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Research Article

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Nutritional and Chemical Quality of Traditional Spreads and Pies of Mediterranean Diet of Greece

Charis Girvalaki[1]*, Constantine I Vardavas[1], George Tsimpinos[1], Georgia Dimitreli[2], Maria N Hassapidou[2] and Anthony Kafatos[1]

Abstract

The value of the Cretan diet and its important role in health promotion and disease prevention emerged mainly through the "Seven Countries Study". The term "Mediterranean diet" is widely used to describe a common dietary pattern of the Greek and southern Italian populations, that was first documented in the 1960's, with adherence to this type of diet and lifestyle, found to lead to long life expectancy and low risk of coronary heart disease.

Traditional spreads and pies are two food groups widely consumed by the Greeks. During preparation of traditional spreads and pies, essential components of the "Mediterranean diet", such as olive oil, wild greens, vegetables, cheese and fish products are used. Ten of the most frequently consumed traditional spreads and pies were chemically analyzed for macronutrient, fatty acid and micronutrient content.

Our study showed that saturated fatty acid levels in both pies and spreads were higher than that of monounsaturated and polyunsaturated fatty acids, contrary to the traditional properties of the "Mediterranean diet". Furthermore, while all products exceeded the recommended Ω-6/ Ω-3 ratio, olive oil still appears to have a dominant role in the Cretan diet. The analyzed traditional products also had elevated concentrations of Ω-6 fatty acids. In conclusion, the importance of the Mediterranean diet in public health is beyond doubt. However, there are several indications in this study that confirm important changes in dietary habits, such as the increased consumption of saturated fatty acids, the decrease in monounsaturated and polyunsaturated fatty acid contribution to daily diet, and the imbalance of Ω-6/ Ω-3 ratio.

Keywords

Mediterranean diet; Traditional spreads; Pies; Micronutrients; Macronutrients; Fatty acids

Abbreviations

SFA: Saturated Fatty Acid; MUFA: Monounsaturated Fatty Acid; PUFA: Polyunsaturated Fatty Acid; TFA: Trans Fatty Acid; TF: Total Fat; CHD: Coronary Heart Disease

***Corresponding author:** Charis Girvalaki, Preventive Medicine and Nutrition Clinic, Department of Social Medicine, Faculty of Medicine, University of Crete, PO Box 2208, Heraklion 71003, Crete, Greece, Tel: 0030 2810 394599; Fax: 2810 394606; E-mail: charis.girvalaki@gmail.com

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Introduction

The term "Mediterranean diet" is widely used to describe a common dietary pattern of the Greek and southern Italian population, that was first documented in the 1960's. Adherence to this type of diet and lifestyle has been reported to lead to long life expectancy and lower risk of coronary heart disease [1,2].

The first study that indicated the important role of the Mediterranean diet and its impact on the population's health was the Seven Countries study, initiated over 45 years ago. It was the very first time that significant data was collected, in order to investigate the relationship between diet and chronic disease (cardiovascular and cancer), in heterogeneous populations of United States, Finland, Netherlands, Italy, Yugoslavia, Japan and Greece [3]. The results of the study showed that the population of Crete had the lowest prevalence of cancers and coronary heart disease, in comparison to the other participating populations [2].

The "Mediterranean diet" itself, is based on the elevated consumption of fresh fruits and vegetables, wheat, cereal, legumes, a moderate consumption of dairy products (mostly yoghurt and cheese), the rare consumption of red meat, less than four eggs per week, wine which was mostly consumed during meals, and finally olive oil, which occupies a central position, as the main source of lipids [4]. Another important factor of Mediterranean diet is the very high monounsaturated/saturated fat ratio [5]. The low saturated fat intake and the high monounsaturated fat intake, mostly through olive oil consumption, has been associated with lower rates of coronary heart disease. Furthermore, wine, fruits, vegetables and olive oil are enriched with many important antioxidants, such as vitamin C, vitamin E, lycopene, β-carotene and polyphenols. In addition the Ω-6/Ω-3 ratio is very low (between 2:1 and 1:1). This is an important factor for normal growth and development, as well as the prevention and management of cardiovascular disease, hypertension, diabetes, arthritis, and possibly, cancer [3]. The Mediterranean diet's impact on the low risk of developing cancer is also connected with its elevated fruit and vegetable intake, low consumption of red meat, defined carbohydrate intake and unsaturated fats [6]. These food categories are commonly found in traditional Greek dishes. This kind of diet combined with the elevated levels of physical exercise is believed to be the most important reason for the health and long life expectancy of the Cretan population [7]. Abundance of wild greens, rich in Ω-3 fatty acids, vitamins, antioxidants and essential fatty acids, is still a characteristic of the Greek daily diet, especially for the elderly during fasting days. Wild greens are consumed either fresh in salads, or cooked as a main ingredient in pies, as our study presents [8].

Traditional spreads and pies are a food group widely consumed by the population of Greece, as they are based on traditional recipes whose main ingredients are based on the traditional cuisine, and thus, on the guidelines of the Mediterranean diet. As they constitute an important factor of the daily diet of the population, the aim of our study was to assess the exact chemical composition of spreads and pies, in order to be able to understand their contribution to the diet of the population of Greece.

Materials and Methods

Sampling

Traditional food samples were purchased from local markets in different Greek cities. The salads (dressings) were taken from the four main Greek companies that produce them: Amvrosia, Delicatessen, BEM and Special Chef.

Sample preparation

Equal amounts of sample from each region were homogenized (using a mixer) and freeze-dried (Martin Christ, model Gamma 1-20, Germany). Freeze-drying parameters were as follows: pre-freezing to -25°C, drying at vacuum 2.460 mbar (- 12°C), and maximum temperature of product 25°C. Freeze-dried samples were milled, vacuum-packed and stored at 4°C before analysis. An amount of the homogenized non-freeze-dried samples was vacuum-packed and stored at 4°C for moisture determination. The sample of "taramosalata" was not freeze-dried, but analyzed as raw samples [9].

Moisture content determination

The moisture content of raw, as well as freeze-dried samples, was determined gravimetrically by heating the samples at 130 ± 1°C, till constant weight [9]. For the analysis, an amount of approximately 2-3 g of each sample was weighed, with the use of a previously weighed and dried sample-container with a lid.

Determination of the energy of the samples

The energy of the samples was determined by the combustion of the samples in a bomb calorimeter (Parr Instruments). Pellets of the freeze-dried samples, of approximately 0.5 g, were used for the analysis. The sample of "taramosalata" was analysed without the formation of pellets. The nutritional value of the samples was calculated as Kcal/g of raw or freeze-dried sample. The results of the freeze-dried samples were finally expresses as Kcal/g of raw sample, by using the moisture content of the freeze-dried samples [9].

Total fat

For the total fat determination, 3-5 g of prepared sample was digested with 50 ml of 4 M hydrochloric acid in a 250 ml conical flask by boiling gently for 1 h, while maintaining the liquid volume at 50 ml. After an hour, 150 ml hot water was added. A fluted hardened filter paper was moistened in a glass funnel, and the contents were filtered. The residue on the filter paper was washed with hot water. The washing continued, until the running did not give any acid reaction to test paper. The filter paper was dried on a watch glass in an oven. The paper was rolled and placed in an extraction thimble. The determination was completed by extraction with hexane or light petroleum ether 40-60°C, using the Soxhlet method [9].

Fatty acids methyl esters (FAME) preparation

Fatty acids of the analyzed samples were first transformed into fatty acid methyl esters (FAME), [10]. Briefly, 20-30 mg of lipid extract was transferred to 12 mL screw-capped Teflon coated vials and were saponified with 0.5 ml of 1N NaOH in methanol, at 80°C for 10 min. The FAME were prepared by adding 2 mL of 14% boron trifluoride in methanol and heating at 80°C for 4 min, washed with 3 ml of saturated NaCl, and extracted with 1 mL of hexane containing 100 ppm of BHT as antioxidant. After centrifugation at 3000 rpm for 4 min, the hexane (upper) layer containing the FAME was transferred to GC vials and stored at -20°C until analysis [10].

Gas chromatography analysis of FAME

For FAME analysis, 1 μl of the hexane layer was injected in the gas chromatograph, and the FAME were separated on a 50 mm ± 0.22 mm internal diameter BPX 70 capillary column, coated with a 0.25 μm film thickness of cyanopropyl silicone (SGE, Melbourne, Australia), using an Agilent (formerly Hewlett Packard, HP) HP-6890 gas chromatograph (Avondale, PA, USA), equipped with MSD-6890 mass ionization detector. HP MS Chemstation software was used for quantization and identification of peaks. Identification of peaks was accomplished by means of a standard mixture of 37 FAMEs purchased from Supelco, and by reference to the NIST 98 (NIST MS search v6.1d) mass spectra library [10]. The mixed FAME standard furthermore served for the calculation of fatty acid response factors. The calculated response factors were found to range between 0.88 and 1.15, and they were applied to the areas derived from the chromatographic traces. The chromatographic conditions employed were as follows: carrier gas: He, flow: 1.0 mL/min, inlet temperature: 230°C, mass detector transfer line temperature: 280°C. The oven temperature program was as follows: initial temperature 90°C and increase to 220 at 3°C/min, where it was held for 25 min [10].

Cholesterol

For cholesterol determination, 1 g of the prepared samples was saponified. Cholesterol was extracted from the saponified samples, and measured with the use of gas chromatography [9].

Determination of Ca, Mg, Fe, P

3-4 g of lyophilized samples were gradually heated with the use of infrared light and placed to desiccators, for at least four hours (500-550°C). Process was repeated, until the ashes were white. Then samples were freezed, dissolved with 2 ml of HNO_3, and transferred into a volumetric flask of 100 ml, filled with water until mark and shaked well. We measured the atomic absorption of 10 ml of each sample using a Perkin-Elmer 2100, multi element hollow cathode lamp. Atomic absorption was measured at 422.7 nm for Ca determination, 285.2 nm for Mg, and at 248.3 nm, for Fe determination.

For P determination, 10 ml of the sample were transferred to several tubes, along with 4 ml of molybdovanadate reagent, stirred well and left for 10 minutes, till the final colorization. Optic densities were then measured using a spectrophotometer at 400 nm [9].

Determination of K, Na, Se, Cr

100 ± 2 mg, of each sample are chemically processed and transferred to an Anton- Parr microwave. After digestion process, samples were filled with HNO_3, until 11 ml of final volume. The detection of the metals was performed with ICP Leeman Labs model PS-1000AT, with the use of standardized control solutions. K was measured at 766.491 nm, Na at 588.995 nm, Cr at 205.552 nm and Se at 196.090 nm [9].

Proteins

For the protein content determination, we used 0.001 g of each sample, in order to calculate the amount of the protein from the nitrogen concentration of the sample, according to Kjeldahl's method [9].

Carbohydrate determination

In order to determine the carbohydrates content of the samples, extraction of the sugars was held with the use of ethanol (80% v/v). The extract was then refined and diluted with pure water. We examined 10 ml of each sample, as for the total assimilable carbohydrates content, which was finally determined with the use of phenol-sulphuric colorimetric method. Each sample was tested twice [9].

Results

Table 1 summarizes the macronutrient composition of the traditional spreads and pies of Greece sampled in our study. The total fat content of the dishes ranged from 17.8 g/100 g to 41.5 g per 100 g of product. For spreads, Taramosalata was found to contain the highest concentration of total fat, and for pies, cheese pie sfoliata had the highest and squash pie with cheese, the lowest. Saturated fatty acids (SFA) for spreads were found within a wide range, from 12.2% to 50.1% of the total fat content. Tzatziki had the highest concentration of SFAs and Melitzanosalata, the lowest. SFAs range for pies was from 30.5%/TF (cheese pie sfoliata) to 54.1%/TF (spinach pie for fasting). The content of cis-monounsaturated fatty acids (MUFA) of spreads ranged from 14.5%/TF (Tzatziki) to 20.4%/TF (chtipiti), and for pies from 21.2%/TF (spinash pie for fasting) to 26.1%/TF (cheese pie sfoliata). Cis-polyunsaturated fatty acids (PUFA) for spreads range was between 33.8% (tzatziki) to 68.1% (aubergine spread) of the total fat content. Spinach pie for fasting was the pie with the highest level of PUFAs (45.8%/TF), in comparison to the other 5 products. As for trans-fatty acids (TFA), the range for pies was from 1.6%/TF (spinach pie for fasting) to 3.9%/TF (cheese pie sfoliata), while the concentration of TFAs in spreads was 0.5%/TF (Tzatziki, Chtipiti). Ω-3 fatty acid concentrations for spreads were found to range between 3.9% (tzatziki) to 7.5% (aubergine spread) of the total fat content. As for pies, the lowest concentration was found in leek pie for fasting (0.5%/TF), and the highest in spinach pie with cheese and traditional cheese pie. Ω-6 fatty acids for spreads ranged between 29.9%/TF (tzatziki) to 60.7%/TF (aubergine spread). Linoleic acid was also highest in spinach pie (45.0%/TF), and lowest in cheese pie sfoliata (14.4%/TF). Furthermore, the Ω-6/Ω-3 ratio was calculated, and for spreads, the range was 7.67 (tzatziki) to 8.29 (chtipiti). As for pies, leek pie for fasting was found to have the highest ratio (88.6), while cheese pie sfoliata had the lowest (16.0).

As shown in table 2, the SFAs that contributed the most to the total fat content were lauric acid (12:0) and palmitic acid (16:0). Lauric acid concentrations in spreads ranged from 0.01% (aubergine spread) to 24.7% (tzatziki). The pie with the highest concentration in lauric acid was cheese pie sfoliata (2.7%). As for palmitic acid, cheese pie sfoliata was found to have the highest (33.9%) concentration and spinach pie for fasting, the lowest (25.5%) for pies. For spreads, palmitic acid ranged from 9.2% (aubergine spread) to 12.4% (chtipiti). Also capric acid (10:0), myristic acid (14:0) and stearic acid (18:0), on average accounted for 2.8%, 5.3% and 4.1% of total fat in both food groups. In regard to MUFAs, oleic acid (18:1 ω9c) in spreads ranged from 13.2% (tzatziki)–18.8% (chtipiti). Among pies, cheese pie (sfoliata) was found to have the highest concentration in oleic acid (23.3%) and spinach pie for fasting, the lowest (19.3%). Furthermore, in regard to PUFAs, linoleic acid (18:2ω6cc) in spreads ranged from 29.7% (tzatziki) to 60.5% (aubergine), and in pies, 14.2% (cheese pie sfoliata)

Table 1: Macronutrients of traditional products of Greece by type.

			Spreads				Pies					
		unit	Aubergine spread	Taramo salata	Tzatziki	Chtipiti	Squash pie with cheese	Spinach pie with cheese	Leek pie (fasting)	Spinach pie (fasting)	Traditional Cheese pie	Cheese pie sfoliata
Energy	Direct calculation	Kcal/100gr	120	406	108	238	338	335	351	376	380	423
	Indirect calculation	Kcal/100gr	53	397	37	70	384	377	379	419	439	480
Proteins		g/100g	9.4	2.6	6.9	15.9	8.3	9.1	5.8	7.3	11.3	13.1
Carbohydrates		g/100g	3.8	3.2	2.3	1.7	47.6	39.7	45.8	48.1	46.7	45.2
Total fat (TF)		g/100g	-	41.5	-	-	17.8	20.2	19.2	21.9	23.0	27.4
	SFA	%recommended fat	12.2	-	50.1	33.1	40.4	37.9	31.1	30.5	50.1	54.1
	MUFA cis	%recommended fat	18.1	-	14.5	20.4	24.5	23.7	21.5	21.2	25.5	26.1
	PUFA cis	%recommended fat	68.1	-	33.8	44.6	30.7	36.0	44.8	45.8	21.4	15.3
	TFA	%recommended fat	-	-	0.5	0.5	3.5	1.7	2.1	1.6	2.6	3.9
	Ω-3	%recommended fat	7.5	-	3.9	4.8	1.0	1.1	0.5	0.8	1.1	0.9
	Ω-6	%recommended fat	60.7	-	29.9	39.8	29.7	34.9	44.3	45.0	20.3	14.4
	Ω-6/Ω-3	-	8.1	-	7.67	8.29	29.7	31.72	88.6	56.25	18.45	16.00
	MUFA/SFA	-	1.48	-	0.29	0.62	0.61	0.63	0.69	0.70	0.51	0.48
	PUFA/SFA	-	5.58	-	0.67	1.35	0.76	0.95	1.44	1.50	0.43	0.28
Water		g/100g	78.5	47.4	81.3	63.1	33.4	41.0	36.8	32.7	31.9	31.9
Cholesterol		mg/100g	<0,5	-	5.2	32.5	12.2	34	<0,5	<0,5	31.6	29.3

Table 2: Fatty acids content of traditional products of Greece by type.

	Spreads			Pies					
	Aubergine spread	Tzatziki	Chtipiti	Squash pie with cheese	Spinach pie with cheese	Leek pie (fasting)	Spinach pie (fasting)	Traditional cheese pie	Cheese pie sfoliata
4:0	0.01	0.03	0.05	-	-	-	-	-	-
6:0	-	0.17	0.22	0.23	0.20	-	-	0.43	0.59
7:0	-	-	-	-	-	-	-	-	0.01
8:0	0.00	1.22	0.82	0.54	0.47	0.04	0.02	0.81	0.90
9:0	0.02	-	-	-	-	-	-	0.02	0.02
10:0	-	1.74	1.20	1.89	1.85	0.07	0.03	2.91	2.84
10:1	-	0.04	0.03	0.05	-	-	-	0.11	-
11:0	-	0.03	0.01	-	0.02	-	-	0.04	0.04
12:0	0.01	24.71	7.39	1.28	1.18	0.38	0.28	2.24	2.74
(12:1)	-	-	0.05	-	-	-	-	-	0.03
13:0	-	0.03	-	-	-	-	-	0.05	0.05
14:0	0.09	6.37	3.77	2.81	2.65	0.96	0.87	5.44	5.16
14:1 7t*	-	0.03	0.05	0.04	0.04	-	-	0.09	0.08
14:1 9c	-	0.12	0.08	0.05	0.03	-	-	0.21	0.24
14:1 5t*	-	0.06	0.09	0.11	0.10	-	-	0.21	0.20
15:0	0.02	0.12	0.15	0.22	0.21	0.03	0.03	0.45	0.36
Br1*	0.01	-	0.03	-	-	-	-	0.05	-
15:1	-	-	0.04	0.04	0.05	-	-	0.10	0.07
16:0	9.22	10.61	12.44	27.43	26.02	25.69	25.59	30.02	33.97
16:1 9t*	0.00	0.06	0.03	0.10	0.11	-	0.02	0.20	0.13
16:1 7c	0.02	0.07	0.08	0.18	0.19	0.01	0.05	0.24	0.23
16:1 9c	0.08	0.26	0.27	0.65	0.68	0.41	0.43	0.95	0.79
Iso2*	-	-	0.02	0.09	0.13	-	-	0.25	0.15
16:2	-	0.04	0.06	-	-	-	-	-	0.08
17:0	0.03	0.03	0.15	0.19	0.17	0.07	0.08	0.29	0.19
Br2	-	0.05	0.07	0.07	0.08	0.05	0.03	0.11	0.10
18:0	2.67	4.82	6.35	5.25	4.59	3.34	3.07	6.66	6.77
Σ18:1t	-	0.11	0.25	2.51	0.92	1.66	1.05	1.10	2.61
18:1 ω9c	17.38	13.27	18.83	22.02	21.22	19.69	19.33	22.40	23.36
18:1 11c	0.47	0.50	0.83	0.90	0.81	0.84	0.84	0.75	0.75
Σ18:1others	-	0.13	0.04	0.48	0.51	0.36	0.33	0.60	0.48
Σ18:2 t	-	0.21	0.12	0.79	0.48	0.47	0.49	0.95	0.86
18:2ω6cc	60.56	29.79	39.61	29.63	34.61	44.25	44.94	19.98	14.18
18:3ω6	0.09	0.04	0.04	-	0.02	-	0.04	0.05	-
18:3ω3	7.39	3.75	4.55	0.55	0.55	0.33	0.64	0.53	0.42
20:0	0.17	0.15	0.29	0.23	0.23	0.23	0.24	0.20	0.15
cd or 18:4ω3	0.10	0.12	0.23	0.30	0.30	0.18	0.13	0.43	0.34
20:1ω9	0.15	0.09	0.12	0.11	0.11	0.18	0.18	0.10	0.10
21:0	-	0.04	0.10	0.02	0.02	-	0.03	-	-
20:2ω6	-	-	0.05	-	-	-	-	0.03	0.02
20:3ω6	-	-	-	-	0.02	-	-	0.04	0.03
20:4ω6	-	0.02	0.05	0.10	0.12	-	-	0.14	0.09
22:0	-	-	-	0.12	0.10	0.14	0.12	0.07	-
20:5ω3	-	-	-	0.02	0.04	-	-	0.03	-
23:0	-	-	-	-	-	-	0.02	-	-
22:2ω6	-	-	-	-	0.05	-	-	-	0.04
22:4ω6	-	-	-	-	0.05	-	-	0.03	0.04
24:0	-	-	-	0.07	0.06	0.07	0.08	0.05	0.02
24:1 ω9	-	-	-	-	0.02	0.02	0.03	0.03	0.05
22:5ω3	-	-	-	0.03	0.02	-	-	0.05	0.04
22:6ω3	-	-	-	0.07	0.06	-	-	0.07	0.05

to 44.9% (spinach pie for fasting). Finally, α-linolenic acid (18:3ω3), was found to range between 7.4% (aubergine spread) and 3.7% (tzatziki). Among pies, the products with the highest concentration were squash pie with cheese and spinach pie with cheese (0.5%).

Micronutrient content in spreads and pies from Greece is presented in table 3. The highest concentration of potassium in pies was found in spinach pie for fasting, 270 mg/100 g, and the lowest in cheese pie sfoliata (102 mg/100 g), and in spreads, the range was from 105 mg/100 g (tzatziki) to 152 mg/100 g (aubergine spread). Among all products analysed, selenium was highest in spinach pie with cheese (120.4 μg/100 g), while chromium was highest in taramosalata (3256.6 μg/100 g). Sodium, on the other hand, ranged from 1081 mg/100 g to 256 mg/100 g among pies with leek pie for fasting, and spinach pie for fasting, recording the highest concentrations of 1081 mg/100 g and 1050 mg/100 g, respectively, while for spreads, the lowest concentration was found in tzatziki (204 mg/100 g), and the highest in taramosalata (480 mg/100 g).

Discussion

In the present study, traditional Greek dishes were chemically analyzed for their micronutrient, macronutrient and fatty acid content. The value of the Cretan diet, and its important role in health promotion and disease prevention emerged mainly through the Seven Countries Study. The study showed that the good health of Cretans was mainly because of high olive oil intake and low saturated fat content in the Mediterranean diet. Furthermore, consumed food was rich in calcium, glutathione, antioxidants, vitamins E and C and minerals [3].

From our results, it is clear that SFA levels in both pies and spreads are higher that the levels of MUFAs and PUFAs, contrary to the traditional properties of the "Mediterranean diet" [11]. The main source of SFAs was palmitic acid, although oleic acid remains the main representative of MUFAs. The main reason for this change is the fact that the Greek population has moved to adopt a more western way of life, the main characteristics of which are the automation of farming, increased consumption of fast foods, and higher meat and cheese consumption [11,12].

However, olive oil appears to still have a dominant role in the Cretan diet. In the present study, the mean contribution of oleic acid was similar to the contribution noted in a 1979 dietary analysis [13]. Olive oil, as a major source of energy, is considered to prevent the development of several types of cancers [14]. Olive oil also reduces arterial blood pressure due to its natural antioxidants, such as carotenes, tocopherols and phenolic compounds [15].

Macronutrient analysis showed that SFA content was high in all products, except melitzanosalata. The main source of SFAs in our study was palmitic acid, the main constituent of SFAs in palm oil, which is widely used nowadays, and may have replaced olive oil in cooking [16]. This finding is alarming, as SFAs are strongly associated with the risk of coronary heart disease (CHD) [17]. The presence of TFAs in all pies is also a source of concern, because they are strongly connected with a higher risk of CHD [17], and are considered to be even more harmful than saturated fatty acids.

Another important factor of the Cretan diet is the Ω-6/Ω-3 ratio. In Cretan diet this ratio used to be 2-1/1, which was quite close to the ratio of Palaeolithic populations (0.79/1) [18]. This effective balance of Ω-6 and Ω-3 fatty acids, associated with lower incidences of lung cancer, asthma and prevention of thrombosis and atherosclerosis [19], was a remarkable achievement of Cretan dietary habits, until 1960's. All products currently exceed the recommended ratio of Cretan diet mentioned above, with leek pie having an extremely high ratio, and tzatziki, the lowest. On the other hand, in order to be able to evaluate correctly the Ω-6/Ω-3 ratio, we have to taken in our account, the exact numbers of Ω-6 and Ω-3. Meaning that, first of all, Ω-3 and Ω-6 content alone in each food must be satisfactory and balanced.

An interesting finding was the concentration in Ω-3 fatty acids. Ω-3 fatty acids are essential components of the Cretan diet. Results have shown that that they have an important role in normal growth and development, and in the prevention of cardiovascular disease [3].

The analyzed traditional products also had elevated concentrations of Ω-6 fatty acids. We could assume that the high levels of Ω-6 detected in our product's analysis, are possibly due to the use of soybean oil, margarines or corn oil during cooking [20]. Ω-6 fatty acids, when not over consumed, are associated with low prevalence of hypertension and systolic blood pressure. Ω-6 fatty acids also appear to reduce the prevalence of prostate and breast cancer, pancreatic tumors and lymphocytic leukemia [21,22].

As for micronutrient content, selenium was found to be high in spinach pie with cheese, and chromium in Taramosalata. Selenium

Table 3: Micronutrient content in traditional products of Greece by type.

			Spreads				Pies					
		Unit	Aubergine spread	Taramo salata	Tzatziki	Chtipiti	Squash pie with cheese	Spinach Pie with cheese	Leek pie (fasting)	Spinach pie (fasting)	Traditional Cheese pie	Cheese pie sfoliata
Metals & minerals	Calcium	mg/100 g	8	8	82	105	38	31	34	50	52	72
	Potassium	mg/100 g	152	106	105	147	105	124	144	270	127	102
	Magnesium,	mg/100 g	26	27	16	24	28	29	27	44	27	28
	Sodium	mg/100 g	258	480	204	414	256	447	1081	1050	618	571
	Selenium	μg/100 g	-	-	14.9	-	-	120.4	-	20.9	-	-
	Iron	mg/100 g	1.4	1.7	0.8	1.3	2.3	1.9	2.3	2.4	1.9	2.4
	Phosphorus	mg/100 g	90	118	241	190	261	287	209	238	392	457
	Chromium	μg/100 g	26.3	3256.6	20.3	40.1	-	-	-	7.3	-	7.1

is a trace element which is necessary, but long term exposure can cause Selenosis [23]. On the other hand, low levels or absence of selenium appears to be associated with hepatocyte damage, necrosis, cardiopathies and several cancer types [23]. Chromium is quite essential for human body, as it plays an important role in human metabolism [24].

Orthodox Church fasting rituals are considered to be one of the most important factors of Cretan dietary habits, since during periods of fasting, meat and dairy-product intake was not permitted [25]. Fasting has been found to lead to decreased energy, cholesterol, protein, total fat, SFA and TFA intake, and higher intake of total carbohydrates, fibre, folate and iron [26]. While the beneficial impact of fasting rituals on health is well documented [26], our results show that traditional fasting dishes, namely Leek pie and Spinach pie for fasting, have the highest concentrations of sodium, which we attribute to the addition of dietary salt, as a means of enhancing the taste of the fasting products. Dietary salt is considered to be one of the main reasons of high blood pressure, while there is strong evidence connecting sodium with cardiovascular disease and stroke, in a dose dependant association [27].

There have been similar attempts in other countries to analyze traditional products, according to their macronutrient, micronutrient and lipid composition. Chemical analyses of Eskimo food which was carried out in Western Greenland showed that their diet is rich in polyunsaturated fatty acids, of the linoleic class. As for the monounsaturated fatty acids, palmitoleic and oleic acid were dominant [28]. Another study which took place in Turkey, included chemical analysis for the most frequently consumed products. Some remarkable results were that among saturated fatty acids, palmitic acid was found abundantly in meat products. Traditional cookies and pastries were found to be made of hydrogenated fats, such as margarine and bakery fats [29]. In general, the northern Europeans diet is characterized by a high daily consumption of vegetables and animal fats. Despite the fact that other differences among European populations seem to be narrowing, differences in traditional food consumption and diet habits still strongly exist between north and south Europe [30].

Some of the limitations of this study are the fact that we were not able to analyze the products for their vitamin, polyphenol and dietary fibre content, Moroever, the composition of the traditional products would be mediated by the recipe applied, and by the cooking technique; each of which could alter the composition of the products consumed. Further investigation is needed in this direction.

In conclusion, this study confirms important changes in dietary habits, such as increased consumption of SFAs, the decrease in MUFA and PUFA contribution to daily diet, and the imbalance of ω6/ω3 ratio.

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References

1. Kien CL, Bunn JY, Ugrasbul F (2005) Increasing dietary palmitic acid decreases fat oxidation and daily energy expenditure Am J Clin Nutr 82: 320-326.
2. Keys A (1997) Coronary heart disease in seven countries. 1970. Nutrition 13: 250-252.
3. Simopoulos PA (2001) The Mediterranean Diets: What is so special about the diet of Greece? The scientific evidence. J Nutr 131: 3065S-3073S.
4. Serra-Majem L, Roman B, Estruch R (2006) Scientific evidence of interventions using the Mediterranean Diet: A systematic review. Nutr Rev 64: S27-S47.
5. Trichopoulou A, Lagiou P (1997) Healthy traditional Mediterranean diet: An expression of culture, history and lifestyle. Nutr Rev 55: 383-389.
6. La Vecchia C (2004) Mediterranean diet and cancer. Public Health Nutr 7: 965-968.
7. Moschandreas J, Kafatos A, Aravanis C, Dontas A, Menotti A, et al. (2005) Long term predictors of survival for the Seven Countries Study cohort from Crete: from 1960 to 2000. Int J Cardiol 100: 85-91.
8. Vardavas CI, Majchrzak D, Wagner HK, Elmadfa I, Kafatos A (2006) Lipid concentrations of wild edible greens of Crete. Food Chem 99: 822-834.
9. Official Methods of Analysis (1990) Association of Official Analytical Chemists. (15th edn), Washington DC, USA.
10. Metcalfe LD, Schmitz AA, Pelka JR (1966) Rapid preparation of fatty acids esters from lipids for gas chromatographic analysis. Anal Chem 38: 514-515.
11. Kafatos A, Diacatou A, Voukiklaris G, Nikolakalis N, Vlachonikolis J, et al. (1997) Heart disease risk-factor status and dietary changes in the Cretan population over the past 30 y: the Seven Countries Study. Am J Clin Nutr 65: 1882-1886.
12. Kafatos A, Mamalakis G (1993) Changing patterns of fat intake in Crete. Eur J Clin Nutr 47: S21-S24.
13. Aravanis C (1980) The Greek islands heart study. In: 3rd International Congress on the biological value of olive oil, Chanea, Crete, Greece.
14. Escrich E, Moral R, Grau L, Costa I, Solanas M (2007) Molecular mechanisms of the effects of olive oil and other dietary lipids on cancer. Mol Nutr Food Res 51: 1279-1292.
15. Psaltopoulou T, Naska A, Orfanos P, Trichopoulos D, Mountokalakis T, et al. (2004) Olive oil, the Mediterranean diet and the arteral blood pressure: the Greek European Prospective Investigation into Cancer and Nutrition (EPIC) Study. Am J Clin Nutr 80: 1012-1018.
16. Edem DO (2002) Palm oil: Biochemical, physiological, nutritional, hematological and toxicological aspects: A review. Plant Foods Hum Nutr 57: 319-341.
17. Astrup A, Dyerberg J, Elwood P, Hermansen KB, Hu F, et al. (2011) The role of reducing intakes of saturated fat in the prevention of cardiovascular disease: Where does the evidence stand in 2010? Am J Clin Nutr 93: 684-688.
18. Eaton SB, Eaton SB 3rd, Sinclair A, Cordain L, Mann N (1998) Dietary intake of long-chain polyunsaturated fatty acids during the palaeolithic. World Rev Nutr Diet 83: 12-23.
19. Xia SH, Wang J, Kang JX (2005) Decreased n-6/n-3 fatty acid ratio reduces the invasive potential of human lung cancer cells by down-regulation of cell adhesion/invasion-related genes. Carcinogenesis 26: 779-784.
20. Hunter JE (1990) N-3 fatty acids from vegetable oils. Am J Nutr 51: 809-814.
21. Bidoli E, Talamini R, Bosetti E, Negri E, Maruzzi D, et al. (2005) Macronutrients, fatty acids, cholesterol and prostate cancer risk. Ann Oncol 16: 152-157.
22. Menendez JA, Ropero S, Lupu R, Colomer R (2004) Omega-6 polyunsaturated fatty acid gamma-linolelic acid (18:3n-6) enhances docetaxel (Taxotere) cytotoxicity in human breast carcinoma cells: Relationship to lipid peroxidation and HER-2/neu expression. Oncol Rep 11: 1241-1252.
23. Navarro-Alarcon M, Cabrera-Vique C (2008) Selenium in food and the human body: A review. Sci Total Environ 400: 115-141.

24. Vincent JB (2001) The bioinorganic chemistry of chromium (III). Polyhedron 20: 1-26.

25. Kromout D, Keys A, Aravanis C, Buzina R, Fidanza F, et al. (1989) Food consumption patterns in the 1960s in seven countries. Am J Clin Nutr 49: 889-894.

26. Sarri OK, Linardakis KM, Bervanaki NF, Tzanakis EN, Kafatos GA (2004) Greek Orthodox fasting rituals: a hidden characteristic of the Mediterranean diet of Crete. Br J Nutr 92: 277-284.

27. Strazzullo P, D'Elia L, Kandala NB, Cappuccio PF (2009) Salt intake, stroke and cardiovascular disease: Meta-analysis of prospective studies. BMJ 339: b4567.

28. Bang HO, Dyerberg J, Sinclair HM (1980) The composition of the Eskimo food in north western Greenland. Am J Clin Nutr 33: 2657-2661.

29. Karabulut I (2007) Fatty acid composition of frequently consumed foods in Turkey with special emphasis on trans fatty acids. Int J Food Sci Nutr 58: 619-628.

30. Trichopoulou A, Soukara S, Vasilopoulou E (2007) Traditional foods: a science and society perspective. Trends Food Sci Technol 18: 420-427.

Author Affiliations

Top

[1]*Preventive Medicine and Nutrition Clinic, Department of Social Medicine, Faculty of Medicine, University of Crete, Heraklion, Greece*
[2]*Department of Nutrition and Dietetics, School of Food Technology and Nutrition, Technological Educational Institute of Thessaloniki, Thessaloniki, Greece*