

Exploring Relationships between Biodiversity and Dietary Diversity in the Mediterranean Region: Preliminary Insights from a Literature Review

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Abstract Achieving sustainable food and nutrition security is dependent on enhancing dietary diversity to address micronutrient deficiency. Biodiversity, which includes diversity within and between species and of ecosystems, is crucial for dietary diversity, a qualitative measure of food variety available for individual and household consumption and a proxy for nutritional adequacy. This paper explores the poorly understood relationships between biodiversity (including agro-biodiversity) and dietary diversity in the Mediterranean area. It is based on an extensive yet targeted literature review carried out using Google search engine to capture important scholarly and grey literature mainly in the periods February-June 2015 and January-April 2016. FAO food supply data from 21 Mediterranean countries show that in the period between 1990-92 and 2007-2009, dietary diversity increased in most countries through a reduction in the contribution of starchy, staple foods to total energy and an increase in consumption of protein from animal origin. Meanwhile, reviewed literature shows that there was over the last decades a general decline of biodiversity and agricultural biodiversity in the Mediterranean region. These contradictory trends affecting Mediterranean dietary patterns may reflect rising affluence and trade liberalisation. The paper also highlights that the dietary polymorphism that has existed in the Mediterranean for millennia, which reflects biological and cultural diversity, is under threat with the erosion of food culture and biodiversity-related knowledge. Further studies, using dietary surveys rather than apparent consumption food supply data and valid dietary diversity scoring methods, are needed to enable a more accurate and evidence-based monitoring of dietary diversity in different Mediterranean countries. Nevertheless, safeguarding and promoting the Mediterranean diet and its inherent diversity is vital for conserving the extraordinary cultural, biological and dietary diversity in the region. Insights provided by the present paper should be taken into consideration in formulating effective policies to deal simultaneously with malnutrition (especially micronutrient deficiencies) and biodiversity loss in the Mediterranean area.

Keywords: *agro-biodiversity, biodiversity, dietary diversity, mediterranean diet, mediterranean region*

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1. Introduction

Achieving sustainable development for the Mediterranean region will not be possible unless basic common goods are protected and enhanced. Priority has to be given to the protection of biodiversity to preserve both natural resources, including oceans, land, soil and water, and cultural resources, so that traditional knowledge of nature and the food cultural heritage of the region are not lost [1]. According to the Millennium Ecosystem Assessment

(MEA) food provisioning is one of the most important services delivered by ecosystems. Biodiversity loss with consequent reduction in delivery of ecosystem services has very high economic and social costs by increasing poverty, hunger and diseases [2]. Biological diversity is defined as “the variability among living organisms from all sources, including, *inter alia*, terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems” [3].

Agricultural biodiversity [4] has always played a pivotal role in sustaining and strengthening food, nutrition,

health and livelihood security [5]. Biodiversity has enabled farming systems to evolve since agriculture was invented about 12,000 years ago [6], but now fifteen out of 24 ecosystem services have been assessed as being in decline [7]. The genetic diversification of food crops and animal breeds is diminishing rapidly. In fact, at the beginning of the 21st century it was estimated that only 10% of the variety of crops that have been cultivated in the past are still being farmed, with many local varieties being replaced by a small number of improved non-native varieties [8]. Now, only 30 crops provide 90% of dietary needs of the world's population, with wheat, rice and corn providing about half of the food consumed worldwide [9]. Of the 15,000 species or so of mammals and birds across the world, only 30 to 40 are domesticated for food production and fewer than 14 species including cattle, goats, sheep and chicken provide 90% of the current global trade in livestock production [6].

Biodiversity is directly linked to food and nutrition security. The *Foresight Global Food and Farming Futures* project [10] identified maintaining biodiversity and ecosystem services as one of the key challenges for the future global food security. Biodiversity management plays a significant role in the development of sustainable agricultural practices and strategies against malnutrition. Biodiversity at three levels - ecosystems, the species they contain and the genetic diversity within species - can contribute to food security and improved nutrition [5,11,12,13,14]. However, agro-ecosystems are under severe stress to meet the demands of a growing global population. If the world's increasing nutritional demands are to be met, greater attention must be devoted to the limits of ecosystems and the services they provide [15]. Populations of poorer regions are greatly dependent on biodiverse agro-ecosystems. Consequently, the loss of biodiversity limits the food options of such populations and undermines the potential for economic growth [6]. The recent shift to industrial agricultural mono-cropping systems in many parts of the world has destroyed the habitat of diverse species that once existed in previous mixed-farming agricultural systems [16]. Other threats to biodiversity include severe pest outbreaks, which may increase with climate change, profoundly affecting agro-ecosystems and global food availability [17].

Nutritional deficiencies and dietary changes, in both rural and urban settings, are among the major health problems of the 21st century [18]. In concert with a growing population, the world is increasingly facing a double burden of malnutrition, whereby undernutrition co-exists with overweight and diet-related chronic diseases [19,20]. Hunger – defined as the lack of sufficient calories – goes hand-in-hand with other forms of malnutrition such as protein, vitamin and mineral deficiencies [21]. Micronutrient malnutrition, often referred to as “*hidden hunger*”, affects approximately 2 billion people worldwide, more than one third of the global population [22,23]. The Mediterranean region is not immune to this issue [21,24]. Monotonous diets based on starchy staples lack essential micronutrients and contribute to the burden of malnutrition and micronutrient deficiencies. Food-based strategies have been recommended as the first priority to meet micronutrient needs [25]. An essential element of food-based approaches involves dietary diversification -

consumption of a wide variety of foods across nutritionally distinct food groups - as a way to meet recommended intakes of nutrients [26]. The simplification of human diets associated with the increased accessibility of inexpensive agricultural commodities and the erosion of agro-biodiversity is partially responsible for nutrient deficiencies and excess energy consumption in many parts of the world [27].

In the late 1980's the Convention on Biological Diversity (CBD) began to recognize the importance of biodiversity for ensuring food security. In 2004, the Conference of the Parties (COP), the governing body of the Convention, formally acknowledged the linkage between biodiversity, food and nutrition, and the need to enhance biodiversity to combat hunger and malnutrition. Two years later, the COP adopted the framework for a cross-cutting initiative on biodiversity for food and nutrition [5], and by 2010, this initiative merged with the work on sustainable diets [28]. The definition of “sustainable diets” [29] highlights the importance of biodiversity and ecosystems for food and nutrition security. The recognition of the value of biodiversity for improved nutrition is one component of the shifting paradigm in approaches to malnutrition. These new approaches go beyond simple improvement of sufficient dietary energy provision, to include wild or underutilized species, varieties and breeds. Gathering wild foods, growing locally adapted varieties and eating from the local ecosystem are considered important and, fortunately, still widespread practices in some countries [5].

Therefore, there is a link between biodiversity and food and nutrition security, which includes a focus on dietary diversity. Dietary diversity is defined as the number of individual food items or food groups consumed over a given period of time [30]. It can be measured at the household or individual level through questionnaires. Most often it is measured by counting the number of food groups rather than food items consumed. At the household level, dietary diversity is usually considered as a measure of access to food (e.g. of households' capacity to access costly food groups), while at the individual level it reflects dietary quality, particularly the micronutrient adequacy of the diet [31,32]. Dietary diversity scores have been shown to be valid proxy indicators for dietary energy availability at household levels and micronutrient adequacy of diets of individuals. Over the past years there have been several studies that have looked at the association between dietary diversity and food security and/or micronutrient adequacy of the diet [26,33]. Studies carried out in individual countries and across diverse age groups showed correlations of 0.36 to 0.66 between dietary diversity scores and micronutrient adequacy ratios [26,34,35,36,37]. FAO has published operational guidelines for measuring dietary diversity in a standardized way [31,38]. The FAO data collection tool gathers information on all food and drinks consumed by households and then records them into one of 16 standardized food groups [26].

The purpose of this literature review is to examine the inter-dependent relationship between biodiversity and dietary diversity across different countries in the Mediterranean region. The findings will help to inform policies that aim to foster a transition towards sustainable food consumption patterns and diets that preserve

biodiversity as well as cultural and dietary diversity. Google was chosen to search for both scholarly and grey literature during 2015 and 2016, as both were considered critical for this broad review.

2. Biodiversity and Agricultural Diversity in the Mediterranean Region

The Mediterranean basin Biodiversity Hotspot (MBH) is the third richest hotspot in the world in terms of plant biodiversity [39]. Approximately 30,000 plant species occur and more than 13,000 species are endemic; yet many more are being discovered every year [40]. The forests of the Mediterranean are diverse, harbouring up to 100 different tree species [41]. The MBH covers more than 2 million square kilometres and stretches west to east from Portugal to Jordan and north to south from northern Italy to Cape Verde. Two main circumstances have contributed to the high diversity of the MBH: (i) its location at the intersection of two major landmasses (Eurasia and Africa) and (ii) tremendous topographical diversity and marked differences in altitude [42].

The World-Wide Fund for Nature (WWF) has listed 32 eco-regions occurring in the Mediterranean hotspot. There are three broad types of vegetation: maquis, forests, and garrigue [16] - the maquis is currently the most widespread. The Mediterranean sea represents 0.8% of the global ocean surface area, 0.3% of the global water volume but as biodiversity hotspot, on average, it is home to more than 12,000 described marine species [42], representing approximately 7- 8 % of the known marine species in the world [41].

The importance of the Mediterranean in terms of crop diversity, is illustrated by the fact that about one-third of the foodstuffs used by humankind comes from the Mediterranean climatic region, if not strictly from the topographic basin proper [43]. Barley, wheat, oats, olives, grapes, almonds, figs, dates, peas and other innumerable fruits and vegetables as well as medicinal or aromatic herbs are derived from wild plants found in the Mediterranean region [41]. The Mediterranean basin was one of the eight centres of cultivated plant origin and diversity identified by Vavilov [44], who listed over 80 crops, the most important, however, being cereals, pulses, fruit trees and vegetables. There were also many herbs, spice-producing plants, horticultural crops, and ornamentals [45]. Several socio-political, agro-climatic, ecological and genetic factors have contributed to this remarkable crop diversity in the Mediterranean [45,46].

Agricultural lands and grasslands occupy 40% of the Mediterranean region, ranging from large intensive olive or citrus groves to more mixed farming systems [47]. The low intensity and localised nature of thousands of years of subsistence farming has had a profound effect on the landscape, creating a complex mosaic of alternating semi-natural habitats rich in wildlife. Vineyards and ancient olive groves are also still a characteristic feature of the Mediterranean landscape. On flatter land and in the plains various forms of sustainable agro-sylvo-pastoral farming systems have evolved that make best use of natural resources [41]. However, whilst small-scale farming is still largely followed, the last 50 years have seen a

significant change in agricultural practices across large parts of the region. Ancient vineyards, orchards and olive groves have been replaced with industrial-scale fruit or olive plantations, and mixed rotational farming methods have yielded to intensive cultivation methods dominated by monocultures [48]. Due to their high demand for pesticides, fertilisers and irrigation water, modern farming practices put excessive pressure on the environment. More than 26 million hectares (ha) of farmland are now under irrigation in the Mediterranean basin. The rapid growth in tourism and urban development in coastal areas, combined with the abandonment of small-scale farming practices puts immense pressure on the Mediterranean region's rich biodiversity [41].

3. Biodiversity Concept in the Mediterranean Diet

Food must fulfil nutritional needs and be safe to consume, but it also plays a number of social and religious roles [49,50]. Food's role in social and cultural life is deeply influenced by the evolution of values and globalisation [51]. Diets vary widely around the world and have co-evolved over millennia mainly due to the influence of environmental (*e.g.* climate, ecology, biodiversity, etc.), social and economic conditions [8].

Change in diets is a universal trend, which often goes hand in hand with economic development and urbanisation [52]. Given the enormous diversity within the human community, individual food requirements are not homogenous [53]. There is also growing acknowledgment of the need to adapt nutrition and health interventions to the needs of individuals and communities. Food production and consumption need to continuously adapt to changing demands of society, and biodiversity provides the basis to support that change [5].

The Mediterranean diet pyramid [54] has been presented as a biodiversity and nutrition resource to support global food security and sustainable development [54,55]. The Mediterranean Diet (MD) emphasizes the development of a relatively new concept which integrates biological and cultural diversity [56,57,58]. The concept of biocultural diversity encompasses biological diversity at all its levels and cultural diversity in all its manifestations [59].

The Mediterranean region has always provided indigenous populations with an array of food species, owing to its great wild and domesticated plant diversity [60]. The traditional MD includes a great diversity of foods that helps to ensure a plentiful mix of macro- and micro-nutrients for the consumer [48]. In fact, Mediterranean food consumption patterns promote the use of a wide range of cereals, fruit and vegetables, not only cultivated products but also spontaneous species, thus enabling them to be conserved along with the local, indigenous and traditional knowledge relating to these species [61].

Mediterranean traditional foods supply a wide diversity of micronutrients [62] and provide those who consume them with sufficient nutrients to meet their nutritional requirements [63,64]. Indeed, many studies have provided strong evidence of the beneficial health effects of

conforming to the Mediterranean dietary pattern [54,65,66,67]. However, despite the Mediterranean diet being recognized as being one of the healthiest diets in the world, still little is known of any associations between the biodiversity and nutritional well-being [68]. It may be the dietary diversity of the Mediterranean diet, arising from the region's biodiversity, which contributes to the prevention of common diet-related chronic diseases, such as cardiovascular disease and type 2 diabetes. It is noteworthy that a study of the index of food variety in several countries has shown that France has a very high rate of dietary diversity (90%) compared to the United States (33%) [48] and the rates of obesity, type 2 diabetes and other diet-related diseases are much higher in the United States than France [69]. This does not imply that dietary diversity is the only factor contributing to these differences in health outcomes, but it is one worthy of further research [68].

Some recent compositional research has provided data to confirm the micronutrient superiority of some lesser-known cultivars and wild-crop relatives over some more widely utilized cultivars [5]. The use of locally available, affordable and versatile genetic diversity enables the improvement of household nutrition even when there is shortage of productive resources [70]. The largely unexplored health benefits of underutilized cultivated and wild plants include micronutrient intake and functions related to energy density, glycaemic control, oxidative stress and immuno-stimulation. Research on the properties of neglected species and local varieties deserves higher priority [27].

In many rural regions, especially of Southern and Eastern Europe, non-cultivated food plants are still gathered or grown on small-scale plots and consumed as salads, vegetables giving rise to local varieties or cultivars or the so-called "local foods" [71]. Local foods represent a type of mutual interaction between the availability of locally growing and edible plants and the nutritional requirements and needs of populations. In general, wild varieties tend to be richer in micronutrients and bioactive secondary metabolites than cultivated ones. Such secondary plant metabolites are produced in adaptation to local environmental conditions [72]. Ethnobotanical research has identified about 2,300 different plant and fungi taxa that are gathered and consumed in the Mediterranean. Among these, 1,000 are consumed in one single zone and are therefore strictly local. The percentage of local Gathered Food Plant (GFP) taxa is higher in the main diversity centres at the periphery of the Mediterranean (Sahara, Alps, Caucasus, Canary Islands, the Levant) and Islands (Sicily, Sardinia, Crete, Cyprus). In an ethnobotanical survey carried out in the massif of Montseny (Catalonia, Spain), Bonet and Vallès [73] recorded the different ways of preparation, preservation and consumption of 132 GFP taxa. As for North Africa, Gast [74] exhaustively reported on 80 species of wild vegetables and grains food plants used by Berber groups during the famine season (December to March) in the Ahaggar region (Algeria).

Unfortunately, globalization of agricultural markets and changes in lifestyles are having a profound impact on the conservation and use of these resources leading to their irreplaceable loss [60]. Maintaining knowledge of indigenous

communities is relevant for the conservation and sustainable use of biological diversity. Indigenous knowledge on how to recognize, cultivate and use local crops is being lost at unprecedented rate. The genetic diversity of food crops and animal breeds is diminishing rapidly [8,75,76]. Since the 1980s the need to protect and preserve biological diversity has been a global priority. At the same time, however, it appears clear that the biological diversity of ecosystems cannot be protected without concurrently preserving cultural diversity [59]. By its definition, biocultural diversity means being aware of the close correlation between the loss of cultural and linguistic diversity and loss of biological and genetic diversity, and vice-versa [77].

The MD captures the intimate relationship between the population and nature [78,79]. Its biological, environmental and cultural diversity is its main asset. Each of these components of diversity can only be sustained with the collective conviction and ambition of the Mediterranean peoples [80]. The unique, complex combination of natural and human capital that has developed through the ages in the Mediterranean region contributes to the survival of the MD and must be retained for future generations [81].

The sustainability of the Mediterranean food system is under threat as was highlighted in the Mediterranean Strategy on Sustainable Development (MSSD) and sustainability is intimately connected with food security [82]. In fact, the MSSD report forecasts a decline of the Mediterranean's healthy diet patterns, with the predominance of imported food consumption patterns, despite the recognised health benefits of a traditional MD [1]. Further, the report states that [1]: *The prospective scenario for the expected impacts of trade liberalization, climate change and the lack of efficient rural policies offers a gloomy picture in some southern and eastern Mediterranean countries, with the prospect of aggravated regional imbalances, deeper ecological degradation and persistent or accrued social instability.*

4. Diversity of food Consumption Patterns and Dietary Diversity in the Mediterranean

The general term "Mediterranean diet" inevitably implies a common dietary pattern in Mediterranean countries that is mainly based on vegetables, cereals and olive oils and a moderate consumption of animal products [83]. However, Mediterranean diets are far from homogeneous; they involve a wealth of typical products and they are extremely varied [84,85]. It is the diversity that provides a certain level of nutritional and social well-being for the various populations [52]. This "dietary polymorphism" partially reflects religious and cultural differences [86] that followed the succession of different dominant peoples (Carthaginians, Greeks, Hebrews, Romans, Arabs, Byzantines, Ottomans, Spanish, Portuguese, etc.) who introduced different crops and foods. Another factor that has contributed to the huge diversity of foods and diets in the Mediterranean is the varied geographical and ecological environments in which food is grown [52]. It is noteworthy, that even within the same

country significant dietary differences can be observed. In Italy, for instance, the consumption of cereals, fruit and vegetables is higher in the southern part of the country than in the north [87,88].

Currently, there are still contrasting dietary patterns between the northern Mediterranean countries (Spain, France, Greece, Italy, Portugal), Balkan countries (Bosnia-Herzegovina, Croatia, Macedonia, Serbia, Slovenia) and southern and eastern Mediterranean countries (Algeria, Egypt, Lebanon, Morocco, Syria, Tunisia, Turkey). Diets in SEMC are mainly vegetarian with foods of animal origin making only a small contribution to the diet; cereals are the basic ingredient and pulses the main protein source. In northern Mediterranean countries, foods of animal origin are considerably more prominent in the diet. The dietary pattern in the Balkan countries is positioned between these two patterns, such that they are richer in animal products than in SEMC but contain more cereals and pulses than in northern Mediterranean countries. The Balkan diet seems to be diversifying to some extent and coming closer to the ideal Mediterranean model [52].

According to food supply data from FAO food balance sheets in 2009 [89], that can be considered as proxy for food consumption data, dietary energy available in the Mediterranean food supply ranged between 2130 kcal/day/person in Palestinian territories and 3666 kcal/day/person in Turkey. Dietary energy increased in the period 1990-2009 in all SEMC except Libya, the Palestinian territories and Turkey [83,90]. The share of plant-based energy in the diet in the Mediterranean is generally higher than 50% of total energy available in the food supply. As expected the share of vegetal-based energy¹ in the diet is lower in France at 66.5% of energy and higher in the Palestinian Territories at 88.8% of energy. The largest share of plant-based energy is derived from cereals. The contribution of cereals to total dietary energy ranges from 21.5% in Spain to 63.7% in Egypt. Importantly, though, the contribution of vegetal-based products to total dietary energy decreased in most of the Mediterranean countries between 1990 and 2009 [90]. In fact, there was a slight increase only in the case of Algeria (+0.27%), Italy (+0.36%), Libya (+1.02) and Cyprus (+1.27%). It should be highlighted that a more notable increase was recorded in France (+4.48%). Meanwhile decrease in vegetal-based products contribution to total dietary energy ranged from -0.19% in Spain to -12.04% in Albania. Important decreases were recorded also in Bosnia (-6.17%), Portugal (-5.80%), Croatia (-3.05%), Lebanon (-3.20%), Israel (-2.41%), Greece (-2.19%), Morocco (-1.65%), Tunisia (-1.83%) and Malta (-1.13%).

Despite this reduction in vegetal-based products (kg/capita/year) available for consumption in the Mediterranean region, it is still higher than in Central and Northern Europe and North America [90]. Furthermore, the quantity of animal-based foods consumed in the

Mediterranean region, especially in the southern and eastern areas, is approximately half of that consumed in the other regions. However, in southern Mediterranean countries, the available food supply has increased considerably over the last 40 years of the last century with an average increase of 800 kcal/person/day in 2005, compared with the kilocalories observed in 1965 [91].

Dietary diversity is inversely proportional to the share of cereals in food intake. That is, the higher the cereals intake the lower the amount of energy derived from fruit, vegetables, fish, etc. Variety of intake is an important aspect of food quality [92]. FAO food balance sheets [89] show that dietary diversity in the Mediterranean region increased over a 17 year period until 2009. In general, there was a decrease in the amount of energy available from cereal-based and starchy foods in the period 1990-92/2007-09 in most Mediterranean countries with an increase of the contribution of non-starchy foods to dietary energy. It should be also highlighted that the increase in dietary energy in most Mediterranean countries between 1990 and 2009 was almost entirely covered by non-cereal foods, including foods of animal origin, because cereals supply decreased in the same period. The share of dietary energy supply derived from cereals, roots and tubers² decreased from -29.3% in Albania to -2.9% in Malta. Important decreases were recorded also in Cyprus (-12.9%), Portugal (-10.8%), Syria (-7.8%), Turkey (-7.4%), Tunisia (-7.1%), Spain (-6.9%), Israel (-5.4%), Morocco (-4.7%) and Greece (-3.0%).

Across this same time period (1990-92 to 2007-09), the average apparent consumption of protein from animal origin in the Mediterranean increased from 1.7% in Italy to 69.2% in Egypt and 75% in Albania. Average supply of proteins of animal origin³ increased significantly also in Lebanon (+45.8%), Tunisia (+36.8%), Portugal (+32.7%), Syria (+31.6%), Morocco (+33.3%), Israel (+26.3%) and Algeria (+21.1%). The only country to report a reduction in apparent consumption of animal protein was France, which reported a 7.7% deficit. While these food supply data offer some understanding of the dietary diversity of different countries in the Mediterranean region, the data only reflects what is available in each country to consume. More detailed survey data of individual and household measures of dietary diversity is needed to obtain a clearer understanding of the shifts in dietary diversity.

Further, while the observed increase in the consumption of proteins of animal origin is an indicator of increasing dietary diversity in the Mediterranean countries, especially in Southern and Eastern ones, it also reflects the ongoing erosion of the Mediterranean dietary heritage. As a matter of fact, despite its well documented benefits there is a decline in adherence to the Mediterranean dietary pattern in the Mediterranean region [93-99]. The evolution of food consumption in the Mediterranean countries is not encouraging, as these countries have followed the trend

¹ Share of vegetal-based components in total energy consumption represents the contribution, in terms of energy supply, of the following food groups: cereals (excluding beer), starchy roots, sugar crops, sugar and sweeteners, pulses, tree nuts, oil crops, vegetable oils, vegetables, fruits (excluding wine), stimulants, spices, alcoholic beverages, and aquatic products (other than fish and seafood). Meanwhile, the share of animal-based energy in total dietary energy reflects, in relative terms, the energy supply of the following food groups: meat, offal, animal fats, eggs, milk (excluding butter), fish and seafood.

² Share of dietary energy supply derived from cereals, roots and tubers represents energy supply (in kcal/capita/day) provided by these starchy food groups divided by total Dietary Energy Supply (DES) (in kcal/caput/day) calculated from data regarding the corresponding countries in the FAOSTAT Food Balance Sheets (FBS).

³ Average supply of proteins of animal origin represents national average protein supply (expressed in grams per capita per day) from the following groups: meat; offal; animal fats and products; milk and products; eggs, fish, seafood and products; and other aquatic products.

towards higher shares of energy-dense foods [100]. Generally speaking, the MD is being increasingly eroded due to the globalization of lifestyles and that loss of awareness and understanding of the problem, together with the younger generations' lack of interest is leading to an inevitable decline in the Mediterranean dietary cultural heritage [101]. The drift in the food consumption pattern caused by the globalization of agro-industrial products, that are too high in empty calories causes, represents a slow emergence of true pandemic potentially very costly in human, social and economic terms [102]. In the decline of the adherence to the MD, there are two major concerns: an increase in the consumption of lipids (e.g. meat, dairy products, etc.) and a decrease in the consumption of complex carbohydrates (e.g. cereals and legumes) [64].

Unhealthy eating practices in the Southern Mediterranean countries include high consumption of saturated fats and refined carbohydrates, low consumption of fibre, and sedentary behaviour [95]. Between 1960 and 2000, average global meat consumption in terms of weight per capita per year increased 50%, with a doubling in North Africa. In the Near East and North Africa, meat consumption increased from 11.9 to 35.0 kg/capita/year while milk consumption augmented from 21.2 to 72.3 kg/capita/year in the period 1964-1966 / 1997-1999 [103].

Changes in intergenerational and gender relations, rising affluence, the role of women in society and increased tourism and migration are having considerable effects on Mediterranean lifestyles and food consumption patterns. Young people are more open to media influence and fashion trends. They cultivate a certain ambiguity towards social identity and traditional food. Essentially, the standardization of lifestyles across the world has led to a decline of the Mediterranean dietary pattern [52]. Urban design and sedentary activities have also contributed to the many health and nutrition challenges facing many societies, including the Mediterranean region [24].

In parallel with the social changes that are occurring as a result of globalization and the homogenization of people's lifestyles are the changes in the landscape and ecosystems in the Mediterranean [104]. The loss of agricultural diversity occurring around the Mediterranean basin is having negative repercussions on the food security and livelihood of populations living in the region. An exacerbation of the genetic erosion of agro-biodiversity due to globalization trends and climate change is reducing the sustainability of local production systems and along with it the ability to safeguard the Mediterranean diet through the continued use of indigenous species and varieties [60]. At the same time, silent cultural erosion is also affecting the diversity of food cultures. Such a phenomenon is undermining also the identity of millions of Mediterranean people whose traditions are so intimately linked to food cultures [78].

5. Conclusions

Mediterranean food consumption patterns and diets are characterised by their huge diversity. Mediterranean dietary polymorphism partially reflects religious and cultural differences. It is also the result of ecological and environmental diversity characterising Mediterranean

landscapes and ecosystems. Mediterranean dietary patterns contribute to biodiversity conservation. However, changes in the Mediterranean ecosystems have increased in recent decades. The main pressures on Mediterranean ecosystems (both natural ecosystems and agro-ecosystems), and their biodiversity come from tourism, urban development in coastal areas, intensive farming and irrigation, and the abandonment of traditional agricultural practices.

The review shows that there are two parallel trends taking place in the Mediterranean region namely increase in dietary diversity (cf. decrease in contribution of starchy foods and cereals to dietary energy) while there is biodiversity erosion. However, it seems that these two trends are not directly correlated. In fact, increasing affluence allow Mediterranean consumers, even urban ones, to have economic access to, so higher utilisation of, local biodiversity. Moreover, trade allows access to "external biodiversity". Anyway, it can be assumed that in a globalised economy, dietary diversity does not depend only on local biodiversity and that trade plays a very important role. Eventually, countries and regions cannot simply rely on 'external biodiversity' to solve local dietary diversity issues, given that global biodiversity is in decline.

This paper suggests that biodiversity is necessary for dietary diversity and nutrition security. The body of existing knowledge is sufficient to pursue action to promote the use of biodiversity in food and nutrition security programmes. The integration of biodiversity into food security policies is likely to generate significant socio-economic benefits.

Safeguarding and promoting the Mediterranean diet is of paramount importance for the conservation of the extraordinary biological diversity in the region and vice-versa. The promotion of the Mediterranean diet needs to be accompanied by parallel actions and initiatives to support local agrobiodiversity and promoting high quality local and typical products.

Research should continue to examine the relationships between biodiversity and nutrition security from different angles, at different levels and in different local contexts also in relation to increasing affluence and trade. However, further research should also better explore the associations between biodiversity, dietary diversity, nutritional well-being and health outcomes of the Mediterranean diet.

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