



Towards an environmentally sustainable and healthy Atlantic dietary pattern: Life cycle carbon footprint and nutritional quality



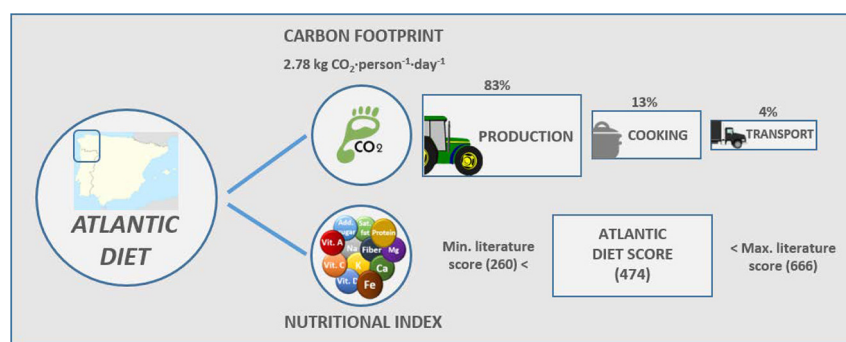
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HIGHLIGHTS

- Nutritional quality and carbon footprint were evaluated for the Atlantic diet.
- A functional unit of 2100 kcal for an adult woman was established.
- Carbon footprint was performed with a cradle-to-mouth life cycle perspective.
- Production stage was the main responsible of total greenhouse gases emission.
- The high intake of plant-based products was beneficial from environmental and nutritional approaches.

GRAPHICAL ABSTRACT



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ABSTRACT

Production and consumption of food has a significant effect on climate change. The effect of different consumption habits on the environment should not be underestimated, as there are different studies that mention the environmental impact associated with different foods, especially those of animal origin. The analysis of the Atlantic diet (AD), as the most common dietary pattern in Northwestern Spain, serves as an example of a diet with a high consumption of local, fresh and seasonal products, home cooking and low-processed foods. The evaluation was carried out by quantifying the carbon footprint following the Life Cycle Analysis methodology and identifying its nutritional quality according to the value of the Nutrient-rich Dietary index (NRD9.3.). According to the main results, the consumption of livestock products and shellfish is responsible for most GHG emissions (70% of the total). The basic ingredients of the AD, such as vegetables and legumes, make a relatively minor contribution (with an impact of 30% of the total) to the total carbon footprint of 3.01 kg CO₂eq·person⁻¹·day⁻¹. As regards nutritional quality, AD has a high nutritional score (474), mainly due to the low intake of sodium, added sugars and saturated fats (nutrients to be limited in healthy diets). In general, both the carbon footprint and the nutritional index score are consistent with those of other studies on the Mediterranean diet, which has been recognised as beneficial. Therefore, it can be concluded that the AD may be recommended from a nutritional and environmental point of view, mainly due to the high intake of fish and vegetables. The communication of this valuable environmental and nutritional information to consumers should be taken into account when considering strategic actions for the adoption of healthy and sustainable dietary patterns.

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1. Introduction

Nutrition is a basic human need and access to adequate nutrition depends on numerous social, political and economic factors (Heller et al.,

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2013). Balanced and complete nutrition affects human health and well-being. The effects of nutritional patterns on overweight, cardiovascular disease and other diet-related health problems are widely known (Coelho et al., 2016; Risku-Norja, 2011). The selection of one type of food versus another entails direct consequences in the supply chain, as well as environmental, economic and social impacts associated with the production process (Cencic and Chingwaru, 2010). In particular, food chains that support diets are linked to environmental issues such as greenhouse gas (GHG) emissions, embedded energy consumption and land use (Irz et al., 2016; Castañé and Antón, 2017). Therefore, environmental pressures on food systems are relevant to public health agendas (Sáez-Almendros et al., 2013).

Food production ranges from agricultural and farming activities to manufacturing, refrigeration, retailing, storage, cooking and final disposal of waste (Garnett, 2011; Sáez-Almendros et al., 2013). According to Garnett (2011) and Irz et al. (2016), 15–30% of total GHG emissions in developed countries are derived from food production, distribution and consumption, and agriculture is responsible for 70–80% of water consumption (Heller et al., 2013). In this regard, researchers are evaluating the sustainability of food production and eating patterns (Baroni et al., 2007; Donati et al., 2016). According to these studies, lactoovovegetarian or plant-based diets are more environmentally sustainable than those containing resource-intensive products (e.g., meat-rich diets) (Baroni et al., 2007; Risku-Norja, 2011). Of special interest is the development of methodologies to analyse the environmental impact of a product or food system with the most objective approach. (Aleksandrowicz et al., 2016; Duchin, 2005; van de Kamp et al., 2018; Van Kernebeek et al., 2014). The environmental footprints of some diets (e.g., omnivorous, vegetarian, vegan, omega-3 fatty acids enriched) have been quantified according to the Life Cycle Assessment – LCA methodology (Pimentel and Pimentel, 2003; Coelho et al., 2016). In this sense, numerous studies can be found in the literature in which the relationship between European diets, nutritional quality and environmental aspects are evaluated in detail (Aleksandrowicz et al., 2016; Duchin, 2005; van de Kamp et al., 2018; Van Kernebeek et al., 2014).

Several studies can be found in the literature where the food trends of Swedish homemade menus were analysed proposing dietary guidelines, with special attention to organic food (Carlsson-Kanyama et al., 2003; Carlsson-Kanyama and Faist, 2000; Carlsson-Kanyama and Linden, 2001). In these studies, the energy needs throughout the life cycle of Swedish diets were estimated with the aim of planning home-cooked meals that were nutritionally rich but included products that were less energy-intensive.

Jungbluth et al. (2000) proposed a simplified LCA approach to assess consumption patterns in Switzerland with the aim of identifying environmental-friendly decisions. The authors propose different actions to reduce environmental impacts. Therefore, it was proposed to reduce meat consumption and demand for airborne products as well as to promote the consumption of organic products.

The effect of Dutch consumption patterns on agricultural land needs was also assessed in detail (Gerbens-Leenes et al., 2002; Gerbens-Leenes and Nonhebel, 2002). According to these studies, large differences in land requirements for food production were identified not only in the Netherlands, but also for other European countries. A hypothetical analysis of a wheat-based diet would require up to six times less soil compared to a meat-rich diet.

Finally, Van Kernebeek et al. (2014) addressed the question of whether plant-based diets have lower environmental impact than those with a significant contribution of food with animal origin, but taking into consideration nutritional quality. To this end, a review of more than fifty peer-reviewed studies was conducted. The results showed that diets with higher percentages of food products of animal origin could be associated with higher GHG emissions and land use requirements, but these results were variable depending on the functional unit considered. Special mention was made of the need to assess the

overall nutritional quality of a diet and the recommended levels of protein intake as particularly relevant elements to be taken into account when comparing dietary patterns.

The most recent literature contains numerous references on the selection of the most appropriate functional units for the calculation of the environmental impacts of food consumption patterns. The energy content (daily calories), protein or fat content of diets are some of the most common examples (Pimentel and Pimentel, 2003; Heller et al., 2013). Moreover, profiles per serving or per potential economic value are also available (Heller et al., 2013; Van Der Werf and Salou, 2015). However, nutritional value must be the crucial element of reference for the definition of a healthy diet. Nutrient-based recommendations should be specifically considered in the search for and promotion of a sustainable dietary pattern that meets these values (Smedman et al., 2010; Heller et al., 2013).

The high consumption of fruits, vegetables and whole grains in the diet is closely related to the reduction of the risk of developing chronic diseases such as cancer and cardiovascular diseases, which are the main causes of death in industrialized countries (Cencic and Chingwaru, 2010). Based on this type of food, healthier and more fruit and vegetable-rich diets have been identified in southern countries. In contrast, northern countries have diets rich in animal fats and food products of animal origin. It is interesting to identify different social contexts and cultural values in relation to food (Nordström et al., 2013). While food is an individual issue in northern countries, society in central and southern Europe associates food with the social dimension of sharing a meal (Cencic and Chingwaru, 2010).

Spain is one of the European countries with the lowest mortality rates for ischaemic heart disease. Within the country, regional differences have been identified in this regard. In fact, variations have been reported to be up to 40% lower than the average in northern cities (Medrano et al., 2012). The traditional Atlantic diet is a common dietary pattern in northern Portugal and Galicia (northwest Spain), culturally and climatically similar areas and has been associated with a lower likelihood of myocardial infarction and good metabolic health (del Mar Calvo-Malvar et al., 2016; Atlantic Diet Foundation¹). The Atlantic diet is characterised by an abundant consumption of plant-based products, as well as local and fresh products (seasonal food) with reduced cooking time. The consumption of meat (mainly beef and pork) and eggs is reasonable and olive oil is considered as the main source of fat for cooking and seasoning (del Mar Calvo-Malvar et al., 2016; Charro et al., 2006). Recently, it has been rated as a world reference for a healthy diet (Vaz Velho et al., 2016). The Atlantic diet differs from the Mediterranean – the most popular in southern Spain, in terms of increased consumption of fish, red meat, pork, milk, potatoes, fruit, vegetables and olive oil (Guallar-Castillón et al., 2013), which implies significant changes in nutrients and functional components. However, both of them can be taken as examples of healthy diet (Tojo and Leis, 2009; Sáez-Almendros et al., 2013).

This study has a twofold objective: to quantify the carbon footprint of the Atlantic diet through a LCA approach associated with the production of the different foods that make up this diet, while identifying its nutritional quality. The recommended Galician dietary pattern and the corresponding intake data have been taken into account. The main causes of GHG emissions will be highlighted to identify options for improvement.

2. Materials and methods

2.1. Weekly menu based on the Atlantic diet

The concept of the Atlantic diet dates back to the traditional menus of Galician gastronomy. With the social awareness of a healthy diet,

¹ <https://www.fundaciondietatlantica.com/eng/index.php> (accessed July 2018).

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