

Fatty acid and salt contents of snacks in the Cretan and Cypriot market: A child and adolescent dietary hazard

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Received 8 August 2005; received in revised form 16 February 2006; accepted 16 February 2006

Abstract

Adult, adolescent and childhood obesity is a growing public health problem, worldwide. The increase in the prevalence of obesity in children and adolescents is believed to be partly attributable to an increase in the consumption of snacks that are high in fat and sugar, and make up a substantial percentage of daily calorie intakes. Our results show a high to very high salt content in almost all of the brands analysed, with salt contents ranging from 0.8 to 3.9 g per 100 g of product (mean value 2.05 ± 0.73 g). The total fat content of brands differed, ranging from 9% to 46% (mean value $31 \pm 8.4\%$). Calories, due solely to fat, also ranged widely from 82 to 413 kcal/100 g of product with an average value of 283 ± 76 kcal. Our results underline the need for stricter regulations and/or the need to inform children and adolescents on the true content of such snacks.

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Keywords: Fatty acid content; Snacks; Salt; Potato crisps; Cyprus; Greece

1. Introduction

Adult, adolescent and childhood obesity is a growing public health problem, worldwide. The effects of obesity are already well known and extensively researched. Numerous studies exist that show that its prevalence has increased significantly, not only in developed countries but also in developing ones (Baskin, Ard, Franklin, & Allison, 2005; Chhatwal, Verma, & Riar, 2004; Hedley et al., 2004; Rennie & Jebb, 2005; Savva et al., 2002; Zimmermann, Gubeli, Puntener, & Molinari, 2004). Obesity in children is partially due to genetic causes; the most common cause of children becoming overweight is a result of energy imbalance and high-energy food intake. The increase in the prevalence of obesity in children and adolescents is also believed to be partly attributable to an increase in the consumption of

snacks that are high in fat and sugar and make up a substantial percentage of daily calorie intake. Many factors contribute to this increase. A startling factor is that children now have access to money at an earlier age, which allows the child to obtain, at will, snacks either from the supermarket or, even worse, from the school canteen, as reported by Roberts, Blinkhorn, and Duxbury (2003).

Children and adolescents spend a large part of their day at school, and inevitably they will purchase a snack or lunch from the canteen or from vending machines. Foods sold in a-la-carte sections of the cafeteria, school stores, and vending machines are usually high in calories, total fat, saturated fat, added sugars, cholesterol and/or sodium, an obvious dietary hazard. What children and adolescents eat depends on many factors: television advertisements and peer pressure are well-known factors and, as reported in numerous studies (Cullen & Zakeri, 2004; Kramer-Atwood et al., 2002; Vereecken, Bobelijn, & Maes, 2005), school canteens also have the power to influence dietary habits,

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by applying a stricter food policy and reducing the availability of high sugar and high fat foods, by raising the price of such foods, or even by reducing waiting time in school canteens. Lowering the prices of healthier snacks has been found to increase the consumption of healthy snacks (such as fruit-and milk-based snacks) and to reduce the consumption of unhealthy snacks sold through canteens and vending machines. French et al. (2001) showed that reducing the price of low fat snacks by 25% and 50% caused a 39% and 93% increase in low fat snacks, respectively.

Schools play a vital role in children's education and teachers and school staff can influence their dietary habits. The inclusion of nutrition in the school educational programme is a major step in that direction (Kramer-Atwood et al., 2002). Kubik, Lytle, and Story (2005) showed that only 18% of parents and 31% of teachers believed schools give adequate attention to student nutrition. Teachers are not always a good role model for healthy eating behaviour at school either; use of candy as a reward is still a common classroom practice and consumption of high fat or high sugar snacks and beverages sometimes is far from preferable (Kubik, Lytle, Hannan, Story, & Perry, 2002).

Child and adolescent dietary habits are not only influenced during school hours but also in their home environment, from peer pressure, and especially from television commercials. Children are exposed to a large number of important unhealthy stimulations in terms of food intake when watching television. Commercials advertising unhealthy foods account for a large portion of children's televised viewing time. Ninety-one percent of advertised foods are high in fat, sugar and/or salt. Not only these commercials but also movies and cartoons often mislead children into conceiving a wrong idea about healthy nutrition (Caroli, Argentieri, Cardone, & Masi, 2004; Linn, 2004; Taras & Gage, 1995).

Increasing consumption of high sugar and high fat snacks is a problem that affects, not only school children and adolescents, but also infants. In Crete, biscuits with high fat, and high sugar contents are commonly given to infants and to preschool children as mid-meal snacks. Fox, Pac, Devaney, and Jankowski (2004) also reported that, from very early ages, snacks are used to reward infants and toddlers with negative health effects on their development by supplementing their diet with high sodium, sugar and fat foods.

These snacks are likely a dietary hazard for children and, as shown in numerous studies, are high in salt and calories and fat (Sanchez-Castillo, Dewey, Reid, Solano, & James, 1997; Mario Fernandez San Juan, 2000; Tavella et al., 2000). A high consumption of such snacks might possibly lead to the prevalence of childhood obesity in Cypriot children, as shown by Savva et al. (2002). Thus, the aim of the present research was to collect, chemically analyze and summarize the compositions of 28 commonly-eaten snacks for their sodium, total monounsaturated, polyunsaturated, saturated, *trans* lipid, total fat and calorie contents.

2. Materials and methods

2.1. Collection-coding-validity

Samples were taken from 28 brands of snacks purchased from supermarkets from the city of Heraklion in Crete, Greece and from the city of Nicosia in Cyprus during February of 2004. Fourteen brands were bought in Crete and another 14 similar brands were bought in Cyprus. They were selected to cover a large variety of different types of snacks and flavours. The brands selected were commonly found not only in supermarkets but also in some school canteens (although school food regulations do not allow such products to be sold, many school canteens do sell high salt, high fat snacks). Each brand was coded with arabic numerals and stored (without being opened) in a dark, cool place prior to analysis. All samples of each brand were analyzed in duplicate. Validation data of the analysis is as follows: fat, s.d. = 0.31, reproducibility = 0.86, recovery = 98.7%, uncertainty = 1.97%. Sodium chloride: s.d. = 0.012, reproducibility = 0.04, recovery = 99.4%, uncertainty = 0.82.

Table 1
Total salt content (results in g per 100 g of product)

Salt (g/100 g)	Product description
<i>Moderate salt content</i>	
0.80	Corn puffs (paprika, onion, bacon flavoured) ^b
0.92	Extra Salted potato crisps with sunflower oil ^a
0.94	Olive oil-salt-pepper flavoured potato crisps ^b
<i>High salt content</i>	
1.28	Peanut and hazelnut flavoured corn puffs ^a
1.38	Peanut and hazelnut flavoured corn puffs ^b
1.38	Vegetable flavoured potato crisps ^b
1.53	Low fat salted potato crisps ^b
1.59	Cheese flavoured corn-flour puffs ^a
1.68	Potato crisps with sunflower oil ^b
1.71	Cheese flavoured corn-potato puffs ^a
1.80	Prawn flavoured potato crisps ^a
1.84	Extra salted potato crisps ^a
1.86	Corn-rice-potato puffs ^a
1.90	Bacon flavoured corn puffs ^b
1.96	Corn-potato puffs (pizza flavoured) ^b
2.05	Corn-potato puffs (pizza flavoured) ^a
2.20	Corn-rice-potato puffs (cheese flavoured) ^b
2.29	Cheese flavoured potato crisps ^a
2.44	Corn-potato puffs (cheese flavoured) ^a
2.46	Salted potato crisps ^a
2.49	Spicy corn chips ^a
<i>Very high salt content</i>	
2.52	Potato crisps (light) ^a
2.53	Corn chips with cheese ^b
2.84	Barbeque flavoured potato crisps ^b
2.92	Cheese flavoured corn-wheat puffs ^a
3.04	Cheese flavoured potato crisps ^b
3.20	Oregano flavoured potato crisps ^b
3.86	Cheese-corn-potato puffs ^b

^a Cypriot snacks.

^b Cretan snacks.

2.2. Laboratory processing

2.2.1. Preparation for analysis

So as to estimate the fat content of each snack, the contents were blended separately for each sample. Blended sample (10–20 g) was used to evaluate the fat content of each brand using the Soxhlet method. The remaining product was then stored in an air-tight container in a dark cool place. So as to calculate the salt content, the defatted samples were ground to fine powder.

2.2.2. Extraction of fats

Fat was extracted from the snacks with a Soxhlet apparatus. About 20 g of homogenized sample was extracted with Soxhlet using petroleum ether, with boiling point 40–60 °C, for 4–5 h under nitrogen. The solvent extracts were distilled off under reduced pressure. The last traces of solvent were removed at about 45 °C under overnight vacuum. The % of fat was calculated by weight.

2.2.3. Total salt

The salt content was determined using the yin-house modified **Mohr method (1981)** avoiding ash. About 2 g of defatted and fine ground sample was dissolved in ca. 100 ml of mineral water. One milliliter of 5% potassium chromate solution was added and titration performed with 0.1 M silver nitrate solution to the first appearance of an orange colour (1 ml 0.1 M AgNO₃ = 0.005844 g NaCl).

2.2.4. Determination of fatty acids

The total fat samples were stored at –80 °C. Prior to analysis, samples were thawed and the fat was transferred to 10 ml screw-capped tubes using Pasteur pipettes. Methyl esters of the component fatty acids were prepared in 10 ml screw-capped vials according to the method described by **EEC Reg. 72/77 Annex VI**; 0.5 ± 0.05 g of fat sample was saponified with 0.5 ml 2 M KOH in methanol, following extraction with hexane. After centrifugation for 5 min at 4000 rpm, the hexane (upper layer) containing the fatty acid methyl-esters (FAME) was transferred to GC vials and stored at –20 °C prior to analysis. The FAME was sep-

Table 2
Total fat content (results in g per 100 g of product)

Fat (g/100 g)	Product description
<i>Fat content < 20%</i>	
9.11	Low fat salted potato crisps ^b
14.99	Prawn flavoured potato crisps ^a
<i>20% < Fat content < 30%</i>	
22.25	Potato crisps with sunflower oil ^b
23.57	Potato crisps (light) ^a
24.96	Bacon flavoured corn puffs ^b
25.32	Peanut and hazelnut flavoured corn puffs ^b
27.34	Cheese flavoured corn-wheat puffs ^a
27.44	Peanut and hazelnut flavoured corn puffs ^a
27.48	Corn chips with cheese ^b
28.01	Spicy corn chips ^a
29.64	Barbeque flavoured potato crisps ^b
29.99	Corn-potato puffs (pizza flavoured) ^b
<i>30% < Fat content < 40%</i>	
30.84	Corn-rice-potato puffs ^a
30.88	Salted potato crisps ^a
31.43	Extra salted potato crisps ^a
31.63	Cheese flavoured potato crisps ^a
32.69	Oregano flavoured potato crisps ^b
33.04	Cheese flavoured potato crisps ^b
34.97	Olive oil-salt-pepper flavoured potato crisps ^b
35.20	Cheese-corn-potato puffs ^b
35.22	Corn-potato puffs (cheese flavoured) ^a
36.31	Corn puffs (paprika, onion, bacon flavoured) ^b
38.13	Vegetable flavoured potato crisps ^b
<i>Fat content > 40%</i>	
40.51	Corn-potato puffs (pizza flavoured) ^a
42.27	Corn-rice-potato puffs (cheese flavoured) ^b
43.26	Extra Salted potato crisps with sunflower oil ^a
45.23	Cheese flavoured corn-potato puffs ^a
45.85	Cheese flavoured corn-flour puffs ^a

^a Cypriot snacks.

^b Cretan snacks.

Table 3
kcalories (kjoules) per 100 g of sample due to fat only

kcalories	kjoules	Product description
<i>kcalories < 200</i>		
82	343	Low fat salted potato crisps ^b
135	564	Prawn flavoured potato crisps ^a
200	836	Potato crisps with sunflower oil ^b
<i>kcalories 200–300</i>		
212	886	Potato crisps (light) ^a
225	940	Bacon flavoured corn puffs ^b
228	953	Peanut and hazelnut flavoured corn puffs ^b
246	1028	Cheese flavoured corn-wheat puffs ^a
247	1032	Peanut and hazelnut flavoured corn puffs ^a
247	1032	Corn chips with cheese ^b
252	1053	Spicy corn chips ^a
267	1116	Barbeque flavoured potato crisps ^b
270	1129	Corn-potato puffs (pizza flavoured) ^b
278	1162	Salted potato crisps ^a
278	1162	Corn-rice-potato puffs ^a
283	1183	Extra salted potato crisps ^a
285	1191	Cheese flavoured potato crisps ^a
294	1229	Oregano flavoured potato crisps ^b
297	1241	Cheese flavoured potato crisps ^b
<i>kcalories 300–400</i>		
317	1325	Corn-potato puffs (cheese flavoured) ^a
317	1325	Cheese-corn-potato puffs ^b
327	1367	Corn puffs (paprika, onion, bacon flavoured) ^b
343	1434	Vegetable flavoured potato crisps ^b
343	1434	Olive oil-salt-pepper flavoured potato crisps ^b
365	1526	Corn-potato puffs (pizza flavoured) ^a
380	1588	Corn-rice-potato puffs (cheese flavoured) ^b
389	1626	Extra salted potato crisps with sunflower oil ^a
<i>Calories > 400</i>		
407	1701	Cheese flavoured corn-potato puffs ^a
413	1726	Cheese flavoured corn-flour puffs ^a

^a Cretan snacks.

^b Cretan snacks.

arated on a 100 m × 0.25 mm, SP-2560 fused silica column, coated with 0.2 µm of biscyanopropyl polysiloxane provided by SUPELCO (Bellefonte, PA, USA), using a Shimadzu (Shimadzu Corporation Kyoto Japan) GC-17A gas chromatograph equipped with an AOC-20 auto sampler and a FID. The analytical conditions employed were as follows: volume injected 1 µl, carrier gas helium (20 cm/s), injector temperature 250 °C, FID temperature 250 °C, split ratio 1:20 to 1:50 (depending on the sample quantity), and oven temperature from 140 °C to 240 °C with stepped temperature programme: with a total run time of 60 min.

The Class-VP chemstation software was used for identification and quantification of peaks. Identification of chromatographic peaks was achieved by comparing their retention times using appropriate standards of mixed FAME and individual FAME (Sigma). Normalization was used for peak quantification, a method which assumes that all components of test materials are represented on the chromatograms; thus the sum of the areas under all of the peaks represent 100% of the constituents used.

2.3. Apparatus

The Soxhlet extractor was a medium size instrument (Corning No. 3740) with 33 × 80 mm extr. Thimbles; Gas

chromatograph was a Shimadzu GC-17A, Auto Injector AOC Shimadzu; gas column was 100 m × 0.25 mm fused silica Supelco SP-2560.

2.4. Reagents

Material were: petroleum ether 40–60 °C, Lab-Scan Code No. G4541; 0.1 N silver nitrate Merck Titrisol 1.09990; potassium chromate Scharlau PO0214; methanol Lab-Scan Code No. C17C11X; potassium hydroxide Merck 1.05033; hexane Merck 1.04371; anhydrous sodium sulphate, Merck 1.06649; sodium chloride, Merck 1.06406

3. Results and discussion

3.1. Total salt – total fat content

The total salt content of the chosen snacks ranged from 0.8 g to 3.86g per 100 g of product with a mean value of 2.05 ± 0.73 g, as shown in Table 1. Only three brands were found to have a moderate salt content (<1 g/100 g product), with most brands exceeding the high salt limit. Seven were found to have more than twice the amount of salt needed to be classified as a high salt content food.

Table 4
SFA, *c*-MUFA, *t*-MUFA, and PUFA content (results in % of total fat)

No.	Product description	SFA	<i>c</i> -MUFA	<i>t</i> -MUFA	PUFA
1	Peanut and hazelnut flavoured corn puffs ^b	20.5	45.8	0.36	32.7
2	Extra salted potato crisps ^a	45.6	42.3	0.35	11.4
3	Corn–rice–potato puffs (cheese flavoured) ^b	51.2	38.8	0.43	9.33
4	Salted potato crisps ^a	45.3	43.3	0.63	10.6
5	Bacon flavoured corn puffs ^b	45.5	43.1	0.52	10.7
6	Potato crisps with sunflower oil ^b	10.0	81.6	0.21	7.83
7	Extra Salted potato crisps with sunflower oil ^a	46.0	42.1	0.60	11.2
8	Prawn flavoured potato crisps ^a	46.8	42.0	0.52	10.5
9	Corn–potato puffs (pizza flavoured) ^b	35.7	49.3	0.44	13.5
10	Corn–potato puffs (cheese flavoured) ^a	10.7	24.8	0.79	63.5
11	Cheese flavoured corn–wheat puffs ^a	45.2	43.0	0.64	10.9
12	Vegetable flavoured potato crisps ^b	45.3	43.1	0.41	11.0
13	Low fat salted potato crisps ^b	77.1	16.9	1.15	4.65
14	Cheese flavoured potato crisps ^b	44.3	43.7	0.38	11.4
15	Olive oil–salt–pepper flavoured potato crisps ^b	43.7	45.5	0.38	10.2
16	Peanut and hazelnut flavoured corn puffs ^a	25.3	51.2	0.33	22.9
17	Oregano flavoured potato crisps ^b	45.5	43.1	0.34	10.7
18	Cheese flavoured corn–flour puffs ^a	46.9	41.6	0.43	10.4
19	Cheese–corn–potato puffs ^b	44.6	42.7	0.45	11.4
20	Corn puffs (paprika, onion, bacon flavoured) ^b	44.6	43.5	0.44	11.1
21	Spicy corn chips ^a	44.7	41.8	0.41	12.6
22	Corn chips with cheese ^b	43.6	41.4	0.49	14.2
23	Barbeque flavoured potato crisps ^b	45.9	43.1	0.40	10.3
24	Corn–potato puffs (pizza flavoured) ^a	47.2	41.8	0.40	9.98
25	Cheese flavoured potato crisps ^a	47.2	42.6	0.44	9.31
26	Potato crisps (light) ^a	46.2	43.1	0.41	9.95
27	Corn–rice–potato puffs ^a	46.9	42.6	0.40	9.51
28	Cheese flavoured corn–potato puffs ^a	47.3	41.7	0.62	9.84
Mean		42.6	43.0	0.48	13.6
Standard deviation		±12.8	±9.91	±0.18	±11.0

^a Cypriot snacks.

^b Cretan snacks.

As is commonly known, potato crisps and other snacks of similar origin not only have high salt but also high fat contents. The total fat content was within a wide range of 9.1 g to 45.9 g per 100 g of product. The mean total fat concentration of the selected snacks was 31.3 g (s.d., ± 8.4 g). Again all products were divided into groups according to their total fat content, as seen in Table 2.

3.2. Calories due to fat only

As shown analytically in Table 3, the energy content due to fat only, ranged from 82 to 413 kcal per 100 g of product. The average content was 283 ± 76 kcal per 100 g of packaged product. Energy in kJoules is also given.

3.3. Saturated fat

As proven by numerous authors, a high fat diet does not necessarily lead to health problems, unless obesity preexists (Ferro-Luzzi, James, & Kafatos, 2002; Keys, 1970). What is important is the type of fatty acid on which the diet is

based. Table 4 summarizes the fatty acid composition of the snack samples, classified in three nutritional groups, saturated, *cis*-monounsaturated, *trans*-monounsaturated and polyunsaturated fatty acids. Saturated fatty acids (SFA) were found within a wide range from 10% to 77% of the total fat content. The mean value of the samples was $42 \pm 12.8\%$. As seen in Table 5, palmitic acid (16:0) accounted for the highest percentage of saturated acid found, ranging from 5.5% to 44.9%, with a mean value of $34.5 \pm 11.1\%$. Stearic acid (18:0) also accounted for $4.2 \pm 0.7\%$ of the total fat content. Saturated fatty acids with 8–12 carbon atoms were also found, suggesting the use of coconut and palm kernel oil. Although caprylic (8:0), capric (10:0) and lauric (12:0) acid, on average, accounted for only 0.15%, 0.16% and 1.57% of total fat, respectively, one sample (no. 13), had higher percentages, specifically it consisted of 2.7% caprylic, 2.6% capric and 37% lauric acid. We note that the sample also had the highest myristic acid (14:0) content and the highest saturated fat/total-fat ratio of 0.77. It is well known that high saturated fat consumption contributes to high rates of chronic diseases related to atherosclerosis, such as cardiovascular disease and diabetes mellitus. By frequently

Table 5
Analytical contents of lipids, 8:0, 10:0, 12:0, 14:0, 15:0 and 16:0 as a percentage of the total fatty acid content

No.	Product description	8:0	10:0	12:0	14:0	15:0	16:0
1	Peanut and hazelnut flavoured corn puffs ^b	N/D	N/D	0.03	0.18	N/D	14.9
2	Extra salted potato crisps ^a	0.02	0.01	0.14	0.90	0.04	40.0
3	Corn–rice–potato puffs (cheese flavoured) ^b	0.05	0.07	0.42	1.17	0.06	44.9
4	Salted potato crisps ^a	0.02	0.02	0.20	0.95	0.04	39.9
5	Bacon flavoured corn puffs ^b	0.03	0.03	0.28	0.98	0.04	39.95
6	Potato crisps with sunflower oil ^b	0.02	0.07	0.01	0.08	0.01	5.51
7	Extra Salted potato crisps with sunflower oil ^a	0.02	0.01	0.16	0.94	0.04	40.4
8	Prawn flavoured potato crisps ^a	0.14	0.09	0.16	0.95	0.04	40.9
9	Corn–potato puffs (pizza flavoured) ^b	0.07	0.08	0.32	1.26	0.06	30.0
10	Corn–potato puffs (cheese flavoured) ^a	0.02	0.04	0.05	0.20	0.03	6.08
11	Cheese flavoured corn–wheat puffs ^a	0.10	0.09	0.31	1.03	0.04	39.4
12	Vegetable flavoured potato crisps ^b	0.03	0.02	0.23	0.97	0.04	39.8
13	Low fat salted potato crisps ^b	2.76	2.62	37.0	13.5	0.02	13.7
14	Cheese flavoured potato crisps ^b	0.05	0.04	0.37	0.94	0.04	38.6
15	Olive oil–salt–pepper flavoured potato crisps ^b	0.05	0.03	0.23	0.94	0.04	38.1
16	Peanut and hazelnut flavoured corn puffs ^a	0.01	0.01	0.08	0.37	0.02	20.3
17	Oregano flavoured potato crisps ^b	0.03	0.04	0.25	0.97	0.04	39.9
18	Cheese flavoured corn–flour puffs ^a	0.12	0.24	0.49	1.81	0.13	39.1
19	Cheese–corn–potato puffs ^b	0.10	0.21	0.43	1.66	0.12	37.3
20	Corn puffs (paprika, onion, bacon flavoured) ^b	0.05	0.09	0.29	1.21	0.07	38.5
21	Spicy corn chips ^a	0.08	0.03	0.24	0.94	0.04	39.2
22	Corn chips with cheese ^b	0.06	0.09	0.34	1.12	0.06	37.5
23	Barbeque flavoured potato crisps ^b	0.03	0.02	0.24	0.99	0.04	40.3
24	Corn–potato puffs (pizza flavoured) ^a	0.13	0.23	0.44	1.69	0.12	39.7
25	Cheese flavoured potato crisps ^a	0.09	0.10	0.35	1.33	0.08	40.7
26	Potato crisps (light) ^a	0.05	0.02	0.23	0.99	0.04	40.6
27	Corn–rice–potato puffs ^a	0.09	0.06	0.29	1.14	0.06	40.8
28	Cheese flavoured corn–potato puffs ^a	0.10	0.21	0.45	1.69	0.12	39.8
Mean		0.15	0.16	1.57	1.46	0.05	34.5
Standard deviation		± 0.51	± 0.49	± 6.94	± 2.39	± 0.03	± 11.1

(N/D, non detectable).

^a Cypriot snacks.

^b Cretan snacks.

consuming such products, the prevalence of these diseases increases, although we do not know the exact consumption of such snacks by Cretan and Cypriot children and adolescents.

3.4. Polyunsaturated fat

The content of polyunsaturated fatty acids (PUFA) ranged from 4.6% to 63.5% with a mean value of $13.6 \pm 11.0\%$ of the total fat content. The rather high standard deviation is due mainly to the 63.5% polyunsaturated fatty acid content of sample no. 11. Excluding that specific sample, the standard deviation drops to 5%. Only 3 of the 30 samples have a PUFA content larger than 20% (no. 1, no. 10 and no. 16) and only sample no. 10 has a PUFA content larger than 10 g per 100 g (22.42 g specifically). Because essential fatty acids ($\omega - 3$ and $\omega - 6$) are included in this group, the PUFA content is very important for the biological and nutritional value of these snacks. As seen in Table 7, linoleic acid, an $n - 6$ essential fatty acid, was the polyunsaturated fatty acid most commonly found in the snacks. It accounted for up to 63.3% of the total fat content of one sample (no. 10) but, on average, it accounted for 13.3%

of the total fat content. Gamma linoleic acid was also found in the samples but in much lower concentrations (mean value of 0.3%)

3.5. Monounsaturated fat (*cis-trans*)

According to Table 4, the *cis*-monounsaturated fatty acid (*c*-MUFA) content of the samples ranged from 16.9% to 81.6%, with a mean value of $43.0 \pm 9.9\%$ of the total fat content. The *cis*-monounsaturated fatty acid mainly represented in the samples was 18:1*c*. It accounted for $42.6 \pm 9.7\%$ of the total fat content on the average. Other similar fatty acids were also found but in minute concentrations (Table 6). The amount of total *trans*-monounsaturated fatty acids (*t*-MUFA) in the samples ranged from 0.21% to 1.15% of the total fat content. The mean value of the concentrations in all the samples was $0.48 \pm 0.18\%$. The most commonly found *trans*-monounsaturated fatty acid was 18:1*t*, which accounted for $0.30 \pm 0.19\%$ of the total fat content. Others, such as 16:1*t*, 18:3*t* and 20:1*t* were also found but in smaller amounts of 0.04%, 0.11% and 0.03% of the total fat content, respectively.

Table 6

Analytical contents of lipids 16:1*t*, 16:1, 17:0, 17:1, 18:0 and 18:1*c* as a percentage of the total fatty acid content

No.	Product description	16:1 <i>t</i>	16:1	17:0	17:1	18:0	18:1 <i>c</i>
1	Peanut and hazelnut flavoured corn puffs ^b	0.03	0.08	0.06	0.03	3.09	43.1
2	Extra salted potato crisps ^a	0.03	0.15	0.08	0.02	4.19	42.0
3	Corn-rice-potato puffs (cheese flavoured) ^b	0.03	0.16	0.10	0.02	4.18	38.6
4	Salted potato crisps ^a	0.03	0.16	0.08	0.02	3.93	43.1
5	Bacon flavoured corn puffs ^b	0.03	0.16	0.09	0.02	3.93	42.9
6	Potato crisps with sunflower oil ^b	0.03	0.10	0.02	0.03	3.94	80.5
7	Extra Salted potato crisps with sunflower oil ^a	0.03	0.16	0.08	0.02	4.19	41.8
8	Prawn flavoured potato crisps ^a	0.03	0.16	0.09	0.02	4.24	41.7
9	Corn-potato puffs (pizza flavoured) ^b	0.04	0.20	0.09	0.03	3.65	49.0
10	Corn-potato puffs (cheese flavoured) ^a	0.02	0.08	0.04	0.03	3.98	24.0
11	Cheese flavoured corn-wheat puffs ^a	0.03	0.16	0.09	0.02	4.02	42.8
12	Vegetable flavoured potato crisps ^b	0.03	0.16	0.09	0.02	3.99	42.8
13	Low fat salted potato crisps ^b	0.01	0.03	0.03	0.01	7.32	16.8
14	Cheese flavoured potato crisps ^b	0.03	0.16	0.09	0.02	3.90	43.5
15	Olive oil-salt-pepper flavoured potato crisps ^b	0.04	0.20	0.09	0.03	3.99	45.3
16	Peanut and hazelnut flavoured corn puffs ^a	0.03	0.11	0.06	0.03	3.18	49.6
17	Oregano flavoured potato crisps ^b	0.03	0.16	0.09	0.02	3.95	42.9
18	Cheese flavoured corn-flour puffs ^a	0.07	0.26	0.14	0.05	4.60	41.2
19	Cheese-corn-potato puffs ^b	0.07	0.27	0.13	0.04	4.46	42.3
20	Corn puffs (paprika, onion, bacon flavoured) ^b	0.05	0.20	0.10	0.03	4.13	43.2
21	Spicy corn chips ^a	0.03	0.15	0.08	0.03	3.90	41.6
22	Corn chips with cheese ^b	0.05	0.18	0.10	0.03	4.10	41.1
23	Barbeque flavoured potato crisps ^b	0.03	0.16	0.09	0.03	3.96	42.9
24	Corn-potato puffs (pizza flavoured) ^a	0.07	0.24	0.13	0.04	4.58	41.4
25	Cheese flavoured potato crisps ^a	0.05	0.21	0.11	0.03	4.28	42.3
26	Potato crisps (light) ^a	0.03	0.16	0.09	0.02	4.06	42.9
27	Corn-rice-potato puffs ^a	0.04	0.18	0.10	0.03	4.17	42.4
28	Cheese flavoured corn-potato puffs ^a	0.07	0.25	0.13	0.04	4.51	41.4
Mean		0.04	0.17	0.09	0.03	4.16	42.6
Standard deviation		± 0.02	± 0.05	± 0.03	± 0.01	± 0.71	± 9.77

^a Cypriot snacks.

^b Cretan snacks.

Table 7
Analytical contents of lipids, 18:2, 18:3, 18:3*t*, 20:0, 20:09*t*, 20:0 and 22:0, as percentages of the total fatty acid content

No.	Product description	18:2	18:3	18:3 <i>t</i>	20:0	20:1 <i>t</i>	20:1	22:0
1	Peanut and hazelnut flavoured corn puffs ^b	31.9	0.88	0.27	1.10	N/D	2.57	1.15
2	Extra salted potato crisps ^a	11.1	0.29	0.11	0.16	0.03	0.05	0.06
3	Corn–rice–potato puffs (cheese flavoured) ^b	9.07	0.26	0.11	0.15	0.02	0.05	0.05
4	Salted potato crisps ^a	10.4	0.27	0.13	0.16	0.03	0.05	0.05
5	Bacon flavoured corn puffs ^b	10.5	0.27	0.12	0.13	0.02	0.05	0.04
6	Potato crisps with sunflower oil ^b	7.58	0.25	0.10	0.11	0.02	0.88	0.22
7	Extra Salted potato crisps with sunflower oil ^a	10.9	0.29	0.12	0.13	0.03	0.05	0.05
8	Prawn flavoured potato crisps ^a	10.2	0.29	0.12	0.11	0.03	0.06	0.05
9	Corn–potato puffs (pizza flavoured) ^b	13.3	0.25	0.12	0.16	0.03	0.05	0.01
10	Corn–potato puffs (cheese flavoured) ^a	63.3	0.18	0.07	0.10	0.06	0.62	0.15
11	Cheese flavoured corn–wheat puffs ^a	10.6	0.28	0.11	0.14	0.02	0.05	0.05
12	Vegetable flavoured potato crisps ^b	10.7	0.27	0.12	0.15	0.03	0.05	0.05
13	Low fat salted potato crisps ^b	4.51	0.14	0.04	0.13	0.01	0.04	0.05
14	Cheese flavoured potato crisps ^b	11.2	0.28	0.11	0.16	0.02	0.05	0.05
15	Olive oil–salt–pepper flavoured potato crisps ^b	9.86	0.29	0.11	0.20	0.02	0.05	0.05
16	Peanut and hazelnut flavoured corn puffs ^a	22.3	0.57	0.18	0.61	0.01	1.46	0.68
17	Oregano flavoured potato crisps ^b	10.4	0.28	0.05	0.16	0.03	0.06	0.05
18	Cheese flavoured corn–flour puffs ^a	10.1	0.26	0.11	0.17	0.03	0.05	0.05
19	Cheese–corn–potato puffs ^b	11.1	0.30	0.11	0.14	0.03	0.15	0.08
20	Corn puffs (paprika, onion, bacon flavoured) ^b	10.9	0.28	0.11	0.13	0.02	0.05	0.05
21	Spicy corn chips ^a	12.3	0.29	0.10	0.16	0.04	0.05	0.05
22	Corn chips with cheese ^b	13.9	0.29	0.10	0.17	0.03	0.05	0.05
23	Barbeque flavoured potato crisps ^b	10.1	0.28	0.11	0.20	0.03	0.05	0.05
24	Corn–potato puffs (pizza flavoured) ^a	9.70	0.28	0.10	0.18	0.03	0.06	0.06
25	Cheese flavoured potato crisps ^a	9.03	0.28	0.11	0.13	0.03	0.05	0.06
26	Potato crisps (light) ^a	9.67	0.29	0.12	0.13	0.03	0.05	0.05
27	Corn–rice–potato puffs ^a	9.22	0.29	0.10	0.11	0.04	0.05	0.06
28	Cheese flavoured corn–potato puffs ^a	9.57	0.27	0.11	0.17	0.02	0.05	0.05
Mean		13.3	0.30	0.11	0.20	0.03	0.24	0.12
Standard deviation		±11.0	±0.13	±0.04	±0.20	±0.01	±0.55	±0.24

(N/D, non detectable).

^a Cypriot snacks.

^b Cretan snacks.

4. Conclusions

The 28 snacks analyzed showed different fatty acid profiles, possibly as a result of the different hydrogenation process conditions used during their manufacture and the different base fats used for their production. The results of the present study indicate that the snacks found in the Cretan and Cypriot market do have, on average, a high fat and high salt contents. Such a nutritional composition could in turn predispose children to nutritional and obesity-related problems. We must emphasize though that further studies are needed to evaluate the exact consumption of those snacks by Cretan and Cypriot children and adolescents and their correlation with nutrition-related diseases.

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