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An Epidemiological Study Report on the Antioxidant and Phenolic Content of Selected Mediterranean Functional Foods, Their Consumption Association with the Body Mass Index, and Consumers Purchasing Behavior in a Sample of Healthy Greek Adults

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Abstract: Functional food consumption is shown to have a positive effect on anthropometric parameters and human health promotion. In addition, consumers seem to be more interested in food choices, that may have a positive effect on their health. The current study aimed to identify the antioxidant and phenolic content of naturally functional foods from the Mediterranean diet and to investigate consumer behavior towards their consumption in terms of their weight control, as well as their purchasing behavior and knowledge of functional foods. For this purpose, blueberries, cranberries, pomegranate, grapefruit, red peppers, almonds and mountain tea were analyzed for their phenolic content and antioxidant capacity, using the Folin-Ciocalteu and Ferric Reducing Antioxidant Power assays, respectively. Furthermore, nine hundred forty-nine healthy Greek adults participated in an epidemiological study, by completing a validated food frequency questionnaire, for the consumption of the above investigated functional foods. Five hundred and fifty participants also completed an online questionnaire investigating factors that consumers evaluate when purchasing functional foods. Study results showed that the analyzed functional foods were high in antioxidants and phenolic compounds, especially the mountain tea. The increased consumption of cranberries, pomegranate, grapefruit, red peppers and mountain tea was significantly correlated with a decreased Body Mass Index, suggesting a possible positive role, in weight control. Participants seemed to be aware of the beneficial role of these specific investigated Mediterranean functional foods to human health. They evaluated the price, taste and nutritional value, as critical factors to buy these food products. A combination of factors seems to lead them to purchase and consume these functional foods. Future epidemiological and clinical studies should be conducted in order to further evaluate consumer preferences and bioactivity mechanisms related to Mediterranean functional food consumption.

Keywords: berries; pomegranates; grapefruits; red peppers; almonds; mountain tea; antioxidant content; Mediterranean functional foods; body mass index; consumer's preferences

1. Introduction

The term “functional foods” first appeared in Japan in 1984, when the country's scientific community defined them as foods that meet nutritional needs, provide satisfaction and have a positive effect on the human body [1]. Nowadays, researchers use

the term “functional” for foods that contain bioactive compounds, such as antioxidants, fiber, phytosterols, probiotics and prebiotics and their consumption is associated with possible health promotion [2]. Foods with functional properties are used as an important component for healthy diets and for the prevention of several diseases [3–6]. Scientific data indicate that functional foods may contribute towards the prevention of the prevalence of chronic diseases including metabolic syndrome and obesity [7,8]. Given the fact that obesity remains a global burden [9], a balanced diet and functional foods could contribute complementarily, to reduced comorbidities [7].

The consumption of several types of functional foods, such as green tea, green coffee, red peppers, blueberries, goji berries, cranberries, nuts, kefir, etc. have been investigated as potential parameters for weight control [10]. Their content of functional ingredients, especially antioxidant compounds, polyphenols, such as quercetin, tannins, anthocyanins and other flavonoids, vitamins, minerals, carotenoids and probiotics, has been studied for its association with the mechanisms of thermogenesis, lipolysis and satiety [11]. In the Mediterranean diet, the consumption of natural functional foods, such as specific fruits, vegetables, legumes, wild greens, herbs, nuts, olives, and olive oil, rich in a plethora of bioactive compounds, has been associated with the prevention of chronic diseases and overall health promotion [5,6,11]. However, factors, such as the growing location, cultivation practices and genetic factors influence the antioxidant activity of these foods [12,13]. Therefore, differences may exist among vegetables and fruits originating from different countries.

In the last decades, the evident health benefits associated with the consumption of functional foods, have become more popular among consumers [14]. Consequently, consumer needs for nutritious food choices have led to a growth in the global functional food market [15]. Therefore, understanding the preferences and reasons that lead consumers to their food purchasing choices, remains crucial for the sector [16]. It will also help health professionals and researchers to raise awareness on healthy food choices in a more suitable way, in order for nutritional policies to be established [17]. However, implemented studies have found mixed and contradictory factors affecting consumer behavior, such as price of functional foods [18], health benefits [19] and even different socioeconomic characteristics and socio-cultural factors [15]. Country-specific studies will contribute towards shedding light on consumer perceptions and better understand their needs.

In Greece, specific studies have shown that functional food consumption is not widespread, although consumers are aware of the potential association of functional foods with health promotion [20,21]. Therefore, a better understanding of consumer food choices, while also determining the nutritional content of functional foods and strengthening the hypothesis of their beneficial role to health, could have a significant impact on the utilization and acceptance of functional foods.

The objective of the present study was to identify the total phenolic content and the total antioxidant activity of blueberries, cranberries, pomegranates, grapefruits, red peppers, almonds and mountain tea, natural functional foods cultivated in Southern Greece and often consumed as part of the Mediterranean diet. In parallel, this is the first epidemiological study to our knowledge that was conducted in Greece and provides an insight into the association between consumption frequency of foods studied for their antioxidant activity and the Body Mass Index (BMI) of the consumers, as well as the consumers’ preferences over these products and functional foods in general.

2. Materials and Methods

In the context of the present study, an *in vitro* study was carried out to evaluate the antioxidant capacity and total phenolic content of various selected Mediterranean functional foods cultivated in Southern Greece, that have been associated with possible impacts on weight control. In addition, an epidemiological study was performed to investigate their consumption and the consumer preferences in a sample of healthy adults

from various regions of Greece without chronic diseases, such as cardiovascular diseases, diabetes, and cancer.

2.1. *In Vitro* Study of Antioxidant Content

2.1.1. Preparation of Sample Extracts

Blueberries ($n = 15$), cranberries ($n = 15$), pomegranates ($n = 5$), grapefruits ($n = 5$), red peppers ($n = 5$) and almonds ($n = 15$) were purchased from local market in Lemnos Island, Greece. The origin of the selected fruits and vegetables was from Southern Greece. At least five samples were used from each food product and pooled together. Then they were homogenized using a kitchen blender. Two grams of each food were added in a conical flask with 50 mL of 50% aqueous ethanol. The flasks were placed in an ultrasonic water bath (ELMASONIC P, ELMA, Singen (Hohentwiel), Germany) for 1 h. Filtration of the extract was followed by filter paper. For the preparation of mountain tea extract, 1 g of the plant was immersed in 50 mL of warm water for 5 min, following by filtration of the extract.

All extracts were collected in plastic tubes and stored at $-80\text{ }^{\circ}\text{C}$, until further analysis.

2.1.2. Determination of Antioxidant Content

Total Antioxidant Activity by Ferric Reducing Antioxidant Power Assay

The total antioxidant activity of samples (food extracts) was determined by the ferric reducing antioxidant power (FRAP) assay [18,22,23]. This method is based on the conversion of the TPTZ- Fe^{+3} complex to TPTZ- Fe^{2+} and determining its amplitude by measuring the absorbance at 595 nm with a spectrophotometer (SPARK, TECAN, Männedorf, Switzerland). The larger absorption difference is related to the greater capacity of the antioxidant to convert TPTZ- Fe^{+3} complex to TPTZ- Fe^{2+} . Antioxidant activity was quantified using a FeSO_4 curve and the results of FRAP assay are expressed in mmol of Fe^{2+} equivalents per gram of food sample. Analysis was performed in triplicate. All reagents were purchased by Sigma-Aldrich (Steinheim, Germany).

Total Phenolic Content by Folin-Ciocalteu Assay

The total phenolic content of the samples was determined by the Folin-Ciocalteu method. This method is based on the reduction of the Folin-Ciocalteu reagent in an alkaline environment and measurement of the absorbance at 765 nm with a spectrophotometer (SPARK, TECAN, Switzerland) [24,25]. The total phenolics were quantified using a standard gallic acid curve and the results were expressed in milligram gallic acid equivalents per gram of food sample. Analysis was performed in triplicate. All reagents were purchased by Sigma-Aldrich.

2.2. *Epidemiological Study*

2.2.1. Participants

Out of 1073 initially distributed questionnaires, 949 were validly completed by the participants. Participants who were selected were healthy adults aged 18–65 years old, from different regions of Greece and completed the online questionnaire with a duration from January 2017 to October 2019. The recruitment of the participants was carried out via social media and online announcements, in a random and representative way (according to the different areas of northern, central, and southern Greece). The inclusion-selection criteria also required volunteers to be healthy adults who had never suffered from chronic diseases, inflammations, or infections, such as cardiovascular diseases, diabetes mellitus, cancer and psychological diseases. These criteria were chosen aiming to better investigate the potential role of functional foods to healthy adults and their opinion about functional food consumption, as the presence of other chronic diseases such as cancer, cardiovascular diseases and diabetes may change the dietary patterns of the participants and may be correlated with weight management programs adoption. Exclusion criteria encompassed

individuals over the age of 65 and under the age of 18 years, due to the different nutritional needs of younger people and the elderly.

2.2.2. Study Design

The study was a retrospective, observational, epidemiological study. The study protocol was conducted in accordance with the Declaration of Helsinki. The participants signed a consent form and were informed about the prime target of the study, the confidentiality of the data, the voluntary nature of the study and the acceptance of their participation. Then, they completed an online questionnaire to assess their dietary patterns and functional food consumption frequency, where they were asked to recall their nutritional habits for the past year. For the determination of their Body Mass Index (BMI), self-reported weight and height were provided. Five hundred and fifty participants out of the nine hundred and forty-nine initially registered to the study also completed another questionnaire to investigate their awareness of dietary functional foods and factors affecting their attitudes and intentions, towards functional food purchasing. However, it should be noted that the study aimed to investigate consumer behaviors about functional foods in a healthy population, due to the possibility of an altered opinion in the case of the presence of pathological situations.

2.2.3. Functional Food Consumption Evaluation

Functional food consumption was evaluated by a validated questionnaire. This questionnaire was a food frequency questionnaire (FFQ) similar to the one used in NHANES (National Health and Nutritional Examination Survey) study [26], with some modifications. Particularly, changes were carried out with a view to include more natural functional foods, without alterations to the type of questions [11]. Participants were informed on the suggested portion sizes of each of the included foods and were asked based on that about their usual frequency of consumption. The frequency of consumption was recorded as 'everyday', '3–6 times per week', '2 times per week', 'once a week', '1–2 times per month' and 'seldom/never'. The questionnaire also included questions regarding demographic characteristics (age, gender, occupation, etc.), anthropometric indicators (weight, height), history of clinical condition and a general nutritional history of the participants.

An extension of this questionnaire was completed by a subsample of 550 participants and included questions on the factors affecting their purchasing of functional food choices and namely the price, nutritional value, taste, brand, packaging and health benefits, as well as their knowledge about functional foods.

2.2.4. Anthropometric Data

Participants self-reported their weight and height. BMI was calculated by dividing weight (kg) by squared height (m^2). The classification of the participants according to their BMI was conducted following WHO guidelines [27,28]. Specifically, participants with a BMI lower than $18.5 \text{ kg}/m^2$ were classified as underweight, overweight with a BMI greater than or equal to $25 \text{ kg}/m^2$ and obese when their BMI was greater than or equal to $30 \text{ kg}/m^2$.

2.2.5. Statistical Analysis

Statistical analysis was performed using the SPSS package, version 16.1 (SPSS Inc, Chicago, IL, USA). We deemed statistical significance at $p = 0.05$. The total antioxidant and phenolic content of the selected food products were expressed as the mean \pm standard deviation (SD). Kruskal–Wallis and Duncan's multiple comparison tests were used to investigate the differences between the food samples. The frequency of functional food consumption, as well as eating habits and preferences of the participants, was presented using descriptive statistics. The Pearson test was conducted for analyzing the correlation between BMI and food frequency consumption and the chi-square test to test differences between genders regarding their knowledge and preferences on functional foods.

3. Results

3.1. In Vitro Study

The results of the determination of the total antioxidant activity with the FRAP assay are presented in Figure 1. Antioxidant activity of mountain tea presented significantly statistical differences with all the analyzed samples, namely blueberries ($p < 0.005$), cranberries ($p < 0.001$), pomegranate ($p < 0.001$), grapefruit ($p < 0.001$), red peppers ($p < 0.001$) and almonds ($p < 0.001$). More specifically, mountain tea had the greatest antioxidant activity 335.19 ± 5.07 mmol Fe^{2+} /g of sample, followed by pomegranate with 106.29 ± 2.82 mmol Fe^{2+} /g, blueberries with 74.05 ± 1.92 mmol Fe^{2+} /g and almonds with 67.80 ± 1.67 mmol Fe^{2+} /g, respectively, without exhibiting statistically important differences. Red peppers with 36.55 ± 4.91 mmol/L, cranberries 36.73 ± 5.85 mmol Fe^{2+} /g and grapefruits with 28.07 ± 2.67 mmol Fe^{2+} /g, had lower total antioxidant activity, but this was not statistically significant.

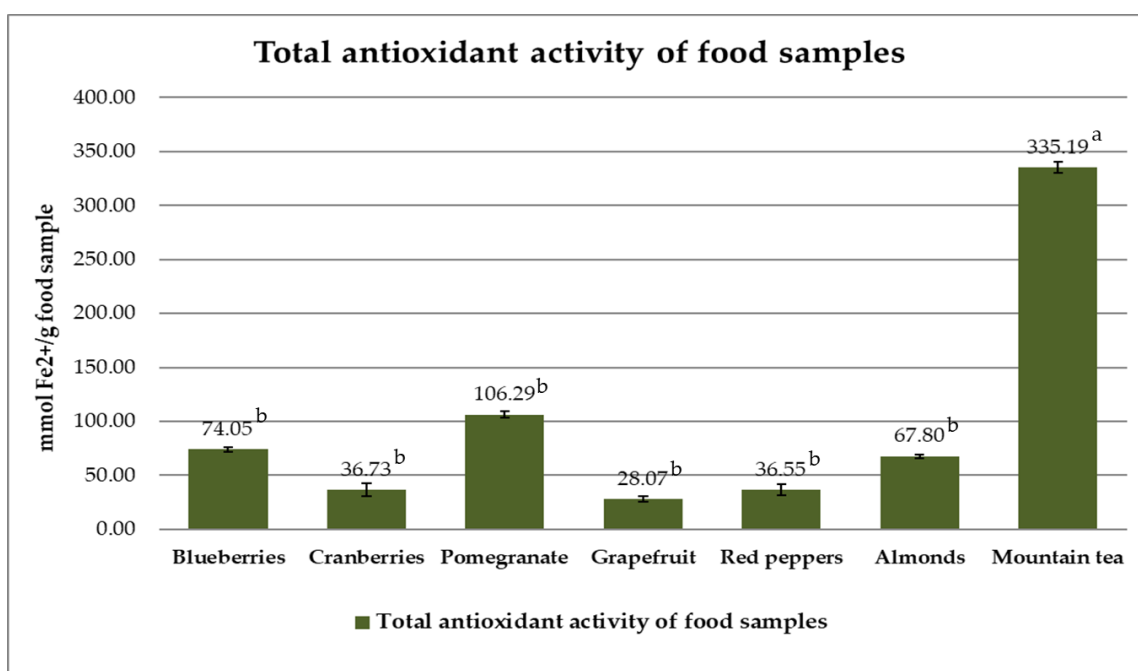


Figure 1. Mean values of total antioxidant activity of different food extracts as determined by Ferric Reducing Antioxidant Power (FRAP) assay. Statistically significant differences are portrayed with superscripts (different letters).

The mean values and the statistically important differences of the total phenolic compounds quantified in the food extracts by Folin-Ciocalteu analysis are presented in Figure 2. The highest content of phenolic compounds was determined in the mountain tea extract with a mean value of 867.95 ± 6.89 mg gallic acid/g of food sample. Next were almonds with 355.00 ± 2.17 mg gallic acid/g, blueberries with 171.25 ± 0.84 mg gallic acid/g, and pomegranate with 90.51 ± 1.13 mg gallic acid/g. Grapefruit with 78.52 ± 0.61 mg gallic acid/g, cranberries with 66.65 ± 0.86 mg gallic acid/g and red peppers with 49.51 ± 0.76 mg gallic acid/g were the samples with the lowest concentrations of total phenolic content. Statistically important differences were observed between the mountain tea and all the analyzed food samples ($p < 0.001$), except for almonds ($p > 0.05$). The total phenolic content of almonds also exhibited statistically important differences compared to all analyzed foods, except for mountain tea ($p < 0.001$). In addition, statistically important differences were observed between the total phenolic content of blueberries and red peppers ($p < 0.05$).

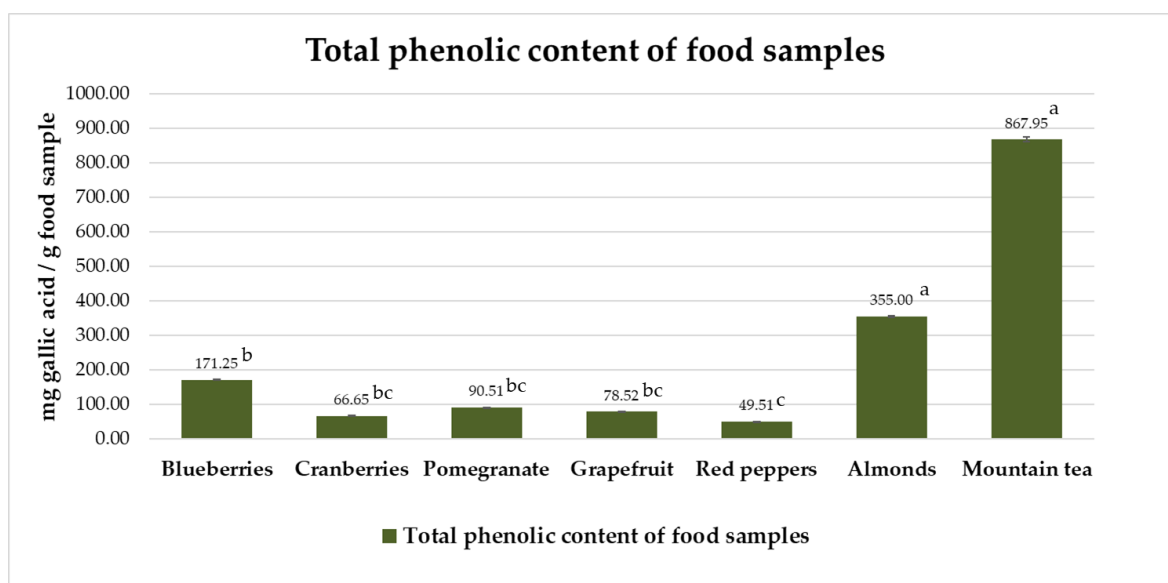


Figure 2. Mean and SD values of total phenolic content of different food samples as determined by the Folin-Ciocalteu assay. Statistically significant differences are portrayed with superscripts (different letters).

As summarized in Table 1, there are several studies in the literature referring to the total antioxidant and phenolic content of the selected foods determined with FRAP and Folin-Ciocalteu assay.

Table 1. Mean concentrations of total phenolic content and total antioxidant activity of blueberries, cranberries, pomegranates, grapefruits, red peppers, almonds, and mountain tea reported in literature.

Food Sample	Origin of Samples	FRAP Assay (mmol Fe ²⁺ /g)	Folin-Ciocalteu (mg GA/g)	Study
Blueberries	Poland	-	0.52	Olas et al. [29]
	Turkey	-	1.58–27.84	Gundesli [30]
	Turkey	-	2.65–3.67	Zorenc et al. [31]
	Italy	1.98–10.29	-	Zorzi et al. [32]
	Brazil	0.25–0.31	19.22–34.56	Pertuzatti et al. [33]
	Australia	0.37	2.93	Subbiah et al. [34]
Cranberries	Poland	-	1.20–3.15	Olas et al. [29]
	Poland	1.02	-	Oszmianski et al. [35]
	Hawaii	0.45	-	Hummer et al. [36]
	USA	-	1.60	Kovacev et al. [37]
	Poland	-	2.5	Skowron et al. [38]
Pomegranates	Spain	61.28	40.74	Martinez et al. [39]
	Croatia	10.03–17.66	57.66–105.99	Peršurić et al. [40]
	Iran	-	22.61	Basiri et al. [41]
Grapefruits	Cina	0.93–1.76	-	Xi et al. [42]
	China	23.46	-	Chen et al. [43]
	Poland	0.46	0.05	Muzykiewicz et al. [44]
Red peppers	Brazil	0.004	1.19	Sora et al. [45]
	Iran	0.5	-	Shotorbani et al. [46]
	Thailand	0.28	3.21	Thuphairo et al. [47]
	Malaysia	0.003	47.06	Huei et al. [48]
Almonds	Italy	0.041 mmol Fe ²⁺ /g	-	Pelegri et al. [49]
	California	36.8–88.8 mmol Fe ²⁺ /g	0.58–1.59	Bolling et al. [50]
	China	-	8	Qureshi et al. [51]
	Italy	-	334.20	Bottone et al. [52]
	Italy	-	21.43–141.06	Bottone et al. [53]
Mountain tea	Greece	0.03–0.11	2.37–4.56	Linardaki et al. [54]
	Greece	0.13	18.63	Goulas et al. [55]
	Spain	-	102.54	de la Puerta et al. [56]

3.2. Epidemiological Study

According to the demographic characteristics recorded in the epidemiological study, a total of 949 participants (524 women and 425 men) took part in the study, with 51.0% aged between 18 to 29 years old. The majority of the participants weren't married (51.3%) and had reached a higher educational level (53.8%). The demographic profile of the participants of the study is depicted in Table 2.

Table 2. Profile of the participants of the epidemiologic study.

Gender	N	%
Female	524	55.2
Male	425	44.8
Age		
18–29	484	51.0
30–39	214	22.6
40–49	170	17.9
50 and above	81	8.5
Marital Status		
Single/never married	487	51.3
Currently married	401	42.3
Widowed	36	3.8
Divorced/separated	25	2.6
Education		
Primary Education	78	8.2
Secondary Education	285	30.0
Higher Education	511	53.8
Master/Doctoral	60	6.3
Other	15	1.6
Total	949	100

In addition, most of the participants (67.7%) were nonsmokers and 35.5% of them were exercising at least two times per week. In terms of their BMI distribution, 1.7% were within the underweight range, 35.7% were evaluated as healthy, 36.2% as overweight, and 26.3% as obese.

Consumption frequencies for the above investigated functional foods namely for the consumption of blueberries, cranberries, pomegranates, grapefruits, red peppers, almonds and mountain tea and their association with the BMI of the participants, are presented in Table 3.

Table 3. Frequency of consumption of blueberries, cranberries, pomegranates, grapefruits, red peppers, almonds, and mountain tea by the participants.

Food Item	Seldom/Never (%)	1–2 Times Per Month (%)	Once A Week (%)	2 Times Per Week (%)	3–6 Times Per Week (%)	Everyday (%)
Blueberries	0.8	3.8	7.3	20.5	60.3	7.5
Cranberries	25.6	18.0	11.0	14.5	24.2	6.6
Pomegranates	17.5	29.9	17.2	17.9	16.4	1.1
Grapefruits	0.1	2.3	6.5	19.5	57.6	14.0
Red Peppers	0.1	2.3	6.5	19.5	57.5	14.0
Almonds	4.3	9.0	18.3	43.0	23.0	2.5
Mountain Tea	15.9	23.1	20.5	21.0	15.1	4.4

The Pearson correlation analysis between BMI and the consumption of the different foods, showed a negative correlation in the case of cranberries ($r = 0.310$, $p < 0.001$),

pomegranate ($r = 0.190$, $p < 0.001$), grapefruit ($r = 0.179$, $p < 0.001$), red peppers ($r = 0.134$, $p < 0.05$) and mountain tea ($r = 0.167$, $p < 0.001$). Specifically, the increased consumption of these functional foods correlated significantly with decreased BMI. No statistically significant correlation was observed for blueberry and almond consumption (Table 4).

Table 4. Association of functional foods consumption with Body Mass Index (BMI) of the participants.

Pearson Correlation		BMI
Blueberries	R	−0.010
	<i>p</i>	0.839
Cranberries	R	−0.310 *
	<i>p</i>	0.000
Pomegranates	R	−0.190 *
	<i>p</i>	0.000
Grapefruits	R	−0.179 *
	<i>p</i>	0.000
Red Peppers	R	−0.134 *
	<i>p</i>	0.007
Almonds	R	−0.007
	<i>p</i>	0.887
Mountain Tea	R	−0.167 *
	<i>p</i>	0.000

* Correlation is significant at $p = 0.05$ level.

A subsample of 550 participants completed an extension of the questionnaire by answering a question regarding their functional food purchasing preferences. The participant's knowledge of the term and properties of "functional foods" was also evaluated. Of the participants, 62.9% correctly reported that functional foods are foods that have beneficial components and 29.8% had a wrong belief regarding functional foods, such as they are in the form of pills, are organic, genetically modified and 17.3% were not aware of the term "functional food". In addition, they were asked how price, taste, package, brand and reported health benefits affect their choice when buying functional foods. As seen in Table 5, price, taste, health benefits and nutritional value of functional foods significantly affected the purchasing options of both male and female consumers. Price was the only factor that statistically affected the choices between males and females ($p < 0.001$).

Table 5. % Percentages of participants replies regarding how (not at all, neutral, much) price, taste, package, brand, reported health benefits and nutritional value affects their functional food purchasing choices.

		Price	Taste	Package	Brand	Health Benefits	Nutritional Value
Male (n = 247)	Not at all	9.7%	8.1%	49.0%	44.1%	6.1%	4.9%
	Neutral	38.5%	40.9%	39.7%	38.9%	17.4%	19.0%
	much	51.8%	51.0%	11.3%	17.0%	76.5%	76.1%
Female (n = 303)	Not at all	8.3%	5.3%	47.5%	39.9%	4.3%	2.6%
	Neutral	33.7%	28.1%	39.9%	43.2%	16.5%	20.8%
	much	57.8%	66.7%	12.5%	16.8%	79.2%	76.6%

4. Discussion

In the last decade, functional foods have been extensively studied, with the application of in vitro methods, for the determination of their total antioxidant capacity and phenolic content, as well as the quantification of their specific bioactive compounds. In the present study, we evaluated the total antioxidant and phenolic content of blueberries, cranberries, pomegranates, grapefruits, red peppers, almonds, and mountain tea. Among them, moun-

tain tea and almonds had the highest values for total phenolics; mountain tea additionally exerted the highest values of total antioxidant capacity. Previously published studies on the determination of the antioxidant and total phenolic content of the above-studied foods, however, presented a wide range of values. This may be due to differences in the extraction method during sample preparation, differences in the variety of the analyzed sample [57], as well as differences in the climatic and soil conditions [58] and therefore the origin of the samples. Recent studies suggest, that foods high in antioxidants over the range of 0.87 mmol Fe²⁺/g of dry sample can be used for the fortification of yogurt [59] and can increase the concentration of total antioxidant compounds of the final product [60]. Therefore, we can assume that mountain tea, almonds, blueberries, and pomegranates cultivated in Southern Greece can be used as a potential source of antioxidants, either by consuming them as a whole or in the form of extracts for the enrichment of foods, that present benefits to human health.

Epidemiological, as well as interventional studies, support the association between the consumption of foods rich in antioxidants and phenolic compounds with weight control [10,61]. Aiming to investigate this hypothesis, the consumption of the above investigated functional foods was evaluated in terms of their association with the BMI of the consumers. The selected functional foods are usually consumed as part of the Mediterranean diet and they have previously been correlated with a possible role in obesity prevention [10]. Indeed, frequency of consumption showed an association with the BMI of the people that habitually consumed them. More specifically, participants that were frequently consuming cranberries, pomegranates, grapefruits, red peppers, or mountain tea, were observed to have lower BMI values. Several studies indicated that functional foods may have a potential effect on anthropometric indicators and thus, on human health and that antioxidants may contribute towards the management of obesity [62]. In a study by Ntrigios et al. (2019), the frequent consumption of goji berry, cranberry and pomegranate has concluded in a reduced BMI [11]. Antioxidant activity is suggested to ameliorate the inflammation and oxidative stress caused by obesity and is thus considered to potentially benefit inpatients [63,64]. Therefore, taking into consideration that obesity, as part of a metabolic syndrome, is a major lifestyle disorder around the world, a healthy diet and functional food consumption can act as a complementary approach, aiming to decrease the incidence of the disease [7]. The synergistic effect of both antioxidant and other bioactive compounds of the specific functional foods may affect procedures, such as fatty acid oxidation, lipolysis, thermogenesis, and satiety, contributing to BMI reduction and weight control. According to our opinion, this study in a healthy population underlines the trends about possible correlations between specific functional food consumption and BMI, contributing to the establishment of nutritional policies about obesity prevention. However, more interventional studies should be performed for safer and clearer results [10]. Nevertheless, other studies with different designs should also be conducted in order to further investigate the association between functional food consumption and weight gain in patients with chronic diseases, such as obesity and metabolic syndromes.

In order to take advantage of the possible health benefits of the above investigated functional foods, it is important for consumers to get familiar with their consumption and include them in their daily diet. The majority of the consumers that participated in the current study, seemed to purchase and consume blueberries, grapefruits and red peppers. Only the minority of the participants consumed blueberries, cranberries, pomegranates, almonds and mountain tea on a daily basis, although their health benefits are evident [10]. It remains interesting, that previous studies conducted in Greece, investigating the frequency of consumption of fruits and vegetables reported that most of the participants consumed them on a daily basis [65]. However, in our study blueberries, cranberries, pomegranates, and almonds were not observed to be in a consumer's weekly choice. In addition, although Greece has a history in herb cultivation [66], preparation and consumption of hot beverages from these herbs are not yet popular among consumers [67].

Therefore, it remains important for consumers to be informed about the health benefits of the above-investigated foods and to incorporate them into their diet. However, studies have shown that consumers often cannot understand how specific foods can contribute to the promotion of their health and the role that specific nutrients present [68]. As health is assumed an important factor affecting consumers in their choice of purchasing food products [19], it can be used as a driver to raise awareness on functional foods [15]. In addition, to achieve so, it also remains important to understand better the perceptions and attitudes of consumer purchasing behavior in terms of functional foods in general.

Our study showed that, although consumers were not familiar with the term “functional food”, as recently also Tsatsou et al. noted [21], they seemed to be aware of the beneficial components of functional foods, which is in accordance with another study conducted in Greece [14]. When purchasing functional foods, they were greatly evaluating the price, taste, reported health benefits and nutritional value of the products. The information included in the label of foods, such as the reported health claims and nutritional value, were therefore positively affecting consumer purchasing choices [69] and should provide consumers with the adequate information on the beneficial role of food products, always in accordance with EU Commission principles [70] to avoid misleading them [71]. However, it should be noted that consumers are not always familiar with the terms used to describe the nutritional value of products, and therefore it remains important to promote an understanding of the beneficial role of nutrients [68], such as in the case of antioxidant and phenolic compounds [72]. In addition, it is reported that consumers are not aware of the specific nutrient food sources for antioxidants and phenolics [73,74], and this can be evaluated as a barrier affecting their food purchasing behavior. On the other hand, high price seems to negatively affect consumer intentions to buy functional foods [18]. Although consumers seem to be willing to pay higher prices for high nutritional value products [75], the exact price depends on their preferred nutritional properties [19]. However, as assumed in other studies, consumers may seem reluctant to purchase a product by choosing health benefits over taste [76]; therefore, taste remains an important factor for consumer choices. In our study brand familiarity of the products seemed to affect consumers neutrally, potentially because of their stated interest in healthy food choices [77]. Studies have concluded in diverse results regarding brand influence on consumer choices with some reporting high influence and other reporting modest [78]. Country-specific differences seem to play an important role in consumer preferences and attitudes [75,79]. Therefore, it remains important to explore the factors that influence consumer attitudes and intentions towards purchasing functional foods, based on cultural differences.

Finally, some limitations of the present study should be considered. Antioxidant activity and the phenolic content of food samples could also be determined with a more accurate methodology such as High-Performance Liquid Chromatography (HPLC) analysis for the quantification of the consumed polyphenols and other antioxidant components. Moreover, although participants of the study were across Greece, the sample cannot be assumed as representative of the overall population, mainly in terms of socio-economical characteristics and income category. Therefore, the results regarding BMI association with frequency of consumption of the investigated functional foods, as well as the functional food purchasing behavior of the consumers, should be interpreted carefully, as differences may occur comparatively to the general population preferences and characteristics. Thus, larger interventional and clinical studies should be performed in order to determine more accurately the association between the consumption of the above-investigated foods and the BMI of the consumers, as well as the behavioral trends and digestibility of the consumed bioactive compounds. Furthermore, for this study, we selected specific natural functional foods of the Mediterranean diet, based on their possible association with BMI reduction, and therefore we did not include products assumed as main components of this specific diet, such as olive oil.

5. Conclusions

In conclusion, blueberries, cranberries, pomegranates, grapefruits, red peppers, almonds and mountain tea exhibited increased antioxidant activity and phenolic content while their consumption is potentially related to BMI and weight control. Rising health consciousness among consumers regarding the beneficial role of Mediterranean functional foods to human health can act as an important driver for their acceptance and incorporation into their daily diet. However, it remains essential to always take other factors into consideration such as the price and taste of the functional products. The present study could contribute to the initial understanding of functional food consumption in the Greek population in order for nutritional policies to be established with the aim of health promotion. However, more research, clinical and epidemiological studies, should be performed in order to further investigate the mechanisms that specific Mediterranean functional foods may contribute to weight management and disease prevention, as well as consumer behaviors about functional foods.

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