

Sustainable food systems and healthy diets: the case of mediterranean diet

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Sustainability should be an imperative in everyone's lifestyle in order to achieve an equilibrium between humans and ecosystem for the wellbeing of current and future generations. Sustainable food systems and healthy diets are main key-players to achieve sustainable planet and lifestyle and at the same time to be in line with the Sustainable Development Goals (Agenda of 17 global goals set by the United Nations General Assembly in 2015 to achieve better and sustainable future for all). Such food systems offer not only a way towards ending the hunger, but also enable healthy nations and less environmental pollution. A good representative of a sustainable food system is the Mediterranean diet that is affordable and accessible even in the regions far from the Mediterranean basin. Raw or minimally cooked plant-based food products flavoured by different herbs and spices are the foundation of this diet packed with powerful nutrients, vitamins, and minerals, enriched with healthy fats from extra virgin olive oil. The Mediterranean lifestyle provides many health and wellbeing benefits for humans. Authors believe that adhering to it leads to healthy nations and a sustainable world with less hunger.

Keywords: mediterranean lifestyle; sustainable food systems; healthy diets, sustainable development goals

1 Introduction

Today, natural cycles are significantly disturbed by the humanity's impact on the planet. Degrading or losing vital ecosystem services can negatively impact human security, health, and biodiversity. Limited natural resources, like land and water, as well as the Earth's capacity to absorb the increased pollution, such as carbon dioxide emissions, methane, etc are alarming global challenges. On the other hand, the increasing population is greatly dependent on the goods and services that the Earth's system provides (food, water, energy). A suddenly increased population, especially in urban areas with strong economic growth, has resulted in a rising demand for natural resources and if these resources continue to be spent in uncontrolled ways, then serious consequences on public health and environment might happen. Although economic growth and global urbanisation have improved the human wellbeing, the demand for natural resources has put increased pressure

on the environment and it leads to climate changes and global warming of the planet (Global Sustainable Development Report, 2019; Lucas & Wilting, 2018; Rööß et al., 2017; Vanham et al., 2019). The traditional diets cannot satisfy the whole population on the Earth, they have been replaced by many unhealthy diets comprising ultra-processed industrial foods, meat products, fast and ready-to-eat food choices rich in salt, preservatives, refined sugars, and unhealthy trans fats (Monteiro et al., 2013; Seto & Ramankutty, 2016).

The search for healthy diets that are beneficial for both, the humans and the ecosystem, has not been always easy. Different aspects of sustainability, health, environment, culture, economy, society are important and should be taken in consideration when adopting a healthy diet. Sustainable food systems are essential to nourish a projected global population of ~10 billion by 2050. Overweight and obesity and their associated diet-related non-communicable diseases (NCDs) are

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contributing to 4 million deaths globally (HLPE, 2017, 2020; Fanzo, 2019; Mozaffarian, 2016; Swinburn et al., 2019). Malnutrition is costly for the health of individuals, their wellbeing and productivity. It also has high socio-economic costs for societies in all regions of the world. Poor diets are a major contributory factor to the rising prevalence of malnutrition in all its forms. Moreover, unhealthy diets and malnutrition are among the top ten risk factors contributing to the global burden of disease (Burlingame & Dernini, 2019).

Today's food systems are far from being sustainable and there is "a short time period" for action. Not only are dietary risk factors and malnutrition in all its forms the leading contributors to the global forms of diseases, but also food systems are not operating within the planetary boundaries; they are the big contributors to irreversible environmental breakdown degradation and damage of natural resources and biodiversity (HLPE, 2017; Lawrence et al., 2019; Meybeck & Gitz, 2017). A wide range of multilateral environmental agreements has been proposed in the past few decades. All of them set targets for sustainable human development; the most notable one is the 2030 Agenda of UN for Sustainable Development. It sets out a long-term global vision for sustainable development; the 17 Sustainable Development Goals (SDGs) are focussed to achieve a prosperous, socially inclusive, stable economic growth and environmentally sustainable future for humanity, young generations, and the whole planet (Fanzo, 2018; Global Sustainable Development Report, 2019; Johnston et al., 2014; Lucas & Wilting, 2018; Meybeck & Gitz, 2017).

In this context, many novel, sustainable and alternative diets are proposed; they offer substantial health benefits, and if widely adopted, they will result in reduced impact on climate changes, reduction in global agricultural greenhouse gas emissions, reduced land clearing and species extinctions, as well as they would help in prevention of diet-related chronic NCDs and diseases related to a polluted planet. There are many multisectoral strategies which are recommended to achieve transformation of food systems, such as producing more nutritious food not just more food, sustainable food production, proper usage of land, water, oceans, stopping land clearing, reduce food losses and food waste, etc. (Alexander et al., 2016; Katz, 2019; Lawrence et al., 2019). Mediterranean Diet (MD) is a good representative of a sustainable food system that is mainly plant-based healthy diet (Trajkovska Petkoska & Trajkovska-Broach, 2020; Trajkovska Petkoska & Trajkovska-Broach, 2021).

Prerequisite for a sustainable future: Living in a harmony with the environment

The term "sustainability" refers to the ability to maintain a certain standard of human living without causing environmental damage or any other harming of the nature. It should be understood that it benefits the human health and well-being, has socio-economic benefits and contributes to environmental integrity (Baroni et al., 2018; Bornkessel et al., 2019; Chen et al., 2019; Monsivais et al., 2012). The 17 SDGs cover three sustainability pillars: environmental, social, and economical. Social sustainability refers to the improvement of living conditions for both current and future generations, while economic sustainability is defined as the ability of the economy to support and maintain economic growth, but at the same time efficient exploitation of natural resources. Hence, socio-economic sustainability could be understood as the ability to ensure economic growth without undermining humans' interests, i.e., to meet the humans' needs without destroying the nature and the environmental system around (Berry, 2019; Egal & Berry, 2020; Meyer & Reguant-Closa, 2017; Skvarciany et al., 2020; Tarsitano et al., 2019).

Agriculture is one of the main producers of emissions of greenhouse gases (GHGs), in particular methane (CH₄) and nitrous oxide (N₂O), which are responsible for global warming. Other parts of the food system chain contribute to carbon dioxide (CO₂) emissions from the use of fossil fuels in food processing, transportation, retailing, storage, and preparation (Joyce et al., 2014; Meyer & Reguant-Closa, 2017; Serra-Majem & Medina, 2015; Springmann et al., 2017; Tom et al., 2016). Currently, food systems are responsible for a significant share (20–35%) of GHG emissions, and are a major driver of land conversion, deforestation, and loss of biodiversity. Agriculture alone accounts for ~70% of global freshwater withdrawals and causes water pollution; it also occupies more than 30% of all potentially cultivatable land. Moreover, the livestock consume around two-thirds of all the land dedicated to agriculture and contribute to about a half of the farming-related GHGs (Aleksandrowicz et al., 2016; Egal & Berry, 2020; Garnett, 2011; Hallström et al., 2015; Rööß et al., 2017).

Food production is also a big player of environmental pressures and depletion of natural resources, related to climate change, water usage, pollution, and toxic emissions (Rööß et al., 2017; Serra-Majem & Medina, 2015). In general, food systems include: i) the activities related to the production, processing, distribution, preparation, and consumption of food, and ii) the outcomes of these activities – contribution to the food security, such as food availability, food access and

food use (Berry, 2019). In this context, the current food systems as major drivers of environmental pressures are far from sustainable. According to FAO (2017), global food demand is projected to increase by 60% towards 2050 compared to 2007, driven by changing consumption patterns and population growth. By 2050, there is an assumption that dietary trends would be a major contributor to an estimated 80% increase in global agricultural GHGs from food production and global land clearing (Aleksandrowicz et al., 2016; Egal & Berry, 2020; Hoekstra et al., 2014; Knorr et al., 2020; Meybeck & Gitz, 2017).

Why the current food systems are not sustainable? There are many factors, which negatively influence the vital pillars of sustainability; in most of the cases, food production uses increasingly unsustainable amounts of natural resources (land, water, energy) with harmful impacts on ecology, economy, and society. Most of the food productions lead to environmental pollution (GHGs, pesticides) with huge impacts on biodiversity and human health. The access to food is not equal worldwide; there is hunger and malnutrition in some parts and excessive food waste, over-consumption and obesity in other parts of the world. Thus, it seems that food consumption instead of having positive impacts on human health, has significant negative impacts on vital pillars. It will not improve if nations and authorities worldwide do not take suitable sustainable actions; the population is growing each year and more and more food will be needed in the future (Aiking & de Boer, 2018; Bhargava, 2019; Fanzo, 2018; HLPE, 2020; Jones et al., 2016; Rööß et al., 2015).

Sustainable food systems (SFS) take into account the environmental needs along the entire food system chain, from production to consumption, incorporating social, health, and economic concerns. The vision of SFS is a world where the earth can produce enough nutritious, safe, affordable food to feed the population, while preserving the biodiversity and ecological needs of the planet now and for the future generations. Such systems ensure food security and nutrition and accommodate most of the 17 SDGs; they are beneficial for every citizen and country, good for the whole planet (Berry, 2019; Burlingame & Dernini, 2019; Fanzo, 2019; Knorr et al., 2020; Meybeck & Gitz, 2017; Trajkovska Petkoska & Trajkovska-Broach, 2020; Von Koerber et al., 2017).

On the other hand, the idea of sustainable diet started by Gussow & Clancy (1986) when they claimed that promoting food sustainability and ecological harmony were essential to promoting a healthy diet for the individuals, and later this concept was further defined by FAO and many others (Aboussaleh et al., 2017; Auestad & Fulgoni III, 2015; Burlingame & Dernini, 2019; Fanzo, 2019;

Johnston et al., 2014; Meybeck & Gitz, 2017; Pradyumna, 2018; Rööß et al., 2015; Springmann et al., 2018; Germaniet al., 2014). According to Berry (2019), the healthy diet is not just a list of “do’s” and “don’ts”, but rather should be a pleasurable, social and tasty experience, which should be instilled in children from a young age as one of the Proverbs 22:6 says: “Train up a child in the way he should go: and when he is old, he will not depart from it”; so the earlier the young generations are taught and practiced, the more likely they are to take root and persist to healthy habits (Berry, 2019; Jakobovich et al., 2019).

In the global nutrition policy sphere, the term “malnutrition” no longer refers only to undernutrition, such as wasting, stunting, underweight or deficiencies in vitamins or minerals. Malnutrition in all its forms includes obesity, as well as dietary factors that increase the risk of NCDs, such as heart disease, stroke, diabetes, and certain types of cancers; they are a major cause of disability and death in all countries (Baroni et al., 2018; FAO & WHO (2019); HLPE, 2019, 2020; Swinburn et al., 2019). Many studies now point to synergies between healthy diets and reduced environmental pressures, leading to the notion of sustainable diets, for healthy lives and healthy ecosystems. Not all food-secure diets are sustainable, but all sustainable diets should be food-secure (Berry, 2019; Jones et al., 2016). The Intergovernmental Panel on Climate Change (IPCC) has also recognized that “Consumption of healthy and sustainable diets presents major opportunities for reducing GHG emissions from food systems and improving health outcomes.” A good representative of a sustainable healthy diet is the Mediterranean diet.

Mediterranean way of living: A sustainable food pattern and a healthy lifestyle

Territorial diets have been linked to specific geographies, but over time they integrated other influences through the migration of people, mixing of cultures, exchange of material goods and foods, etc. They are linked not only to the landscape that characterize agriculture and the economy, but also to particular ecologies, historical and cultural contents, as well as social resources including institutions, knowledge, traditional practices, recipes, and rituals (Barre et al., 2018; Dernini & Berry, 2016; FAO & WHO, 2019; UNESCO, 2010).

The Mediterranean Diet (MD) and the New Nordic Diet (NND) are plant-based diets with little to moderate amounts of animal-sourced foods (FAO & WHO (2019)) amongst the other territorial diets. There is a lot of scientific evidence for MD for being nutrient-packed diet with benefits on the overall wellbeing and health along with its economic and socio-cultural benefits (Baroni et al.,

2018; Cena & Calder, 2020; Davis et al., 2015; Donini et al., 2016; González et al., 2019; Roman et al., 2019; Tarsitano et al., 2019; Trichopoulou et al., 2014). It has emerged as a science-backed diet mainly plant-based to prevent a good physical and mental health, reduce the risks for severe diseases, such as NCDs, and promote healthy aging and longevity (Dinu et al., 2017). The MD is a highly diversified heritage, in which food cultures and systems vary from country to country in the Mediterranean basin. In the Mediterranean, there is a widespread awareness of the social, cultural, economic and health aspects of food, and this is shared by all Mediterranean people in countries bordering the Mediterranean Sea; adherence to this diet is easy and its transferability to non-Mediterranean regions has been proven (Aboussaleh et al., 2017; Antonopoulou et al., 2020; Baroni et al., 2018; Benhammou et al., 2016; Bonaccio et al., 2012; Dernini & Berry, 2016; Hidalgo-Mora

et al., 2020; Peng et al., 2018a; Peng et al., 2018b; Serra-Majem et al., 2003–2004; Trichopoulou et al., 2014).

In general, MD emphasizes daily use of whole-grains, fruits, and vegetables, not only cultivated products, but also wild species, spices, and herbs, thus sustaining them together with the local, indigenous, and traditional knowledge about their use and food preparation. In addition, a variety of legumes, nuts, and seeds are consumed in abundance along with moderate amounts of dairy products and proteins from animal sources (Serra-Majem & Medina, 2015; Siotos et al., 2019; Trajkovska Petkoska & Trajkovska-Broach, 2021). Fig. 1 presents MD selected typical foods with their nutrients. Extra virgin olive oil is one of the crucial ingredients of the MD and consumed in large quantities (25–40% dietary fats of the total calories), not only for its inherent

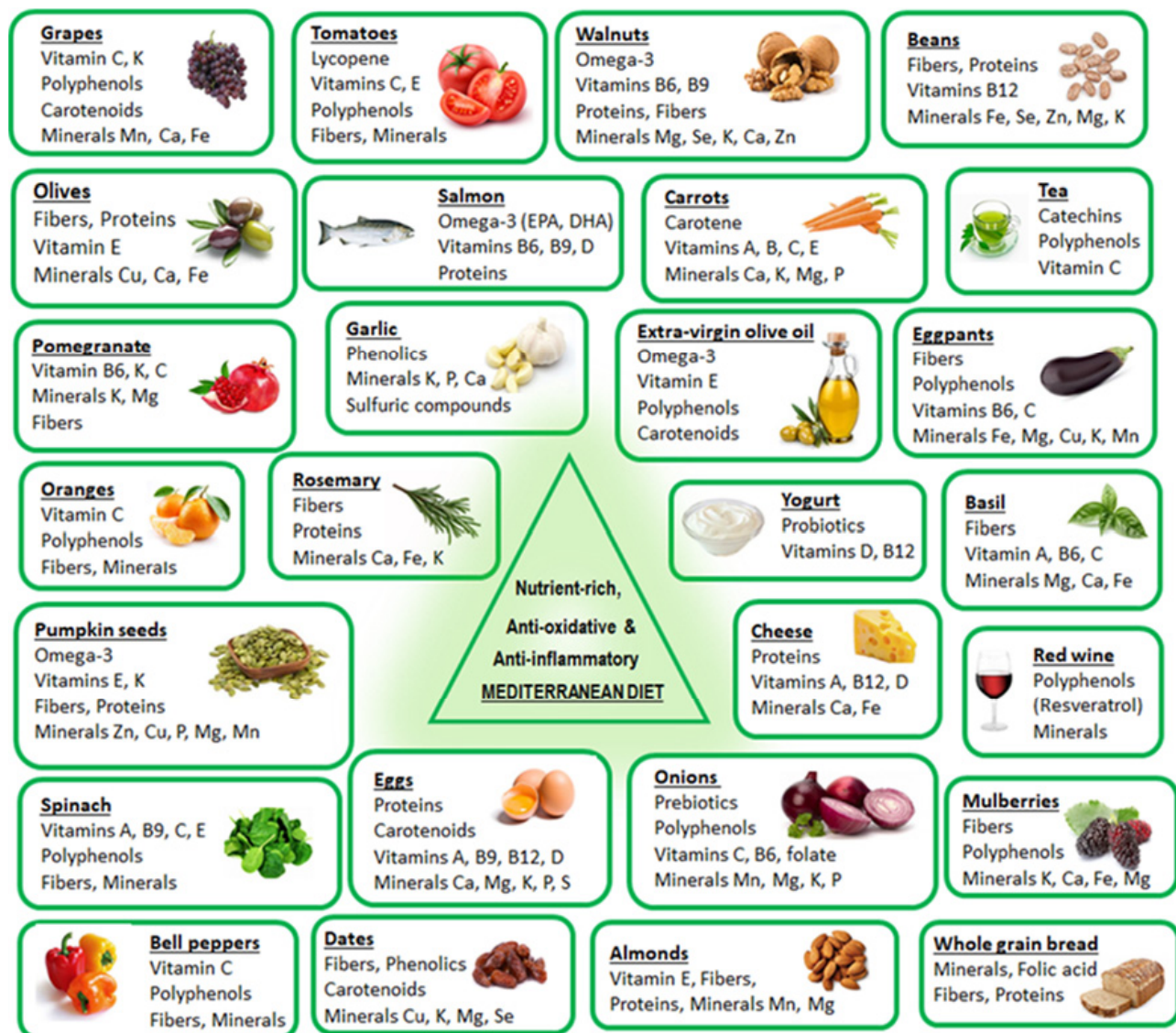


Figure 1 Selected typical foods in the MD are mainly of plant-based origin (MD Inspired™)

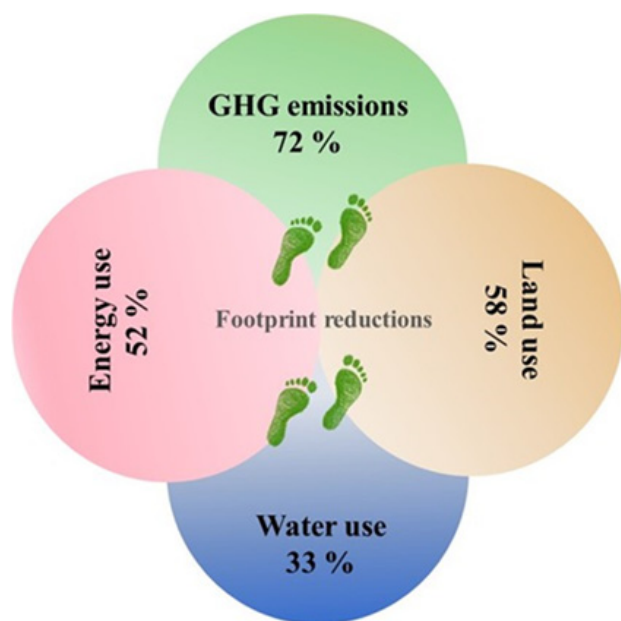


Figure 2 Estimated reductions in the environmental footprints by adopting MD: reductions in GHG emissions and the consumption of energy, land and water use

nutritional effects, but also the cumulative benefits of the foods typically prepared in it (e.g. vegetables), which have been proven to have anti-thrombotic, anti-inflammatory and antioxidative properties (Muralidharan et al., 2019; Ramírez-Anaya et al., 2015). Contrary to MD, the nutritional guidelines in the Western countries limit the total fat intake to less than 30% (even less than 20%) of total calories, which mainly originates from animal sources (Blomhoff et al., 2006; Bower et al., 2016; Mazzocchi et al., 2019; Serra-Majem et al., 2003–2004; Trajkovska Petkoska & Trajkovska-Broach, 2021). MD is not just a dietary pattern; it is more than that – it is a lifestyle; the social aspects – conviviality, preparing and eating the food together with others, the sense of community, play a big role in the lives of people adhering to the Mediterranean lifestyle.

MD as a plant-based diet has been associated with a reduced risk of chronic diseases, cancers, dementia, Alzheimer's disease and has also been linked to longevity of the people adhered to it. A range of bioactive compounds, phytochemicals, found in fruits and vegetables has been reported for their protective health benefits and reduction of the risk for developing NCDs, which are attributed to chronic inflammation and oxidative stress. For example, the dietary polyphenols in MD are known to be immunomodulatory and anti-inflammatory in reducing the risk of cardiovascular disease, neurological diseases, and cancer (Ramírez-Anaya et al., 2015; Dinu et al., 2017; Childs et al., 2019;

Gonzalez et al., 2019; Roman et al., 2019). MD has also been proven to improve gut microbiome diversity, which is due to consumption of various plant-derived foods (fruit, vegetables, nuts, seeds, whole grains) in abundance as well as healthy fats from extra virgin olive oil. The gut microbiome is further regulated by live microbes (probiotics) originating from the regular consumption of fermented milk products (yoghurt, curds, cheeses) or fermented vegetables (Mazzocchi et al., 2019; Muralidharan et al., 2019; Roman et al., 2019; Trichopoulou et al., 2014). In addition, Mediterranean dietary pattern affects not only the human health and wellbeing, but also the natural resources and the ecosystem. A Spanish study compared the MD to the modern diets and showed that adherence to the MD would significantly reduce all environmental footprints – GHG emissions, land, water and energy use. On the other hand, the adherence to Western dietary patterns implies an increase in all these descriptors somewhere between 12% and 72% (Fig. 2) (Sáez-Almendros et al., 2013).

Final thoughts: Is it worth adhering to MD?

While for decades the focus in food science has been primarily on increasing productivity and achieving lower prices at higher volumes of energy-dense foods, the future of sustainable production should be focused on quality and tendency to achieve healthier nutrient-dense foods originating from sustainable production systems. Nutrition policy should prioritize food-based dietary targets, public communication of trusted science,



Figure 3 MD positively affects the human health and wellbeing, society, economy, and environment, all in line with the SDGs

investment, and cultural strategies to create sustainable food systems across the regions, nations and worldwide (Irza et al., 2019; Mozaffarian et al., 2010; Mozaffarian & Forouhi, 2018; Mozaffarian et al., 2018; Nelson et al., 2016; Poore & Nemecek, 2018). Shifting dietary habits towards the healthy ones, especially between younger generation from early age and on, presents a significant challenge for cultural, ecological, and economic reasons, and will require actions from different entities such as governments, businesses, and individuals that go beyond information and education programmes.

Today, we are facing multiple recommendations from professionals toward healthy diet choices emphasizing plant-based diets vs. animal-based foods; promoting better and healthier way of life associated with lesser environmental impact. A perfect representative of such lifestyle is the MD; it emphasizes consumption of vegetables, fruits, nuts, legumes and seeds, virgin olive oil, fermented products, fish and lean meat rich with vitamins, minerals, probiotics, dietary fibres and other phytonutrients, which in combination with the physical activities and the socializing aspects of this lifestyle contribute to the overall wellbeing and health. Simply, MD is not a dietary pattern only, but a way of living with a positive impact on the health, society, economy, and environment. It seems to be the best compromise between the need to reduce the environmental impact of food consumption and still maintain a healthy food consumption behaviour, biodiversity, and food security. The growing body of scientific evidence has shown the significant health and wellbeing benefits, positive societal and economic impacts, and low environmental footprints of MD (Fig. 3) (Trajkovska Petkoska & Trajkovska-Broach, 2020; Trajkovska Petkoska & Trajkovska-Broach, 2021). As Dernini et al. (2015, 2016) have stated “A well fed nation is a healthy nation; it is a sustainable and productive nation”, we all could benefit from the Mediterranean lifestyle (Conrad et al., 2018; Dernini et al., 2017; Dernini & Berry, 2015; Galanakis, 2020; Martínez-González et al., 2017; Mantzioris & Villani, 2019; Moore et al., 2018; Muscogiuri et al., 2020; Pairotti et al., 2015).

Knowing the history of MD as a diet of mainly poor people which is no longer considered as such, we strongly believe that adhering to the Mediterranean lifestyle could lead to healthy nations and a sustainable world with less hunger.

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