Carbon footprint of university food courts and its relationship with type of food consumed

Huellas de carbono de las cafeterías universitarias y su relación con el tipo de alimento consumido

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Abstract
The aim of this work was to establish the environmental carbon footprint impact of food courts of the Autonomous University of the State of Mexico by type of food consumed. This was achieved by conducting a life cycle assessment according to ISO 14044, 2006. The environmental impact was calculated with the SimaPro 9.1.0.11 PhD software with the EU & DK input/output food database. The method was IPCC 2013. The assessed impact category was global warming potential 100 years, associated with the type of food consumed, classified in the following groups: sugar, fruit and vegetables, dairy, grain crops, oils and fats, meat and fish products. It was found that the carbon footprint of the food courts is 7199.29 kgCO\textsubscript{eq}per day, with a diet constituted by 42% fruits and vegetables, 19% meat and fish products, 12% grain crops, 11% dairy and 8% sugar, oils and fats. The average of carbon footprint per student per day according to the food consumed in University food courts is 3.33 kgCO\textsubscript{eq}per day.

Life cycle assessment, Sustainable diet and nutrition education

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Introduction

The global food systems emit 20-35 % of greenhouse gases (GHG) emissions, and it is necessary to achieve critical progress on all 17 Sustainable Development Goals (SDGs) (FAO, 2019). One-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion (FAO, 2011). The sustainable consumption of diet with low environmental impacts contribute to food and nutrition security to a healthy life for present and future generations, adopting a sustainable production and consumption throughout the global food supply chain (Ribal et al., 2016). Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources (FAO, 2011) The sustainable consumption, respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardize the needs of future generations (UNEP, 2007).

The Intergovernmental Panel on Climate Change (IPCC) in their most recent report recognized that “Consumption of healthy and sustainable diets” presents major opportunities for reducing GHG emissions from food systems and improving health outcomes, support the preservation of biodiversity and planetary health. (IPCC, 2019). The nutrition diet and school education converge with consumption habits and reduce GHG while remaining nutritionally adequate (Colombo et al., 2020).

Climate change is an aspect to build a sustainable healthy lunch in the University Food Courts (UFC) (Ribal et al., 2016). The source of emissions in UFC spaces are derived from quality of nutrition (meals), food waste and the management options in the waste hierarchy. Incorporate these topics associated with circularity and the integral management of waste in environmental high education programs has been achieved under a life cycle perspective.

Life cycle assessment (LCA) for the calculation of environmental impacts such as carbon footprint, is an internationally technique that analyses a product over its entire life cycle, quantifying its environmental impact.

Herrero et al., (2020) studied an integration of life cycle methods, including the role of embedded impacts within environmental, cost and nutritional attributes.

The sustainability with life cycle perspective in UFC allows to formulate institutional public, suggesting plausible sustainable solutions, positioning universities in a global interest of scientific community (Kooduvalli et al., 2020; Rada et al., 2020), considering environmental aspects implementing eating habits, including high amounts of plant-based food (e.g., vegetables, fruits, seeds, nuts, legumes, and whole grain foods) and moderate amounts of animal-based foods (e.g., meat, poultry, seafood, eggs, and dairy) (Steenson & Buttriss, 2020). Also, a sustainable solution is the reduction in the consumption of high environmental impact food, a minimum of food waste generation and choosing unpacked foods or with a minimum of package, among others.

The objective of this study was to assess the environmental carbon footprint (CFP) impact of food courts of Autonomous University of the State of Mexico (UAEMex) by type of food consumed. In part 2, the methodology describes the sector of society for data collection, which allowed the integration of an inventory for LCA from the food system of UFC. The results are reported in part 3, the evaluation was of the mid-point environmental impact of global warming potential. This research pretends to establish a representative baseline of current diets in UFC with a potential positive impact on healthy diets and on the reduction of environment impacts such as carbon footprint.

Methodology

The methodology was implemented in the municipality of Toluca, State of Mexico; data on food consumption was collected per day considering 27 UFC, which were classified into four sections (S1, S2, S3 and S4), making an allowance for routes of waste collection by the Department of Services of the UAEMex (Table 1).

Table 1 Academic spaces with University food courts in the UAEMex
Source: Department of services of the UAEMex, 2020

<table>
<thead>
<tr>
<th>Sections</th>
<th>Academic spaces</th>
</tr>
</thead>
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| S1       | Faculty of Medicine  
Faculty of Urban and Regional Planning  
Faculty of Nursing  
Faculty of Chemistry  
Faculty of Anthropology  
Faculty of Languages  
Faculty of Dentistry |
| S2       | San Cayetano  
Faculty of Gastronomy and Tourism  
Administrative building  
Faculty of Agricultural Sciences  
Cerrillo piedras blancas  
El Rosedal |
| S3       | International Centre for Language and Culture (CILC)  
Faculty of Tourism and Gastronomy  
University Town  
Faculty of Performing Arts  
Faculty of Economics  
Faculty of Geography  
Faculty of Engineering |
| S4       | Campus No. 2, Preparatory School "Nezahualcóyotl"  
Faculty of Accounting and Administration  
UAEM "Unidad Los Uribe" Santa Cruz Atzcapotzaltongo  
Central Library  
Faculty of Psychology  
Preparatory 3 "Cuauhtémoc"  
Center of Sustainable Chemistry UNAM-UAEM  
Campus No. 4, Preparatory School "Lic. Ignacio Ramírez Calzada"  
Campus No. 1, "Lic. Adolfo López Mateos"  
Campus No. 5, Preparatory School "Dr. Angel Ma. Garibay Kintana" |

The assessed impact category was global warming potential 100 years, associated with the type of food consumed, classified in the following groups: sugar, fruit and vegetables, dairy, grain crops, oils and fats, meat and fish products (Figure 1).

![Figure 1](source: Own Authorship)

Diagramming software: Ludichart Web 2.0

Results and discussion

According to the survey applied to the UFC managers, the type of food that is mainly consumed is fruits and vegetables, 42%; meats and fish products, 19%; grain crops, 12%; dairy products, 11%; and finally, sugar, oils and fats, 8%. These results are depicted in Graphic 1. It can be observed in Graphic 2 that the sources of GHG emissions, animal-based food (meat, fish and dairy products), considerably contribute to carbon dioxide equivalents (kg CO₂eq) towards climate change, more than plant-based foods, this is in concordance with that previously reported by Bastian et al., (2021). In United States schools canteens, it has been reported that the highest environmental contribution occurred at the food procurement stage (85%), while the lowest occurred at food preparation (2%) (Herrero et al., 2020).
The major long-lived greenhouse gases in the atmosphere are carbon dioxide (CO$_2$), methane (CH$_4$) and nitrous oxide (N$_2$O). In order to integrate the effect of the three gases on the global warming, the unit of kgCO$_2$eq was established. In such a unit, it is considered that one ton of CH$_4$ will cause the same amount of warming as 28-36 tons of CO$_2$, in a similar way, 1 tonne of N$_2$O is considered to cause the same warming than 265-298 tons of CO$_2$ (US EPA, 2021). The CFP by type of food consumption in all sections of the UAEMex, is depicted in graphic 2. It is interesting to observe that despite not being the most consumed food (see Graphic 1), meat and fish products have the highest environmental contribution 34-47% emitting (71.34-1275.84 kgCO$_2$eq).

This is because the animal-based food production requires a high amount of water and volume of crops. Mekonnen & Hoekstra (2012) reported that one kilocalorie of beef is estimated to have been produced with 20 times more water than one kilocalorie of a grain food or starchy root vegetable. This also explains why the consumption of dairy products represents the second largest contributor to the CFP in the UFC. It can be observed in Graphic 2 that this type of food contributes with 29-44% (91.59-1201.37 kgCO$_2$eq) to the CFP.

Fruits and vegetables are the type of food mostly consumed (see Graphic 1), nevertheless, it only contributes with 31.03-432.65 kgCO$_2$eq that represents 13-15% of the total CFP of the UFC. The contribution of the other type of foods is as follows, sugar (3-4%) 8.85-124.01 kgCO$_2$eq, oils and fats (2-5%) 5.23-171.05 kgCO$_2$eq, and grain crops (1%) 2.18-27.08 kgCO$_2$eq.

These results suggest that a diet with an increased ratio of (fruits+ vegetables+ grain crops consumption)/(meat+fish+dairy products consumption), would reduce the CFP of the UFC at UAEMex. This suggestion is worth to be analysed also in the context of nutrition, however, such an analysis is out of the scope of this work.
It can be observed in Graphic 4 that the contribution order to N₂O, CH₄, CO₂ emissions is S₄ > S₁ > S₃ > S₂. It is not a coincidence that this sequence follows the same order in number of academic spaces per section. This explains why S₄, with nine studied UFC, represents the largest environmental contribution with 45% to the total of GHG emissions (CH₄, CO₂, and N₂O). Nevertheless, in all cases and at any extent, the contribution to the GHG can be mainly ascribed to the consumption of meat, fish and dairy products.

This in concordance with that reported by González-García and collaborators (2018), who pointed out that in northern and Western Europe, as well as in the United States, the highest carbon footprints in the world are due to the consumption of dairy products in the daily diets. In addition, the meat and dairy products from ruminants, are associated with CH₄ enteric fermentation emission, in which food is fermented and decomposed in the digestive tract by the action of microorganisms with the consequent release of methane into the atmosphere (García-Oliveira et al., 2020). Also, the intensively managed grasslands are the dominant source of N₂O emission in dairy farming systems (Velthof et al., 1998) due to the use of fertilizers. For mitigation strategies, it is important to consider the reduction of these GHG emissions through dietary manipulation.

Graphic 3  Carbon footprint (kgCO₂eq) by type of consumed foot in the different sections of the UAEMex using the IPCC 2013 method GWP 100 years V1.03  
Source: Own Authorship

Table 2  Total carbon footprint in spaces of the UAEMex per day and percentage of impact.  
Source: Own Authorship
In this context, the World Health Organization (WHO) promotes a healthy diet and protect public health establishing standards to foster healthy dietary practices through ensuring the availability of healthy, nutritious, safe and affordable foods in schools and other public institutions (WHO, 2021). It is important to consider recent public documents which help to promote positive and gentle persuasion to encourage sustainable diets behavior in higher education campuses, like “The Little Book of Green Nudges” (UNEP, 2020), Figure 2.

This carbon footprint is due to the consumption of meat, fish and dairy products and not to the consumption of fruits and vegetables that is the type of food mostly consumed. For the total University food courts in academic spaces, section “S4” has the 45% of environmental contribution of total global warming potential, “S1” 32%, “S3” 20% and “S2”, 3%. Based on our results, it is recommended to promote to increase the consumption of grain crops, fruits and vegetables. This strategy of nutritional education would pursue a behavior change of managers and consumers to choose sustainable healthy diets. Further research could be meals into University food courts, considering nutritional indicators, food waste and cost.

References


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IPCC. (2019). *El cambio climático y la tierra*.


