Review Article

Review on chemical composition of gluten-free food for celiac people

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Abstract
Gluten free food lead to possible nutrient unbalance resulting in improper nutritional quality of diet. The aim of this review is to show and discuss the composition of main components of common gluten free products in order to provide doctors and nutritionists the necessary data to compile balanced diets for users of gluten-free products and to determine their contribution to the daily intake of nutrients and micro elements. Special emphasis has been addressed to metal contents, fatty acid profiles and fibers.

Scopus Library was used to search for articles published and particular attention was focused on literature published from 2007 to 2018. A total of 68 research papers were taken into considerations. Compared to common food, GF products show deficit for nutrients and, at this regard, a GF-diet was found to be poor in essential metals such as iron, zinc, magnesium and calcium. On another hand, higher content of fatty acids, especially saturated fatty acids, were founded in several papers were taken into considerations. Compared to common food, GF products show deficit for nutrients and, at this regard, a GF-diet was found to be poor in essential metals such as iron, zinc, magnesium and calcium. On another hand, higher content of fatty acids, especially saturated fatty acids, were founded in several papers were taken into considerations.

Introduction
Celiac disease (CD) is a common chronic enteropathy disease which affects approximately 1-2% of the word population [1]. CD is intolerance for gluten in genetically predisposed individuals and is characterized by an inappropriate immune response of the T-lymphocytes of the small intestines to gluten peptides [2]. In celiac people, ingestion of gluten leads to inflammation and mucosal damage of the small intestine [3]. The typical lesion in the small intestinal epithelium is villous atrophy with crypt hyperplasia, leading to malabsorption of most nutrients such as minerals (Fe, Ca, Zn, etc.) and others essential components (folic acid, fat-soluble and vitamins) [4]. Today, the only available treatment for celiac patients will result, in the majority of cases, a normalization of symptoms and cytological and histological parameters [5]. Generally, coeliac people need assistance from a dietician that has no knowledge on mineral contents or fatty acids, proteins, sugars compositions of available gluten-free products, and, for this reason, it is necessary to know the composition of gluten free foods commonly consumed by individuals with celiac disease.

The increasing number of cases of celiac disease consequently favored the production of numerous commercial food products. In several cases, food companies, in order to improve workability of products, use raw materials at low prices, for an example palm and palmist oils [6,7]. Moreover, in the last ten years, there has been increasing interest on gluten-free bakery and breads. A large type of flours and starches (rice, corn, carob, etc.) as well as many ingredients such as gums, enzymes, soybean proteins, and have been used to mimic the viscoelastic properties of gluten and contribute to improve acceptability and shelf life of gluten-free food [8]. Unfortunately, the use of several bad raw materials long-term can cause several health damages.

On another hand, gluten free diet may lead to possible nutrient deficiencies (such as fiber, micro and macro elements, fatty acids, etc). In detail, common ingredients used in of gluten-free foods are starch and flour of corn, potato, tapioca, rice, etc) and, these raw materials can be considered poor of several micro and macro nutrients. Moreover, in several cases, gluten-free foods tend to be high in fat and calories to enhance flavor, texture and appearance [9]. Several authors [10] assert that many gluten-free cereal products, compared with the enriched wheat products contain lower amounts of thiamin, riboflavin, niacin, folate and iron products that they are intended to replace.

Generally, literature report inadequate intakes of fiber, iron, and calcium in 50% of celiac females studied [11]. To moderate this leak of nutrients, in few cases, flours are fortified with vitamins and minerals, such as B vitamins and iron [12].

Jason [13], analyzing nearly 1200 gluten free foods (Table 1), affirms that these products have a low average proteins content and are carbohydrate-rich. Considering that the used ingredients are often very low in vitamins and minerals, the Jason findings highlight the need of future researches to examine the levels of these nutrients in foods for celiac people. In addition, Jason affirms that results today do not support the contention that gluten free foods are consistently lower in fiber content or that the nutritional quality of these foods are seriously adversely influenced by the addition of saturated fat or sugar.

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The better nutritional properties of pseudo cereals are well known [19], and other staple foods. The preeminent pseudo cereals known so far are amaranth (Amaranth caudatus, Amaranth cruentus, Amaranth hypochondriacus) and quinoa (Chenopodium quinoa), which have fiber levels comparable to those of common cereals [22].

In celiac diet, two of the most important sources of essential elements is representing from rice, corn and their derivatives. Rice flour contain about 0.04% ashes, 0.21% lipids and 10.7% proteins. Corn flour contains 0.33% ashes and 7.50% proteins. In several cases, field bean semolina (Vicia faba) is used in the gluten free food production that contains 0.08% ashes, 1.08% lipids, 30.0% proteins [18].

Recently, pseudo cereals are used in the preparation of gluten free food. A pseudo cereal is defined as any plant that does not belong to the grass family but produces fruits and seeds used as flour for bread and other staple foods. The preeminent pseudo cereals known so far are grain amaranth (Amaranth caudatus, Amaranth cruentus, Amaranth hypochondriacus), quinoa (Chenopodium quinoa), and buckwheat (Fagopyrum esculentum).

The better nutritional properties of pseudo cereals are well known [19], having higher protein percentages than wheat, and constituting a good source of calcium, magnesium and iron. Consequently, in several cases, pseudo cereals constitute a valid alternative to common gluten-containing grains, add variety and improve nutritional quality of gluten free food.

Protein content in amaranth and quinoa (Table 2) [19] is generally higher than in cereals containing gluten such as wheat [20,21] and is usually highest in amaranth followed by quinoa and buckwheat.

In pseudocereals the protein bioavailability is high, and the amino acid composition is well balanced, with a high content of essential amino acids, and is higher compared to that of cereals containing gluten [19].

Amaranth, quinoa and buckwheat represent good sources of fiber; in buckwheat seeds the content is significantly higher than that of amaranth and quinoa, which have fiber levels comparable to those of common cereals [22].

Teff is a gluten free grain [23] gaining attractiveness due to its positive nutritional properties [24]. The teff flour is rich in fiber due to the incorporate of bran components. It is also a source of bioactive compounds such as polyphenols [25].

Despite the great rise in consumption of gluten free foods, there is a lack of evaluation of their composition and nutritional profile and how they compare foods containing gluten. Another important issue in environmental and food quality regard to pollution from organic or inorganic substances, because many of these substances are not degradable and can be bioaccumulate in food chain [26,27]. Food and Agriculture Organization of the United Nations (FAO) has discussed the tolerable intake for several food contaminants, including toxic metals as As, Cd and Pb (FAO, 2010). These microelements can be found in celiac food and their detectable can by scripted by two different origins. The first one depends on the use of massive use of pesticides, the second from possible release from raw materials employed during food manufacturing.

The aim of this review is to show the chemical compositions and discuss the nutritional qualities of GF products in order to provide doctors and nutritionists the necessary data to compile balanced diets for users of gluten-free products and to determine their contribution to the daily intake of nutrients and micro elements. Special emphasis

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Table 1. Metal contents in raw materials used for gluten free products

| Ref.   | Sample               | Element | P (mg/g) | Ca (mg/g) | Mg (mg/g) | K (mg/g) | Na (mg/g) | Mn (mg/g) | Fe (mg/g) | Ni (mg/g) | Cu (mg/g) | Zn (mg/g) | Cr (mg/g) | Co (mg/g) | As (mg/g) | Se (mg/g) | Cd (mg/g) | Sb (mg/g) | Hg (mg/g) | Pb (mg/g) |
|--------|----------------------|---------|----------|-----------|-----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| [13]   | Flour corn           |         | - 6.10   | 4.70      | 120       | 1000     | - 1100    | - 29      | - 500     | 2.6       | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [55]   | Flour rice           |         | -        | -         | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [55]   | Flour wheat          |         | -        | -         | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [55]   | Other                |         | -        | -         | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [55]   | Whole grain rice     |         | -        | -         | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [55]   | White                |         | -        | -         | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [55]   | Brown                |         | -        | -         | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [55]   | Enriched white       |         | -        | -         | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [23]   | Teff seed            |         | 4.29     | 1.80      | 1.84     | 4.27     | 0.12      | - 76.3    | - 36.3    | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [23]   | Flour                |         | -        | -         | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [19,22]| Amaranth             |         | - 1.80   | 2.88      | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [19,22]| Quinoa               |         | - 0.33   | 2.07      | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [19,22]| Buckwheat            |         | - 0.61   | 2.03      | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [19,22]| Wheat                |         | - 0.35   | 0.96      | -         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [29]   | Quinoa               |         | 3.83     | 1.48      | 2.50     | 9.27     | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [29]   | Wheat                |         | 4.68     | 0.50      | 1.69     | 5.78     | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [29]   | Rice                 |         | 1.38     | 0.07      | 0.74     | 1.18     | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [29]   | Barley               |         | 5.03     | 0.43      | 1.29     | 5.03     | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [33]   | Flour for cakes      |         | - 0.39   | 9.8       | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [33]   | Flour                |         | - 2.6    | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [39]   | Teff                 |         | - 0.79   | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| [54]   | Teff flour           |         | -        | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         | -         |
has been addressed to metal contents, fatty acid profiles, fibers and vitamins.

Materials and methods

In the last 10 years, documents concerning to gluten free aspects are increasing (Figures 1A-1C). Most of studies concerning to gluten free food, were conducted by US researchers, on another hand, Italy was the second country in term of report produced. At July 2018, literature reporting gluten free as key word shows 6627 documents and only 466 documents are relative at chemistry field. In this context, was necessary to focused attention concerning to several aspect regarding food nutrients in gluten free.

The researches in literature were performed by used the key words gluten free using Scopus as search engine. From the search resulted 58 articles and only 23 are related to nutritional aspects, published from 2007 to spring 2018. The last were considered for the purpose of this review. Other relevant papers concerning to food quality and their chemical analyses were considerate.

Table 2. Macro compounds in raw materials and products

| Reference | Sample   | Carbohydrates | Saturated fatty acids | Unsaturated fatty acids | Sugar | Protein | Fiber |
|-----------|----------|---------------|-----------------------|-------------------------|-------|---------|-------|
| [13]      | Flour corn | 49000 ug/g | - 800 ug/g | - | - | 110000 ug/g |
| [29]      | Quinoa   | 63000 ug/g | - | - | - | 165000 ug/g |
| [29]      | Barley   | 19000 ug/g | - | - | - | 108000 ug/g |
| [29]      | Maize    | 47000 ug/g | - | - | - | 102000 ug/g |
| [29]      | Rice     | 22000 ug/g | - | - | - | 76000 ug/g |
| [29]      | Wheat    | 23000 ug/g | - | - | - | 143000 ug/g |
| [29]      | Oat      | 52000 ug/g | - | - | - | 116000 ug/g |
| [29]      | Rye      | 18000 ug/g | - | - | - | 134000 ug/g |
| [29]      | Bean     | 11000 ug/g | - | - | - | 280000 ug/g |
| [29]      | Lupine   | 70000 ug/g | - | - | - | 391000 ug/g |
| [29]      | Soya     | 189000 ug/g | - | - | - | 361000 ug/g |
| [23]      | Teff seed | 23800 ug/g | 44900 ug/g | 16600 ug/g | 18400 ug/g | 133000 ug/g |
| [19,22]   | Amaranth | 57000 ug/g | - | - | - | 165000 ug/g |
| [19,22]   | Quinoa   | 52000 ug/g | - | - | - | 145000 ug/g |
| [19,22]   | Buckwheat | 21000 ug/g | - | - | - | 125000 ug/g |
| [28]      | Amaranth | 50000 ug/g | - | - | - | 110000 ug/g |
| [28]      | Buckwheat | 25200 ug/g | - | - | - | 130700 ug/g |
| [28]      | Quinoa   | 34400 ug/g | - | - | - | 113200 ug/g |
| [32]      | Bread    | 110500 ug/g | - | - | - | 483000 ug/g |
| [32]      | Bread    | 110500 ug/g | - | - | - | 811800 ug/g |

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| [28]      | Quinoa   | 34400 ug/g | - | - | - | 113200 ug/g |
| [32]      | Bread    | 110500 ug/g | - | - | - | 483000 ug/g |

Carbohydrates

Starch, the main biopolymeric constituents of plants (grains, tubers and seeds), is the major source of physiological energy in the human diet and accordingly it is classified in general as an available carbohydrate. Some authors [28,29] affirms that in the quinoa, carbohydrates ranges from 67-74% and the amylose content is about 11% which is lower than in cereals. Other carbohydrates are in small amounts: monosaccharides (2%), disaccharides (2.3%), crude fiber (2.5-3.9%) and pentosans (2.9-3.6%) [30,31]. María Estela Matos [8] established that gluten-free breads show a high contribution to the carbohydrate dietary reference intake (Table 2), moreover, starch is the most important component of teff grain [23] and may amount up to over 70% of the dry weight.

Macrolelements

In food, metals and other elements [32-35] can be found by naturally source or can enter as the result of human activities such as industrial and agricultural processes. The macro elements are very important in several biochemical processes and play a fundamental role in human homeostasis [36]. The content of some minerals in amaranth, quinoa, buckwheat and teff, determinate by several authors, are shown in Table 1 [37]. High calcium content in amaranth seeds were founded, and about teff grain [23], calcium and magnesium have similar concentration (1800 and 1840 mg Kg⁻¹ respectively), similarly, potassium and phosphorous content are 4270 and 4290 mg Kg⁻¹ respectively. Teff seeds contain 120 mg Kg⁻¹ of sodium. Baye et al. [38] showed that the Ca contents of whole grain teff are 788 mg Kg⁻¹. Moreover, numerous researchers have also highlighted the high minerals content of pseudocereals [19-21,38].

In a paper [39] researchers report the results for the quantification of K, Li, Sr, Na, Ca, Mg and Al in seventeen gluten-free food (Table 3). Considering all analyzed food, potassium ranged from 14 to 3747 mg kg⁻¹. The highest contents were found by us in a flour for cakes (3747 mg kg⁻¹), crouton (2479 mg kg⁻¹) and in the two local bread samples (1327 and 1082 mg kg⁻¹). The mean K concentration was 716 mg kg⁻¹ and is very lower those measured in Hispanic products that showed K concentration in the interval 4000 and 5000 mg kg⁻¹ [40-42].

The sodium content of the gluten free food samples ranged from 306 to 12315 mg kg⁻¹ with average of 3015 mg kg⁻¹ and the highest sodium levels were measured in three bread samples. The sodium concentrations in the analyzed samples are very high, for example the mean Na concentration in some Hispanic wheat cultivars varied significantly between 41.0 and 273 mg kg⁻¹ [43]. The concentration of calcium in samples ranged from 5 to 1682 mg kg⁻¹. The mean value was 413 mg kg⁻¹. The highest values were detected in the Local bread (1682 mg kg⁻¹), flour for cake (1658 mg kg⁻¹) and Biscuit (1288 mg kg⁻¹), while the lowest concentrations were found in two pasta samples. Magnesium content was in the range 30-1207 mg kg⁻¹. The mean value was 333 mg kg⁻¹. The highest values were detected in the of breadsticks (1207 mg kg⁻¹) and flour for cakes (813 mg kg⁻¹).

Considering the average concentrations of the elements analyzed, excluding lithium, authors concluded that they are inadequate if compared with the recommended daily intake by international
Matrices, the analyst often has to determine the characteristics of a large quantity of product. Theoretically, the chemist or biologist should analyze every part of the material to obtain accurate measures of the property of interest, but, considering practical and economical aspects, this is impossible. At this regard, analyst carry out the analyses on a representative sample and to extend results to all the lot of food. Homogenization is part of the sample preparation procedure and includes mixing and blending of the sample, particle size reduction, and mass reduction.

Literature reported several methods able to mineralize food samples. The most used analytical technique employs sample digestion in a microwave oven by means of HNO$_3$ (63%) and H$_2$O$_2$ (30%). Regarding to determination aspects, at present, official methods for the analysis of micro and macro elements content in food matrices can conducted by several instrumental and analytical techniques as reported in Table 4. Based on data reported in Table 4, the choice of method depends on several aspects, from metals to concentration levels in sample.

**Microelements**

The heavy metals of particular concern in relation to harmful effects on health are mercury, lead, cadmium, tin and arsenic. The toxicity of these metals can be expressed by acute or chronic, depending to the fact that they accumulate in biological tissues, for a process known as bioaccumulation. This process of bioaccumulation occurs in all living organisms as a result of exposure to metals in food and the environment and includes biomagnifications processes. On another hand, high levels of several metals, due to pollutant contamination, release during manufacturing process and food organisms [40], providing only from 1.5 to 20% of the RDI for the essential metals. In particular, considering that many celiac people consume small quantities of potassium which contribute to regulate blood pressure and prevent hypertension. The tolerable upper level intake is exceeded by consuming more than 200 grams of gluten free bread during a day.

Generally, analyses of food were carried out by four steps; sampling, homogenization, mineralization and analyses. Concerning the quantifications of micro and macro constituents of gluten food

| Sample          | K (ug/g) | Li (ug/g) | Sr (ug/g) | Na (ug/g) | Ca (ug/g) | Mg (ug/g) | Al (ug/g) |
|-----------------|----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Pasta           | 250      | 3.0       | 6.6       | 1205      | 5         | 102       | 21        |
| Noodles         | 331      | 19        | 2.5       | 549       | 133       | 423       | 0.8       |
| Flour           | 208      | 2.8       | 6.2       | 905       | 57        | 86        | 16        |
| Biscuits        | 635      | 2.8       | 6.1       | 1986      | 69        | 280       | 18        |
| Pasta fusilli   | 386      | 8.0       | 0.2       | 306       | 106       | 359       | 0.6       |
| Pasta linguine  | 611      | 2.9       | 6.3       | 923       | 5         | 207       | 19        |
| Egg noodles     | 211      | 15        | 102       | 793       | 272       | 373       | 1.5       |
| Finger biscuits | 109      | 43        | 4.5       | 1136      | 340       | 291       | 1.7       |
| Buckwheat biscuits | 1238  | 2.7       | 6.0       | 4172      | 105       | 495       | 17        |
| Croutons        | 14       | 4.5       | 78        | 808       | 265       | 256       | 1.3       |
| Rice noodles    | 131      | 2.8       | 6.3       | 682       | 237       | 224       | 9.5       |
| Couscous        | 940      | 2.6       | 5.8       | 838       | 100       | 247       | 18        |
| Corn couscous   | 905      | 2.7       | 48        | 874       | 196       | 273       | 16        |
| Flour for cakes | 3747     | 2.8       | 6.2       | 5427      | 1658      | 813       | 10        |
| Lasagna         | 1171     | 2.8       | 6.2       | 4071      | 1098      | 210       | 14        |
| Corn flakes     | 855      | 2.7       | 6.0       | 5245      | 123       | 160       | 1.0       |
| Dietary biscuits| 73       | 9.1       | 12        | 909       | 826       | 231       | 1.0       |
| Breadsticks     | 322      | 68        | 3.5       | 3209      | 374       | 1207      | 1.5       |
| Local bread B   | 1327     | 5.8       | 19        | 10383     | 1682      | 317       | 12        |
| Local bread P   | 1082     | 2.8       | 6.2       | 12315     | 490       | 308       | 13        |
| Corn flakes     | 855      | 2.7       | 6.0       | 5245      | 123       | 160       | 17        |
| Shortbread      | 72       | 25        | 3.5       | 792       | 264       | 279       | 1.0       |
| Biscuits        | 33       | 7.7       | 2.0       | 382       | 1288      | 436       | 1.4       |
| Butter cookies  | 42       | 15        | 56        | 1134      | 40        | 314       | 1.2       |
| Croutons        | 2479     | 248       | 36        | 5816      | 637       | 441       | 13        |
| Egg biscuits    | 195      | 40        | 3.9       | 1070      | 297       | 30        | 12        |
| Industrial bread| 1115     | 2.9       | 13        | 10520     | 361       | 456       | 23        |
packaging, can cause health damage because can be considered as interference with essential metals.

Trace amounts of some metals, manganese, copper, and zinc are essential micro nutrients and have a variety of biochemical functions in all living organisms. For example, copper, is present in enzymes and proteins that protecting the body from free radicals [44]. On another hand, these elements can be considered as toxic when taken in excess and some minerals may constitute a potential health risk if consumed above the tolerable upper in-take levels over extended periods. Examples of these are iodine, lead, arsenic, cadmium and mercury poisoning. For other minerals, the negative effects are less hazardous, producing e.g. gastrointestinal problems. For non-essential elements exposures are undesirable, but acceptable levels are determined by the World Health Organization (WHO) and other international authorities [40,45,46]. Indeed, since rice-based foods are widely consumed by celiac people, the exposure to non-essential elements such as arsenic, cadmium and lead is a global concern [47-50].

A study on whole grain teff showed that the Fe and Zn contents are 316 and 23.1 mg Kg\(^{-1}\) (dry basis), respectively [38]. The total iron content (76.3 mg Kg\(^{-1}\)) is high if compared with other microelements, is respectively 21.3-6.7 and 41-22 µg/g (dry basis), respectively [38]. The total iron content is used in the food industry as a leavening agent in baked goods and generally, in foods with gluten, contain additives. NaAl\(_2\)H\(_5\)(PO\(_4\))\(_3\) is used in the food industry as a leavening agent in baked goods and NaAl\(_2\)OH\(_5\)(PO\(_4\))\(_3\) as an emulsifying agent [57]. The concentrations of Al in convenience and fast foods analyzed by some researches [58] ranged from 0.85 to 38 mg kg\(^{-1}\), (referred to fresh weight of the edible portion) are higher than gluten free food. In food, aluminum may be: a natural contaminant of vegetal and animal ingredients; a contaminant of industrial food processing; contained in additives; released from kitchenware used for food preparation and/or serving stocking and packaging food materials.

The aluminum content quantified [39] in seventeen gluten-free food samples ranged from 0.6 to 23 mg kg\(^{-1}\) with average of 10 mg kg\(^{-1}\) and in agreement to those (0.4-13 mg kg\(^{-1}\)) determined by several authors [55,56] in cereals. In this case, the highest Al levels were measured in two pasta samples. Considering that Al additives are contained in specific processed foods, contrary to our expectations, the lower concentrations (about 1 mg kg\(^{-1}\)) were found in some that generally, in foods with gluten, contain additives. NaAl\(_2\)H\(_5\)(PO\(_4\))\(_3\) is used in the food industry as a leavening agent in baked goods and NaAl\(_2\)OH\(_5\)(PO\(_4\))\(_3\) as an emulsifying agent [57]. The concentrations of Al in convenience and fast foods analyzed by some researches [58] ranged from 0.85 to 38 mg kg\(^{-1}\), (referred to fresh weight of the edible portion) are higher than gluten free food. In food, aluminum may be: a natural contaminant of vegetal and animal ingredients; a contaminant of industrial food processing; contained in additives; released from kitchenware used for food preparation and/or serving stocking and packaging food materials.

### Table 4. Analytical techniques used in metals analyses in food

| Analytical techniques                      | Metal analyzed                  | Linear range µg Kg\(^{-1}\) | Reference |
|--------------------------------------------|---------------------------------|-------------------------------|-----------|
| Flame atomic absorption                    | Alkaline and alkaline earth metals | 1000-100000                   | [34]      |
| Furnace atomic adsorption                  | Alkaline, alkaline earth and transition metal | 1-5                       | [35]      |
| Plasma atomic emission inductively coupled spectroscopy (ICP-OES) | All metals wit some exceptions | 1-200                       | [36]      |
| Inductively coupled plasma-time of flight-mass spectrometry | All metals | 1-500 | [34] |
| Electro-analytical techniques              | All metals or substance that can be oxidized or reduced | 0.1-10                | [36]      |

### Table 5. Microelement contents and total fatty acids in several gluten free food

| Ref. | Samples | Metals | Total fatty acid | Salt | Mn | Fe | Ni | Cu | Zn | Cr | Co | As | Se | Cd | Sb | Hg | Pb | ug/g |
|------|---------|--------|-----------------|------|----|----|----|----|----|----|----|----|----|----|----|----|----|     |
| [55] | Rice    | -      | -               | NaAl\(_2\)H\(_5\)(PO\(_4\))\(_3\) | 20.1 | 13.3 | 0.4 | 2  | 14.3 | 189 | 23.5 | 141 | 115 | 15.9 | 2.9 | 3.4 | 22 | -   |
| [55] | No rice | -      | -               | NaAl\(_2\)H\(_5\)(PO\(_4\))\(_3\) | 13.9 | 26.1 | 0.2 | 3.4 | 20.9 | 111 | 6.7 | 15  | 340 | 52.4 | 1.7 | 1   | 7  | -   |
| [55] | Rice    | -      | -               | NaAl\(_2\)H\(_5\)(PO\(_4\))\(_3\) | 17.9 | 14  | 0.3 | 2.2 | 15  | 108 | 19.3 | 147 | 114 | 21.3 | 3.3 | 2.5 | 18 | -   |
| [55] | Other   | -      | -               | NaAl\(_2\)H\(_5\)(PO\(_4\))\(_3\) | 33.1 | 70.7 | 2.4 | 10.4 | 38.1 | 55  | 113.8 | 13 | 207 | 31.5 | 5.2 | 1.7 | 1  | -   |
| [2]  | Snacks  | 19400  | -               | -    | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | 22470 |
| [2]  | Fast food | 14600 | -               | -    | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | 11660 |
| [2]  | Nuts and oilseed | 8300 | -               | -    | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | 45620 |
| [2]  | Cereal products | 4300 | -               | -    | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | 11770 |
| [2]  | Sauces  | 19700  | -               | -    | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | 29910 |
| [2]  | Potato products | 11600 | -               | -    | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | 25580 |
| [23] | Pasta   | -      | -               | -    | 6.4 | 6.1 | -   | 2  | 9.9 | 41  | 19  | 94  | 55 | 14  | -  | -  | 55 | -   |

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The concentrations of seventeen microelements (As, Ba, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Sn, V and Zn) were quantified by Orecchio [32] in twenty-seven samples (Table 6) of gluten-free products (pasta, biscuits, flours, etc.) produced in Italy and collected in 2013 from markets and pharmacies in Palermo (Italy). Inductively coupled plasma mass spectrometry technique (ICP-MS) was used to quantify all the analytes. The highest arsenic and molybденum concentrations were measured in Rice Noodle from China (0.088 and 0.47 mg kg⁻¹ respectively). The highest concentrations of some metals (Cu, Ba, Cd, Pb, Hg, Sr and V) were found in bread and breadstick samples produced in different bakeries located at Palermo. The analytical results indicate a large variability between samples with respect to metal concentrations, which could be due to the proportion of different ingredients used in the food compositions and to different levels of contaminants in the production laboratories. In particular, foods analyzed contain levels of hazardous trace elements under the limits tolerated by the law and the contribution of the foods to the daily intake of all the elements analyzed remains under the recommended levels by international organisms. Considering the average concentrations of some microelements found in this study, authors concluded that they are inadequate if compared with the recommended daily intake by international organisms, providing from 1.1 to 53% of the RDI for the essential metals. These conclusions are in good agreement to some authors affirming that commercial gluten-free cereal foods, made of refined flours or starches, are of lower nutritional value compared to their wheat counterparts.

**Fatty acids**

Fatty acids play important roles in human activities. A large variety of fatty acids has been found in the diet of humans, in the bloodstream and in cells and tissues. Fatty acids, in addition to be energy sources, represent membrane constituents. Indeed, they have biological activities those explicate actions on tissue metabolism, function, and responsiveness to hormonal and other signals. Through several effects, fatty acids influence health, wellbeing, and disease risk. In this context, food characterization regarding by fatty acids, represents an important tool in order to prevent some health effect. For example, Polyunsaturated Fatty Acids (PUFA) constitute an important group of molecules that promote health, while Saturated Fat Acids (SFA) intake represent a risk for atherosclerotic cardiovascular disease in humans. Substituting polyunsaturated fat for saturated fat reduces LDL cholesterol and the total cholesterol to high-density lipoprotein cholesterol ratio. Epidemiologic studies and randomized clinical trials have provided evidence that replacing saturated fat with polyunsaturated fat is beneficial for coronary heart disease.

Generally, for food analyses, total fatty acids must be extracts from sample and subsequently analyzed directly by weighing. The most important procedures and instruments involved in fatty acid profile determinations in food after derivatization procedures are reported in Table 7.

Many studies were conducted about lipid profiles in food analyses, however, on fatty acids in gluten free foods, literature reported only few studies [7,19]. Alvarez [19] found that lipid content in amaranth and quinoa is between 2 and 3 times higher than in buckwheat and common cereals such as wheat. Amaranth, quinoa and buckwheat lipids contain fatty acids having high degree of unsaturation, which is favorable from a nutritional point of view. Linoleic acid is the most abundant fatty acid (50% of the total fatty acids in amaranth and quinoa, and approximately 35% in buckwheat) followed by oleic acid (25% in amaranth and quinoa and 35% in buckwheat) and palmitic acid [10,19,59-61]. High a-linolenic acid (C18:3 n-3) percentage is contained in quinoa seeds ranging from 3.8-8.3%

| Table 6. Microelement contents in gluten free food [33] |
|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Sample              | Cr                  | Mn                  | Co                  | Ni                  | Cu                  | Zn                  | As                  |
|                     | ug/g                | ug/g                | ug/g                | ug/g                | ug/g                | ug/g                | ug/g                |
| Pasta               | 0.0001              | 0.0091              | 0.47                | 0.0003              | 0.016               | 0.3                | 1.2                |
| Noodles             | 0.088               | 0.0268              | 1.6                 | 0.0026              | 0.040               | 0.6                | 4.4                |
| Biscuits            | 0.044               | 0.0151              | 0.4                 | 0.0008              | 0.22                | 0.9                | 4.6                |
| Pasta fusilli       | 0.0039              | 0.011               | 0.08                | 0.0029              | 0.25                | 0.9                | 0.3                |
| Pasta Linguine      | 0.0075              | 0.078               | 0.6                 | 0.0070              | 0.53                | 0.9                | 3.8                |
| Egg noodles         | 0.0021              | 0.031               | 0.9                 | 0.0025              | 0.06                | 0.4                | 4.0                |
| Egg noodles         | 0.0021              | 0.031               | 0.9                 | 0.0025              | 0.06                | 0.4                | 4.0                |
| Finger biscuits     | 0.0065              | 0.16                | 0.80                | 0.0028              | 0.10                | 0.4                | 5.6                |
| Buckwheat biscuits  | 0.0093              | 0.040               | 0.5                 | 0.0073              | 0.33                | 1.6                | 6.5                |
| Croutons            | 0.028               | 0.21                | 0.75                | 0.0020              | 0.50                | 0.6                | 3.6                |
| Rice noodles        | 0.0033              | 0.13                | 0.5                 | 0.0151              | 0.14                | 1.7                | 10.7               |
| Couscous            | 0.0029              | 0.040               | 1.0                 | 0.0010              | 0.31                | 0.8                | 3.2                |
| Couscous            | 0.0029              | 0.040               | 1.0                 | 0.0010              | 0.31                | 0.8                | 3.2                |
| Corn couscous       | 0.0054              | 0.063               | 0.81                | 0.024               | 0.12                | 0.37               | 2.9                |
| Lasagna             | 0.071               | 14.4                | 2.5                 | 0.54                | 15.0                | 1.5                | 7.2                |
| Corn flakes         | 0.028               | 8.4                 | 2.1                 | 0.15                | 10.3                | 1.1                | 3.3                |
| Dietetic biscuits   | 0.049               | 9.1                 | 1.5                 | 0.15                | 10.0                | 1.2                | 3.7                |
| Breadsticks         | 0.035               | 8.7                 | 4.4                 | 0.16                | 10.5                | 1.1                | 5.0                |
| Local bread B.      | 0.074               | 8.7                 | 3.1                 | 0.17                | 10.3                | 1.3                | 5.7                |
| Local bread P.      | 0.036               | 8.7                 | 4.8                 | 0.16                | 10.2                | 1.8                | 8.4                |
| Corn flakes         | 0.031               | 8.1                 | 2.1                 | 0.15                | 10.0                | 1.1                | 3.5                |
| Shortbread          | 0.033               | 9.7                 | 3.8                 | 0.19                | 12.4                | 1.4                | 13.7               |
| Biscuits            | 0.057               | 14.0                | 4.7                 | 0.20                | 14.0                | 1.6                | 7.4                |
| Butter cookies      | 0.054               | 14.0                | 4.6                 | 0.19                | 13.8                | 1.1                | 6.0                |
| Croutons            | 0.005               | 0.031               | 0.4                 | 0.013               | 0.11                | 1.8                | 6.7                |
| Egg biscuits        | 0.014               | 0.035               | 0.6                 | 0.011               | 0.21                | 1.3                | 6.3                |
| Industrial bread    | 0.052               | 0.054               | 0.2                 | 0.015               | 0.17                | 0.94               | 3.7                | 0.020              | 0.014               | 1.5                | 0.28                | 0.050              | 0.031               | 0.60                | 0.0059              | 0.052               | 0.021               |

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A high percentage of \( \alpha \)-linolenic acid is advantageous because it reduces cardiovascular disease, cancer, osteoporosis, inflammatory and autoimmune diseases [62].

Several authors [23,51] affirm that the lipid content of teff (3.7 - 4.4%) is higher than that of wheat (3.6%), rice (0.9%), sorghum (3.5%), and maize (2.5%) flours, and was lower than that of oat (6.7%) and quinoa (8.6%) [23,63]. The majority of the free fatty acids are unsaturated (84%) and are similar to that of maize, sorghum, and quinoa. Linoleic (50%) and oleic (29%) are the predominant acids and are similar to those of sorghum and maize [63]. Other analyses carried out by Gebremariam [24] showed that the content of oleic acid (32%) was higher than that of linoleic acid (24%) as affirmed previously. As in other cases, the variances may be due to the different analytical methods and teff genetics (Table 8).

A recent study [7] carried out by us included 35 different products (snacks, biscuits, bakery products, pasta, flours, etc.) from several Italian manufacturers. Table 7 shows the data concerning proteins, energy, carbohydrates, and salts of the foods taken into consideration for the determination of individual fatty acids. The data in Table 9, with the exception of the total and saturated fatty acids content, were obtained from the labels of the aforementioned gluten free products. Furthermore, Table 7 shows, for comparison (\( R^2 \) values), the data concerning some containing gluten. After extraction and esterification, the fatty acid composition was determined by gas chromatography (Table 10). The mean content of total lipids was 12.6%. The highest percentages were found in a wafer biscuit (25%) and in a muffin (23%) sample, while the lowest in a flour mix for bread (1.2%). Saturated fatty acids were contained in all analyzed samples ranging from 2.8 to 72%. The highest contents were found in the wafer biscuit (72%) in an Easter cake (66%) and in the rice, corn, and red fruit flakes sample (63%), while the lowest (2.8%) percentage in a biscuit sample. Palmitic acid was the major component, and high amounts of this fatty acid were detected in all samples. Meanly, mono-unsaturated fatty acids (MUFA) were found to be the major constituents (57%), followed by saturated fatty acids (SFAs) (30%), and polyunsaturated fatty acid (13%). Only 15 of the 35 gluten-free products analyzed supply adequate energy intake, while, in 11 samples, saturated fatty acids were found to give more energy than that recommended by the European Food Safety Authority EFSA [64]. Moreover, data analyses showed that, although gluten-free commercial products are high-added-value foods, industrial products in many cases contain palm and palm kernel oils, whereas the local producers generally use the finest raw materials, such as olive oil.

Albuquerque [65] studying nuts and oilseeds, often used in the preparation of gluten free cakes, showed the highest fat content of these ingredients followed by sauces, potato and potato-products, and snacks samples. These were also the ingredient showed a higher MUFA and PUFA contents, whose percentages were significantly higher in the nuts and oilseeds.

**Proteins**

According to information furnished by suppliers, an evaluation on the nutritional characteristics of gluten-free breads representative of the Spanish market was carried out by Matos Segura [32]. The authors established that the protein, fat and mineral content of the gluten-free breads showed great variation, ranging from 9.0 to 155 g Kg\(^{-1}\) (20.0 to 261 g Kg\(^{-1}\)) and 11.0 to 54.3 Kg\(^{-1}\), respectively. Furthermore, gluten-free breads show very low contribution to the recommended daily protein intake, with a high contribution to the carbohydrate dietary reference intake. A research affirms that the protein contents of two variety of teff are 12.8 and 10.5%, which result higher compared to that of other cereals [63,66].

### Table 7. Procedures and instruments used in fatty acid determination in food sample

| Sample                  | Extraction/purification procedure | Derivatization procedures | Analytical instrument |
|-------------------------|-----------------------------------|--------------------------|-----------------------|
| Oil                     | SPE; Dilution                     | KOH in methanol          | GC-FID; GC-MS;        |
|                        | SPE; Dilution                     | CH\(_3\)NaO in methanol  | GC-FID; GC-MS;        |
|                        | Bligh and Dyer method             | BHT in methanol          | GC-FID; GC-MS;        |
| Liquid sample           |                                   |                          |                       |
| (milk, fruit juice)     | Funnel separation                 | KOH in methanol          | GC-FID; GC-MS;        |
|                         |                                   | CH\(_3\)NaO in methanol  | GC-FID; GC-MS;        |
|                         |                                   | BHT in methanol          | GC-FID; GC-MS;        |
| Solid samples           | Soxhlet                            | KOH in methanol          | GC-FID; GC-MS;        |
|                         | Ultrasonic bath                   | CH\(_3\)NaO in methanol  | GC-FID; GC-MS;        |

### Table 8. Micro and macro nutrient contents in several gluten free foods

| Ref. | Sample                          | Minerals | Na   | Mg   | Fe   | Cu   | Zn   | Cr   | Co   | As   | Se   | Cd   | Pb   | Fatty acid | Protein | Sugar |
|------|---------------------------------|----------|------|------|------|------|------|------|------|------|------|------|------|----------|---------|-------|
| [18] | G. F. products from Vicia faba |          |      |      |      |      |      |      |      |      |      |      |      | 18000    | 30000   |       |
| [2]  | Bakery Products                 | 760      |      |      |      |      |      |      |      |      |      |      |      | 174600   |         |       |
| [2]  | Cookies, biscuit and wafers     | 700      |      |      |      |      |      |      |      |      |      |      |      | 201600   |         |       |
| [23] | Cookies, cereal bars            |          | 9    | 13.5 | 2.1  | 8.4  | 43   | 13   | 53   | 101  | 11   | 69   |      |          |         |       |
| [13] | Cereal bars                     | -       | 54   |      |      |      |      |      |      |      |      |      |      | 50000    | 90      | 300   |
| [13] | Cake                            | -       | 300  |      |      |      |      |      |      |      |      |      |      | 340000   | 40      | 440   |
| [13] | Sweet biscuits                  | -       | 183  |      |      |      |      |      |      |      |      |      |      | 130000   | 45      | 310   |
| [13] | Ice Cream                       | -       | 490  |      |      |      |      |      |      |      |      |      |      | 51000    | 33      | 184   |
| [13] | Corn and potato chips           | -       | 5960 |      |      |      |      |      |      |      |      |      |      | 40000    | 60      | 200   |
| [13] | Cured meats, sausages and hot dogs | -    | 10560|      |      |      |      |      |      |      |      |      |      | 80000    | 180     | 90    |
| [13] | Sugar-based confectioneries      | -       | 5100 |      |      |      |      |      |      |      |      |      |      | 20000    | 3400    | 380   |
Table 9. Nutritional characteristics of analyzed gluten free samples and reference food (R_x) [7]

| N°  | Sample                        | Energy (Kcal/100 g) | Total fats (g/100 g) | Saturated fatty acids (g/100 g) | Carbohydrates (g/100 g) | Proteins (g/100 g) | Sals (g/100 g) |
|-----|-------------------------------|---------------------|----------------------|---------------------------------|--------------------------|-------------------|---------------|
|     |                               |                     |                      |                                 |                          |                   |               |
| Flours                             |                   |                     |                      |                                 |                          |                   |               |
| 1   | Rice flour                    | 365                 | 1.3                  | 0.29                            | 80.15                    | 6.67              | 0.1           |
| 2   | Red teff flour                | 380                 | 1.4                  | 0.27                            | -                         | -                 | -             |
| 3   | Flour for bread               | 352                 | 1.2                  | 0.3                             | 79.6                      | 5                 | 0.01          |
| Rflour0 | Flour 0 with gluten           | 363                 | 1.5                  | 0.27                            | 73.8                      | 11.5              | -             |
| Rflour00 | Flour 00 with gluten          | 366                 | 1.5                  | 0.3                             | 76.2                      | 9.7               | -             |
| Rrice | Rice flour                    | 366                 | 1.4                  | 0.39                            | 80.1                      | 5.9               | -             |
| Rfcorn | Corn flour                    | 375                 | 1.4                  | 0.17                            | 82.8                      | 5.6               | -             |
| Bread                            |                   |                     |                      |                                 |                          |                   |               |
| 4   | Handcrafted bread             | 360                 | 3.7                  | 0.9                             | -                         | -                 | -             |
| Rbread1 | Bread with gluten             | 271                 | 3.5                  | 0.86                            | 50                        | 8.8               | -             |
| Rbread2 | White Bread with gluten       | 238                 | 2.1                  | 0.63                            | 43.9                      | 10.6              | -             |
| Breadsticks                       |                   |                     |                      |                                 |                          |                   |               |
| 5   | Breadsticks a                 | 425                 | 9                    | 1.8                             | 75                        | 2.4               | 1.9           |
| 6   | Breadsticks b                 | 416                 | 8.5                  | 3.2                             | 79.9                      | 4                 | 2.7           |
| 7   | Breadsticks c                 | 462                 | 17.2                 | 2.54                            | 73.57                     | 0.99              | 1.6           |
| 8   | Breadsticks d                 | 446                 | 14.6                 | 2.9                             | 75                        | 2.4               | 1.9           |
| 9   | Breadsticks with olive oil    | 431                 | 12                   | 3.5                             | 79                        | 1.3               | 2.12          |
| 10  | Breadsticks with rosemary     | 460                 | 16                   | 5.13                            | 76.32                     | 2.04              | 2.8           |
| 11  | Mini breadsticks             | 427                 | 12.8                 | 1.7                             | 74.9                      | 1.4               | 1.2           |
| Crackers                          |                   |                     |                      |                                 |                          |                   |               |
| 12  | Buckwheat crackers           | 369                 | 3.6                  | 0.6                             | 72                        | 9.1               | 2             |
| 13  | Crackers with rosemary        | 446                 | 12                   | 7.1                             | 79                        | 3.3               | 1.3           |
| 14  | Rice Crackers                | 454                 | 13.8                 | 1.3                             | 78.5                      | 2.8               | 1.9           |
| 15  | Turmeric crackers            | 455                 | 17                   | 1.8                             | 66                        | 7.6               | 2.1           |
| Rcrackers                        |                   |                     |                      |                                 |                          |                   |               |
| 16  | Corn and quinoa crackers      | 422                 | 9.8                  | 0.9                             | 79.5                      | 1.8               | 1.7           |
| Snack                             |                   |                     |                      |                                 |                          |                   |               |
| 17  | Apricot snack                | 620                 | 7.5                  | 0.99                            | 71                        | 2.5               | 0.23          |
| 18  | Crispy sheets                | 436                 | 12                   | 1.5                             | 78.5                      | 2                 | 1.86          |
| 22  | Rice and corn flakes         | 382                 | 2                    | 0.4                             | 83                        | 6.4               | 0.3           |
| Biscuits                          |                   |                     |                      |                                 |                          |                   |               |
| 19  | Chocolate biscuits           | 453                 | 14                   | 7.7                             | 77                        | 4                 | 0.55          |
| 20  | Biscuits d                   | 422                 | 18.4                 | 2.3                             | 66.3                      | 4.6               | 0.3           |
| 21  | Biscuits f                   | 451                 | 15                   | 7.8                             | 72                        | 5.4               | 0.4           |
| 23  | Lemon biscuits               | 435                 | 11                   | 1.5                             | 78                        | 4.6               | 0.9           |
| 24  | Seven cereal biscuits        | 456                 | 16.5                 | 9.1                             | 72                        | 3.5               | 3             |
| 25  | Biscuits o                   | 456                 | 13                   | 4.6                             | 83                        | 2                 | 0.57          |
| 26  | Chocolate wafer              | 505                 | 25                   | 16                              | 62.1                      | 6.4               | 0.25          |
| Rw  | Wafer with gluten            | 433                 | 14.2                 | 4.2                             | 72.4                      | 6.6               | -             |
| 29  | Biscuits n                   | 439                 | 14                   | 4.2                             | 69.4                      | 7                 | 0.7           |
| 30  | Tumeric biscuits             | 441                 | 16                   | 1.8                             | 78                        | 2.3               | 0.33          |
| 31  | Chocolate biscuits           | 425                 | 11.7                 | 2.7                             | 73.6                      | 5.1               | 0.8           |
| 33  | Buckwheat biscuits           | 444                 | 14                   | 8.9                             | 72                        | 4.2               | 0.85          |
| 34  | Biscuits c                   | 372                 | 19.9                 | 2.5                             | 52.8                      | 4.4               | 0.07          |
| 35  | Crunchy cereal biscuits      | 472                 | 18                   | 8                               | 70                        | 5.3               | 0.75          |
| Muffin and cakes                  |                   |                     |                      |                                 |                          |                   |               |
| 27  | Easter cake                  | 410                 | 18                   | 14                              | -                         | -                 | -             |
| 32  | Quinoa cake                  | 407                 | 17                   | 2.5                             | 55                        | 7.3               | 0.5           |
| 28  | Chocolate muffin             | 441                 | 23                   | 8.6                             | 52                        | 3.9               | 0.5           |
| Rm  | English muffin with gluten   | 223                 | 2                    | 0.29                            | 44.8                      | 8.7               | -             |
Conclusions

Most of the nutritional data reported in literature, are based on food labels. Few data were obtained by direct chemical analysis of food. In this context, will be necessary to encourage the use of chemical analytical practices in order to provide doctors and nutritionists the necessary data to compile balanced diets for users of gluten-free products and to determine their contribution to the daily intake of nutrients and micro elements. Special emphasis has been addressed to metal contents, fatty acid profiles and fibers.

Literature analysis has highlighted that, the most gluten free food, show a deficit of nutrients in term of concentrations. At this regard, an inadequate nutritional value of the GF-diet was observed from several authors. In detail, it was found nutrient deficiencies for essential minerals such as iron, zinc magnesium and calcium, and on another hand high content of saturated lipids were detected.

Furthermore, the dietary-therapeutic approach should encourage the use of naturally gluten free products such as pseudo-cereals and fruits concerning to metal contents, and fish or seafood regarding fatty acids, especially for satured and unsatured fatty acid ratio.

Moreover, alimentary education should become part of the therapeutic pathway to understand the importance of labels, choice of food and combination of macro and micronutrients.

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| Fatty acid | Samples | C18:1 (g/100g) | C18:2 (g/100g) | C18:3 (g/100g) | C20:1 (g/100g) | C20:2 (g/100g) | C20:3 (g/100g) | C22:1 (g/100g) | C24:1 (g/100g) | C24:2 (g/100g) | C24:3 (g/100g) |
|-----------|---------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| C4:0      | 0.01    | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           |
| C6:0      | 0.01    | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           |
| C8:0      | 0.01    | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           |
| C10:0     | 0.01    | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           |
| C12:0     | 0.01    | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           |
| C14:0     | 0.01    | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           |
| C16:0     | 0.01    | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           |
| C18:0     | 0.01    | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           |
| C20:0     | 0.01    | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           |
| C22:0     | 0.01    | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           | 0.01           |
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