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Impact of current, National Dietary Guidelines and alternative diets on greenhouse gas emissions in Argentina

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ABSTRACT

Diets have become an increasingly important driver of environmental pressures due to greenhouse gas emissions (GHGE), land use and other indicators of environmental impact associated with food production. In the present study we analyse the GHGE and the potential climate change mitigation through dietary changes in a country with high beef consumption, to contribute to the debate on what constitutes a healthy and sustainable diet. Data collected in the National Survey of Household Income and Expenditure 2012/2013 was used to estimate the composition of the current diet in Argentina, and four dietary scenarios were developed following the nutritional recommendations of the National Dietary Guidelines (NDG). We found that the GHGE related to the current Argentinian diet are very high (5.48 ± 1.71 kg CO_2-eq/person/day), with beef production contributing to the largest share of emissions (71%). The NDG suggest a 50% reduction of total daily intake of meats compared to current consumption, which, if adopted, would reduce GHGE in 28%, to 3.95 ± 0.96. Further reductions in GHGE appear possible while maintaining a healthy and balanced diet. The scenarios with non-ruminant meats and lacto-ovo vegetarian lead to similar GHGE, 2.11 ± 0.41 and 1.73 ± 0.37 kg CO_2-eq/day/person, respectively; and the vegan diet results in the lowest, 1.47 ± 0.34 kg CO_2-eq/day/person. Indicators for nutrient efficiencies were also developed. All nutrient efficiencies decreased in diets with bovine meat with respect to the non-ruminant, vegetarian and vegan ones. The results of this study therefore indicate that a set of dietary changes would significantly contribute to lower GHGE. Argentina's NDG should include the environmental impacts of food consumption with the aim of raising consumer awareness.

1. Introduction

Diet and nutrition are major determinants for maintaining health and preventing non-communicable diseases in modern societies (Katz and Meller, 2014). In the last 50 years, there has been a shift in food consumption patterns towards higher food energy density, with an increased participation of more resource-intensive foods, in particular animal-source foods (Imamura et al., 2015; González et al., 2011).

Besides the impact on public health associated with this trend (Popkin et al., 2012), dietary shifts have become an increasingly important driver of environmental pressures (Godfray and Garnett, 2014), a process that is likely to continue even if the rate of population growth slows down (van Vuuren and Carter, 2014). Food production requires a large share of available natural resources, such as land, fresh water, agricultural inputs and energy, and emits pollutants to the biosphere (CO_2, CH_4, NO_x, $SO_4{}^{2-}$ and $PO_3{}^{3-}$), altering global biogeochemical processes (Westhoek et al., 2016; Tuomisto et al., 2017).

It has been estimated that the global surface temperature should not rise more than 2 °C above pre-industrial level to avoid dangerous climatic changes (IPCC, 2014). On the other hand, the share of the food system accounts for approximately one third of total greenhouse gas emissions (GHGE) worldwide (Vermeulen et al., 2012), of which up to 80% are associated with animal-source foods production (Tubiello et al., 2015). Therefore, a sharp decrease in GHGE in the agricultural sector has been suggested (Wollenberg et al., 2016), particularly those related to the livestock sector (Herrero et al., 2016; Röös et al., 2017). In spite of this, projections indicate an increase in animal-source foods production and consumption in the next decades, particularly in developing countries (Alexandratos and Bruinsma, 2012); hence an increase in GHGE in the food sector is also expected (Tubiello et al., 2015; Davis et al., 2016). Technological improvements in animal husbandry and in agricultural practices are still possible, though it would not be enough to decrease the GHGE to achieve the required levels (Bryngelsson et al., 2016; Röös et al., 2017).

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Recent studies have shown that diets with high proportion of animal source foods are associated with larger GHGE and several other environmental burdens, as land and water use and eutrophication potential (Gephart et al., 2016; Alexander et al., 2016; Behrens et al., 2017). Thus, a growing body of evidence suggest that dietary change towards less meat and dairy, in addition to food waste reduction and technical improvements in the agricultural sector, seems to have a large potential to mitigate climate change and comply with the 2°C goal (Hedenus et al., 2014; Bajzelj et al., 2014; Hallström et al., 2015; Röös et al., 2017). Previous studies on diet choices and GHGE were performed for countries with low to medium levels of beef consumption, which has been shown to be the food with the highest GHGE (De Vries et al., 2015), and so there is a gap of knowledge on how much GHGE could be reduced by diet changes in countries with high beef consumption. Argentina is a developing country with a long tradition on beef consumption and at present closely rivals Uruguay for the most beef consumption per capita worldwide (OECD, 2017). The daily amounts ingested exceed by far the recommendations for prevention of cancer and other non-communicable diseases (WCRF and AICR, 2007; Larson and Orsini, 2014; Bouvard et al., 2015), which led the Ministry of Health in Argentina to recommend a healthier diet (National Dietary Guidelines, NDG) with a significant reduction of total meat consumption and an increase in the amount of vegetables, fruits and whole grains (Ministry of Health, 2016).

Using Argentina as a case study, the aim of the present work is to analyse the current GHGE and the potential climate change mitigation through dietary changes in a country with high beef consumption, to contribute to the debate on what constitutes a healthy and sustainable diet. We analysed the composition of the current diet in Argentina and estimated the GHGE associated. Four additional dietary scenarios were developed following the nutritional recommendations of the NDG to be compared. Indicators of nutrient delivery efficiency as a function of GHG emitted were also defined and quantified for protein, carbohydrate, fat and food energy. These indicators give an assessment of the climate impacts of whole diets based on the nutritional content of foods.

2. Materials and methods

2.1. Dietary and nutritional data

The composition of the current diet (CD) was estimated using The Food Consumption Atlas, a tool developed by the National Institute for Agricultural Research (INTA) to facilitate the visualization and analysis of the data collected in the National Survey of Household Income and Expenditure 2012/2013 (NSHIE), carried out by the Institute of Statistics and Censuses (Brescia and Rabaglio, 2015). The NSHIE 2012/2013 was performed in households of urban settlements of more than 5,000 inhabitants, comprising 86.7% of the total population of the country and 99% of the urban population (INDEC, 2017). The rural population, around 14% of the total, was not considered. The information in the Food Consumption Atlas was freely downloaded and includes the monthly consumption of more than 300 types of foods and drinks of all the population represented in the NSHIE. This food items are expressed in kilograms or litres consumed per month at national scale, so the amounts were adapted as grams/person/day or millilitre/person/day using the total consumption data and population represented in the survey. Although NSHIE does not report real consumption but purchase, it is a good proxy to estimate food consumption for the general population (Sununtnasuk and Fiedler, 2017). Food wastage was not considered due to lack of data for Argentina. We did not attempt to use food wastage estimates from other countries due to different social and cultural characteristics, which might lead to unknown uncertainties.

The food composition database from the United States Department of Agriculture (USDA, 2017) was used to assess energy, protein, carbohydrate and fat content in foods. We use this database instead of an Argentinean source because it has all food items required to perform the analyses. To organize the assessment, all food items were classified in 18 categories (see Table 1). Dairy products were unified as "milk equivalent" using conversion factors detailed in Supplementary materials (Table 1) and processed meats and cold meats were allocated into the categories of meat according to their ingredients (for instance, meat in salami are assumed to be 60% pork and 30% bovine, while 10% comprises water and additives).

Finally, the CD was standardized to 2000 kcal/person/day to be compared. Table 1 shows the results of the food, energy and macronutrients composition of CD in Argentina.

Table 1
Food, energy and macronutrient diet composition in grams per person per day.

Food type	Current diet	MDP scenario	NRM scenario	LOV scenario	VG scenario
Beef	135	71.3	0	0	0
Pork	14.2	7.5	15.5	0	0
Poultry	85.7	45.2	107	0	0
Lamb	1.3	0.7	0	0	0
Fish and seafood	7.8	4.1	7.1	0	0
Dairy (milk equivalent)	335	524	520	513	0
Eggs	16.1	25.2	23.5	23.1	0
Legumes and pulses	4	16.1	14.6	115	233
Rice	23.2	41.1	25.4	37.7	57.3
Cereals and pasta	66.8	88	65.6	80.7	170
Baked products	144	120	119	110	126
Fruits	85.4	298	304	286	373
Vegetables	144	406	408	414	629
Starchy vegetables	87.4	73	64	66.9	127
Nuts	0.1	0.1	0.1	19.8	34.7
Oils and fats	23.7	16.1	14.1	22.7	34.5
Energy and macronutrients					
Grams/day	1290	1859	1996	1799	1954
Kcal/day	2000	2000	2000	2000	2000
g/protein/day	85	79	83	69	61
% of kcal	17%	16%	17%	14%	12%
g/fat/day	85	67	70	64	51
% of kcal	38%	30%	32%	29%	23%
g/carbohydrate/day	224	270	259	287	324
% of kcal	45%	54%	52%	57%	65%

2.2. Dietary scenarios

To compare the current diet with alternatives, four scenarios have been proposed: (1) Model Dietary Plan based on the National Dietary Guidelines, named MDP scenario; (2) diet with no-ruminant meats, named NRM scenario; (3) lacto-ovo vegetarian, named LOV scenario; and (4) vegan diet, named VG scenario. All dietary scenarios were also standardized to 2000 kcal/person/day and modelled following the NDG from the Ministry of Health (2016), which was designed by consensus among local experts following the energy consumption and macronutrients suggested by the World Health Organization and Food and Agriculture Organization (WHO/FAO, 2003; WHO/FAO/UNU, 2007; Burlingame et al., 2009), and for vitamins and minerals by the Food and Nutrition Board of the Institute of Medicine (Otten et al., 2006). For the aims of this comparative study, the items in the salt and spices, soft drinks, alcoholic drinks, sweet and sugary foods categories were excluded, assuming them rather constant across the scenarios.

Daily intake of meats recommended by the NDG is 130–150 g/person/day for all meats combined (Ministry of Health, 2016), in contrast with the CD which includes 244 g/person/day. Therefore, MDP and NRM scenarios are modelled to NDG recommendations, which contains almost half of the weight of meats in relation to the current