration of highly sensitive C-reactive protein, and this could be one of the mechanisms whereby antioxidant rich foods protect against cardiovascular disease. On that basis we selected the total antioxidant capacity of the MD as a key parameter in their health effects. Total dietary antioxidant capacity (TDAC) can be defined as the antioxidant capacity of all plant foods and beverages (alcoholic and non alcoholic) consumed daily in a diet. This parameter provides an integrated measurement rather than a single sum of measurable antioxidants and may represent the amount of antioxidant units (trolox equivalents) present daily in the human gut (Saura-Calixto and Goñi, 2006).

Phytosterols Intake

Human clinical trials have established that plant sterols lower total and LDL cholesterol, since they competitively inhibit intestinal cholesterol uptake (Kritchevsky, 2005). Plant foods contain a large number of plant sterols (chiefly campesterol, ß-sitosterol, stigmastanol and stigmasterol) as minor lipid components. The high phytosterol content in traditional Mediterranean food (olive oil, nuts, legumes) along with the fact that the bioavailability of these compounds is higher in oils than in cereals—the main dietary source of phytosterols in Northern Europe—suggests that dietary phytosterols may be a factor in the lower cardiovascular disease death rates in Mediterranean countries (Fito et al., 2007; Jiménez-Escrig et al., 2006). Most bioactive compounds have antioxidant capacity. Thus, dietary polyphenols, carotenoids, and other minor antioxidants contribute to TDAC values. But phytosterols exhibit no antioxidant activity, and a specific parameter for phytosterols is needed.

DIETARY INDICATORS IN THE SPANISH MEDITERRANEAN DIET

The essential dietary indicators were quantified in the Spanish diet on the basis of national food consumption data for the year 2000 (MAPA, Ministerio de Agricultura Pesca y Alimentación, 2001).

Monounsaturated to Saturated Lipid Ratio

The Spanish diet contains a high level of dietary fat, and that fat contains a high percentage of monounsaturated fatty acids (contributing 19% of energy; saturated fatty acids contribute 12% and polyunsaturated fats 6%). The MUFA/SFA was estimated at 1.6 (Saura-Calixto and Goñi, 2005)

Table 2 Intake of dietary fiber (DF) in the Spanish diet (Saura-Calixto and Goñi 2004)

	DF (indigestible fraction) (g/person/day)			DF (traditional) (g/person/day)		
Source	Total	Soluble	Insoluble	Total	Soluble	Insoluble
Cereals	22,25	5,47	16,78	7,28	1,95	5,33
Fruits	6,49	0,71	5,78	5,05	2,09	2,96
Vegetables	8,16	1,66	6,50	4,69	1,90	2,79
Legumes	3,92	0,50	3,42	0,75	0,23	0,52
Nuts	0,67	0,04	0,63	0,57	0,13	0,45
Total	41,49	8,38	33,11	18,35	6,30	12,05

Dietary Fiber (as Total Indigestible Fraction)

The intake of DF as total indigestible fraction in the Spanish diet (41.5 g/person/day) was much higher than the total DF intake measured as traditional DF (18.30 g/person/day), (Table 2), (Saura-Calixto and Goñi, 2004). Fresh fruits and vegetables are the main sources of DF: 53.1% of the total intake measured as traditional DF (Goñi, 2001) and 35.3% measured as indigestible fraction (Saura-Calixto and Goñi, 2004). The appreciable difference in the relative contribution of cereals to DF values (53.6% to indigestible fraction and 39.7% to traditional DF values) is due to the presence of resistant starch as a major constituent of the indigestible fraction. Resistant starch is not included in traditional DF values.

Antioxidant Capacity

TDAC of the Spanish diet was estimated at 3550 μmol trolox equivalent by ABTS method (free radical scavenging capacity), (Table 3). This represents the estimated amount of dietary antioxidants, expressed as trolox equivalent, that daily enters in the gut (Saura-Calixto and Goñi, 2006). It is generally thought that plant foods are the main source of antioxidants in the diet; however, the findings of these reports indicate that beverages are the largest source of antioxidants in the Spanish diet (72.6% — ABTS values — of TDAC). Fruits and vegetables contributed 17.3%, while the contribution of cereals and vegetable oils was very low; olive oil accounted for just 0.4%. Nuts and legumes contributed nearly 9% of TDAC.

Food items such as olive oil and wine are very important components of the Spanish diet. Olive oil has been shown to have a significant association with lower blood pressure, (Psaltopoulou et al., 2004) but not with lower mortality (Hu, 2003). The MUFA/SFA is the only item included in the definition of the MD that has been shown to have a significant association with low mortality from cardiovascular disease and overall mortality.

Table 3 Total dietary antioxidant capacity (TDAC) in the Spanish diet (Saura-Calixto and Goñi, 2006)

Source	Antioxidant capacity (ABTS method) (μmol trolox equivalent)
Nuts	176.0
Fruits	342.0
Vegetables	272.0
Legumes	134.7
Cereals	33.4
Beverages	
Coffee	1581.7
Wine	616.6
Others	377.7
Vegetable oils	
Olive	12.8
Others	2.4
TDAC	3549.3

Olive oil may produce its dietary health benefits by lowering blood pressure (Psaltopoulou et al., 2004)—a cardiovascular disease risk factor—and by contributing to a proper lipid intake in two ways: directly by increasing monounsaturated lipids, and indirectly by decreasing saturated lipids intake. It has also been widely suggested that the beneficial effects of olive oil derive not only from its high oleic content but also from the presence of polyphenolic antioxidants; however, other authors consider that the olive oil phenols intake in the MD is probably too low to produce a measurable effect on oxidation markers in humans (Vissers et al., 2004).

Regular, moderate consumption of wine is a feature of the MD. Wine consumption represents 17.4% of the TDAC of the Spanish diet, but surprisingly, coffee was the single largest contributor (44.6%), (Saura-Calixto and Goñi, 2006). The high contribution of coffee to antioxidant intake in the Spanish diet had previously been reported (Pulido et al., 2003) and was again recently confirmed in a nationwide Norwegian survey (Svilaas et al., 2004). We know that the major antioxidants in coffee (chlorogenic acids) are less bioavailable than the major antioxidants in wine (flavonoids), but the health significance of high consumption of coffee antioxidants in western countries remains to be elucidated.

With regard to food microconstituents, vitamins C and E account for only about 10% of TDAC in the Spanish Mediterranean diet, polyphenols being the major antioxidant (Saura-Calixto and Goñi, 2006). Determination of the TDAC may be a useful additional tool for interpreting some clinical and epidemiological results. Following is an account of two examples.

The MONICA epidemiological study (Renaud and Lorgeril, 1992) found the lowest coronary heart disease mortality in the region of Toulouse, where a daily intake of 383 mL of wine was reported. If we assume that the antioxidant capacity of the Toulouse wine is comparable to that of Spanish red wine (Table 3), the antioxidant capacity from wine intake in Toulouse is equivalent to the TDAC of the whole Spanish diet (around 4000 μmol trolox equivalent, ABTS method). If we add the AC corresponding to the reported intake of 238 g of fruit and 306 g of vegetables, then the estimated TDAC in the Toulouse diet is very high and could be a key factor in the low coronary heart disease mortality in this region.

A prospective investigation in Greece of Trichopoulou et al. (2003) showed that adherence to a MD was associated with significantly lower total mortality, mortality from coronary heart disease, and mortality from cancer. However, despite a robust inverse association between the MD and mortality, no appreciable associations were found for most of the individual dietary components used to construct the score, including foods containing antioxidants such as olive oil, legumes, vegetables, cereals, nonalcoholic beverages, and juices. Only the intake of fruits plus nuts and the MUFA/SFA were predictive of total mortality. The introduction of the TDAC may contribute to a better understanding of these intriguing results (Saura-Calixto and Goñi, 2006). If we consider that fruits and nuts are the plant foods that exhibit the highest antioxidant capacity, and that the reported daily intake of these items (390 g) was higher than in the Spanish diet (272 g), it is not surprising that the intake of fruits and nuts was significantly associated with disease prevention. Probably fruits plus vegetables, as opposed to fruits plus nuts, would also exhibit a significant inverse association with mortality. The MD aside, numerous epidemiological studies have correlated the intake of fruits and vegetables with low incidence of cardiovascular diseases (Bazzano et al., 2002; Djoussé et al., 2004). The intake of antioxidant capacity derived from the consumption of the amount of fruits and vegetables reported in these studies, totalling over 500 g, is close to the total antioxidant capacity in the MD.

Phytosterols Intake

The per capita daily plant sterol intake in the Spanish diet was estimated at 374.2 mg, (Table 4). ß-sitosterol was the major contributor to the total intake. The main individual contributors are sunflower oil, olive oil, bread, orange, chickpeas, lentils, and beans. Most of these are considered typical Mediterranean foods ((Jiménez-Escrig et al., 2006). Spanish intake of plant sterols is in the same range as other countries with higher mortality from cardiovascular disease such as Finland and the Netherlands (Valsta et al., 2004; Normén et al., 2001). However, there are some qualitative differences in the plant sterol sources: cereals in the Northern diets versus vegetable oils in the Spanish diet. The intake from vegetable oils is especially

Table 4 Phytosterols intake in the Spanish diet (Jimenez-Escrig et al., 2006)

Source	mg/person/day
Cereals	87.9
Fruits	38.4
Vegetables	24.0
Legumes	27.1
Nuts	8.3
Vegetable oils	188.5
Total	374.2

important since the bioavailability of plant sterols is enhanced in oils.

A COMPLEMENTARY DEFINITION OF THE MEDITERRANEAN DIET

A complementary definition based on the dietary indicators described above is useful to render the traditional definition based on food intakes more comprehensive. In this traditional definition the consumption of foods is assessed in imprecise terms such as "moderate" or "high," but not in concrete figures. Thus, in the Spanish diet 414 g/person/day of dairy products is moderate consumption, while 14 g/person/day of legumes is high and 179 g of meat and meat products is low.

The Spanish diet, an alimentary pattern that matches the defined characteristics of the MD, was used to quantify the dietary indicators. The traditional Spanish Diet is described as providing an abundance of plant foods (fruits, vegetables, bread, cereal products, legumes, nuts, and seeds), wine, and olive oil and favoring the consumption of locally grown, seasonally fresh, and minimally processed foods. It includes a wide variety of fish and modest amounts of foods from animal sources; this assures the necessary intake of macro- and micronutrients while keeping saturated lipids low.

During the Sixties the Spanish diet followed this traditional Mediterranean pattern, but since then the food consumption pattern has changed greatly (Table 5). It appears that consumption of meat, fruit, dairy products, and fish has increased while consumption of bread, potatoes, olive oil, and legumes has decreased. As a consequence, the contribution of fat and protein to the total energy intake is high while the contribution of carbohydrates is below the recommended levels. In spite of these changes, the present Spanish diet still falls within the pattern of the MD, mainly thanks to increased consumption of fruit and fish and a moderate decline in consumption of olive oil, wine, and legumes (Saura-Calixto and Goñi, 2005). These dietary indicators were at their highest in the 1960s and are lowest at present. The values of these indicators for current diet were determined by analytical determinations performed in foods collected in 2000. These values were extrapolated to food consumption in 1964 to estimate the dietary indicators at that date. 1964 was chosen because it was the first year in which National Surveys were conducted using the same methodology as nowadays. These data are obtained annually from daily budget questionnaires. Six thousand households are surveyed, along with 700 hotels and restaurants and 200 institutions such as schools, hospitals, and the armed forces (confidence level 95%; error range 2% in amount of food). Twenty-one food groups, which include 130 food items, are specified (MAPA Ministerio de Agricultura Pesca y Alimentación, 2001).

On this basis, the MD can be characterized by the following four essential dietary indicators:

1) MUFA/SFA between 1.6 and 2.0.
2) A daily intake of DF (as total indigestible fraction) of 41–62 g per capita.
3) A TDAC equivalent to a daily intake of 3500–3500 trolox equivalents per capita (measured by the ABTS method).
4) A daily phytosterols intake of 370–555 mg per capita.

Bioactive compounds are integrated in the values of indicators 3 and 4, where they are the major or sole contributors, and partially in indicator 2 as a minor fraction associated with DF. Table 6 indicates the foods that contribute most to these dietary parameters. The majority are traditional Mediterranean foods.

Table 5 Intake of selected foods and nutritional parameters of the Spanish diet*

Food (g or mL/person/day	1964	2000
Cereals (white bread)	436 (368)	222 (160)
Fruits	162	257
Vegetables (potatoes)	451 (300)	303 (132)
Legumes	41	14
Milk and dairy products	228	414
Fish	63	89
Meat and meat products	77	179
Olive oil	53	31
Wine	130	90
Total energy (Kcal)	3008	2795
Profile (%):		
Protein	11	14
Carbohydrates	58	40
Lipid	31	46
Monounsaturted fatty acids to saturated fatty acids ratio	1.98	1.58

*From the Spanish Ministry of Agriculture, Fisheries, and Food, and National Statistical Institute.

Table 6 Essential dietary indicators in the Mediterranean diet

Indicator	Range	Major contributors
Monounsaturated fatty acids /saturated fatty acids	1.6–2.0	Olive oil
Dietary fiber intake as indigestible fraction intake (g/person/day)	41–62	Cereals: white bread; pasta; rice Fruits: orange; apple; grape Nuts: walnut Vegetables: tomato; potato Legumes: dry beans; chickpeas
Antioxidant activity intake (μmol trolox equivalent/person/day)	3500–5300	Coffee; wine Fruits: Orange; apple; grape Vegetables: tomatoes; onions; capsicum; garlic Legumes
Phytosterols intake (mg/person/day)	370–555	Vegetables oils: Sunflower; olive Cereals: white bread Fruits: orange Legumes: chickpeas Vegetables: tomatoes

FUNCTIONAL FOODS AND HEALTHY DIETS

Nowadays, the market offers consumers a large variety of functional foods, dietary supplements, and traditional foods enriched with DF and bioactive compounds. The health claims of these products are often based on short-term studies conducted with doses which exceed the amounts consumed in common diets, while the real effects of long-term consumption are unknown. In order to avoid dietary disorders associated with uncontrolled consumption of functional foods and dietary supplements, it seems only prudent not to exceed the amounts historically ingested in human diets. The intake of bioactive compounds in recognized healthy diets such as the MD may serve as a benchmark until scientific knowledge in this field is sufficiently advanced to establish daily allowances.

A healthy diet, besides the required amounts of energy and nutrients, assures an adequate MUFA/SFA and a sufficient daily intake of DF and bioactive compounds to produce significant effects in the prevention of chronic diseases. Traditional mediterranean foods are rich in these compounds and the MD is a specific type of healthy diet.

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