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Letter to the Editor

Underutilized and Pseudocereals in the Mediterranean Diet

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Worldwide there are thousands of different plant species that significantly contribute to the livelihoods, health and environments of millions of people. Most of these plant species or crops are important only locally or regionally and as such are known under several common names, i.e. minor, neglected, underexploited or underutilised crops [1]. The European continent is home of a great variety of underutilized cereals, which should be in the future more used to preserve diversifying European agriculture and food. In the past decades, indeed, economically more important crops replaced many traditional varieties and landraces of minor crops. Many of those are fortunately still well preserved in a number of plant gene banks in different countries, but lots of them are also lost forever [2].

Intensive modern agriculture is based on a few monoculture crops whose production reduces fields' biodiversity, including the number of utilized crops and as a consequence natural health and nutritional compounds in the food are reduced as well [3]. In recent decades there has been a small input of agricultural research concerning underutilised crops, and consequently little investment from research institutions and development agencies. Many underutilised species have an excellent nutritional profile compared to the major crops (maize, wheat or rice), with high protein, vitamin and/or mineral contents that can contribute to alleviating 'hidden hunger' in better-off as well as low-income communities [1]. Most of the underutilized crops are no longer suitable for today's intensive agriculture, so the success can be achieved only by planned long-term breeding programmes instead of screening underutilized crops again and again [4].

In the Mediterranean basin underutilized cereals are comprised of sorghum *(Sorghum bicolor L.)*, the millets (major species-pearl millet, foxtail millet, proso millet, finger millet), oat *(Avenasativa L.)*, rye *(Secale cereal L.)* and ancient wheat types (major species-einkorn, emmer, spelt wheat) [2,5,6]. Sorghum is an example of an ancient whole grain cereal better known to Western societies as an animal feed rather than a human food source [6]. Cultivation of sorghum is spreading around Mediterranean countries, and raising the chance to design some new foods based on sorghum flour, especially for people suffering from gluten-intolerance disease [7].

The term pseudo cereals define seeds of non-grass species that are consumed in the same way as cereal grains and having nutritional value competitive to conventional crops or in most cases even better[8]. The major species referring to pseudocereals are buckwheat (*Fagopyrumspp.*), amaranth (*Amaranthus* L) and quinoa *(Chenopodium quinoa)* [5,9,10]. These pseudocereals have unique texture and nutritional features which make them suitable for replacing, at least in part, traditional cereal based products. Over the last few years they were recognised as important for food security and human health [5]. Production of buckwheat, amaranth and quinoa has recently become more and more interesting due to unique and healthy nutritional grains value, especially if they are grown organically [11]. These pseudocereals are gluten free with good nutritional quality characteristics [12]. Amaranth is a good source of technologically useful proteins with antifungal effect [13].

The genus Fagopyrum includes several different species, among which common buckwheat *(Fagopyrum esculentum Moench)* and Tartary buckwheat (*Fagopyrum tartaricum* L. Gaerth) are mainly cultivated worldwide and used for human consumption. Consumption of the grains of common and Tartary buckwheat, as part of an everyday diet, has increased over the past few years due to the number of health-beneficial properties [14]. It is well established that both buckwheat types represent a rich source of high quality proteins, with a balanced amino-acid composition, dietary fibre, retrograded starch, high quality lipids, vitamins, essential minerals and antioxidants [9,15]. Common buckwheat is manly cultivated in Russia, Japan, Canada, and Europe. Gradually replaced by wheat and other cereal with higher yields, this crop has recently aroused new interest due to the possibility of preservation of biodiversity and the recovery of marginal areas. Tartary buckwheat is besides in Asia, also cultivated in limited regions of Slovenia, Italy and Northern Europe [16].

Quinoa has a broad genetic diversity which allows it's adaptation to various environments such as highland and frost. Due to its high nutritive potential and genetic diversity is classified by FAO as one of humanity's promising crops for food security in the 21st century [17]. Although it was only recently introduced into Europe, quinoa is arousing considerable interest in international markets because of its high content of protein (14%-20%), essential amino acids, linolenic and linolenic fatty acids [9] and antioxidants, which are at least 5-fold higher than those of cereal flours. Quinoa is also a good source of dietary fibre and contains relatively high quantities of vitamins, minerals, iron and calcium [18]. Quinoa has considerable varietal and environmental differences in the content of nutrients, bioactive compounds and saponins, which is important from agricultural and nutritional perspectives [17].

Mediterranean diet is a term used to describe the traditional eating habits of people in Crete, South Italy and other Mediterranean countries [19]. The notion of the Mediterranean diet has undergone a progressive evolution over the past 50 years-from that of a healthy

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diet to a cultural model and sustainable diet, to a sustainable lifestyle model. Today is Mediterranean diet well documented and acknowledged as a healthy, but is among the young generations in most Mediterranean countries experiencing abandonment. The erosion of the Mediterranean diet heritage has become alarming with undesirable impacts, not only on health, but also on socio-cultural, economic and environmental dimensions in the Mediterranean region [20]. Fruits, vegetables and cereals form the basis of the Mediterranean diet. Regarding cereals, one or two servings per meal as bread or side dish, preferably as a whole grain, are suggested [21]. Cerealsrepresenta major energy provider in all Mediterranean countries with the highest importance in Northern Africa where the lowest contribution of domestic production occurs [22].

Foods based on wholegrain cereals, which contain all the parts of the grain (bran, germ and endosperm), play an important part in health and well-being. Wholegrain cereals with recognised benefits for health are rich with dietary fibre, antioxidants, phytoestrogens, vitamins and minerals [23]. The dietary-therapeutic approaches encourage the use of naturally products from underutilizes and pseudocereals [12]. Here, there are many challenges and opportunities for integration of foods from underutilized and pseudocereals in Mediterranean diet. Especially in bread making applications, these cereals deserve special attention due to their unique nutritional components. The general growing demand for novel tasty and healthy foods together with the increasing number of people suffering from celiac disease and wheat intolerances, has driven a new market, consisting of cereal products made from grains alternative to wheat and rye, in which oat, sorghum and millet have gained a special position [24]. Cereal brans are also functional ingredients with high nutritive value and enormous health properties. Cereal brans have not been fully utilized in food systems despite their health benefits [25].

The nutritional and agronomic advantages of underutilized and pseudo cereals, combined with a growing consumer movement dedicated to healthy living, has peaked commercial interests in developed economies on how to make food products more accessible to consumers which remain largely unaware of their potential health benefits.

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