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# *Ecological footprint and processing level in menus offered at a university restaurant*

## Pegada ecológica e nível de processamento em cardápios oferecidos em restaurante universitário

Abstract

*Introduction*: In the face of a global syndemic, the dominant agrifood system has its efficiency questioned in relation to health and sustainability. Institutional restaurants are an important locus for encouraging healthy diets and sustainable systems. *Objective*: evaluate the ecological footprint (EF) by comparing it across types of menus, processing levels and food groups in a university institutional restaurant. *Method*: Cross-sectional study with a quantitative approach. Data were obtained from technical preparation sheets of each omnivorous and vegetarian menus offered at an average of 286 daily meals. PSPP software was used for statistical analysis, performing descriptive and frequency tests, Kolmogorov-Smirnov and Mann Whitney tests to identify differences between groups. *Results*: Ecological Footprint (EF) medians were significantly different between omnivorous and vegetarian menus (p<0,00), between white and red meats (p=0,027), and between vegetarian menus with eggs and others (p=0,018). It was also possible to verify that, amongst processing levels, EF median of the organic and/or minimally processed foods group is higher than the others due to the group of meats, eggs, milk and other dairy products. The ultra-processed group has the fourth-highest median. *Conclusion*: Based on data gathered, menus planning should be reconsidered in order to ensure adequate eating habits and low environmental impact.

Keywords: Ecological Footprint. Processing Level. Food Collective. Menus

Resumo

*Introdução*: Diante de uma sindemia global, o sistema agroalimentar dominante tem sua eficiência questionada em relação à saúde e à sustentabilidade. Restaurantes institucionais são um lócus importante para incentivaro consumo de preparações saudáveis provenientes de sistemasalimentares sustentáveis. *Objetivo*: Avaliar a pegada ecológica (PE) comparando-a entre os tipos de cardápios, níveis de processamento e grupos alimentares em um restaurante institucional universitário. *Método*: Estudo transversal de abordagem quantitativa. Os dados foram obtidos de fichas técnicas de cada preparação dos cardápios onívoros e vegetarianos ofertados para uma média de 286 refeições diárias. Foi utilizado o *software* PSPP para as análises estatísticas, realizando testes descritivos e de frequências, teste Kolmogorov-Smirnov e teste de Mann Whitney para identificar diferenças entre os grupos. ***Resultados***: As medianas da Pegada Ecológica (PE) apresentaram diferenças estatisticamente significativasentre cardápios onívoros e vegetarianos (p<0,00), entre os tipos de carne, brancas e vermelhas (p=0,027) e entre cardápios vegetarianos com ovos e os demais (p=0,018). Também foi possível verificar que, dentre os níveis de processamento, a mediana da PE do grupo dos alimentos *in natura* e/ou minimamente processados é maior que os demais devido ao grupo de carnes, ovos, leite e derivados. O grupo de ultraprocessados tem a quarta maior mediana.***Conclusão***: A partir dos dados encontrados, o planejamento dos cardápiosdeve ser repensado, a fim de garantir uma alimentação adequada e com baixo impacto ambiental.

Palavras-chave: Pegada Ecológica. Nível de Processamento. Alimentação coletiva. Cardápios.

## INTRODUCTION

We are living witha global syndemic characterized by the coexistence of three types of pandemic: obesity, malnutrition and climate change. Along with it, the global agri-food system hasshownhigh levels of productivity, but its consequences end up calling into question its efficiency regarding sustainability. In the global and Brazilian context, such consequences can be identified through nutritional and population health issues as well as social and economic problems associated with food production and environmental issues.[1]

In the medium and long term, food systems will face considerable pressure from population growth, climate change, increased competition for natural resources, income growth, urbanization and globalization of diets, and many of these effects are negative. Therefore, it is of utmost importance that those in charge of strategies analyze the consequences of all these factors of change regarding their own food systems.[2]

In this fight, the *Guia Alimentar para a População Brasileira* (Dietary Guidelines for the Brazilian Population)points to the construction of a more sustainable food system by focusing on the consumption of fresh and/or minimally processed, organic and/or agroecological foods, with a greater supply of plant-based foods.[3] This consumption model aims to promote an environmentally sustainable agri-food system, based on family farming and the local economy, leading to biodiversity and reducing environmental impacts offood production and distribution. It recommends lower consumption of animal-based foods to minimize greenhouse emissions, deforestation and intense use of water. It also suggests restrictions on the consumption of ultra-processed foods, products high in fats and/or sugars, that is, high-caloriefoods that arehigh in sodium and low in fiber, which contribute to obesity and other chronic diseases.[4]

To assess the environmental impacts of the food system, there is the ecological footprint (EF), which measures and assesses the impacts of human action on nature by analyzing the area of bio-productiveland (biologically productive land and water area) required to produce resources that an individual, population or activity consumes and to absorb the resulting waste, considering the use of technology and resource management.[5] The result presents how an individual, city or country is consuming natural resources and the consequences of it.[6]

EF is based on three principles: sustainability, equity and overshoot. Sustainability seeks to satisfy human needs in the present and future, without destroyingthe environment. This principle is related to equity, for there is no sustainability without equality. Also, it is impossible to achieve equity with economic growth alone, given the biosphere is limited. The ecological footprint demonstrates that the limit is already being exceeded and that this will destroy the natural capital we currently depend on. Overshoot refers to the existing limit of all types of energy and matter. With the high consumption of natural capital exceeding the limits, nature will not be able to regenerate itself, which brings consequences such as depletion of renewable and non-renewable resources.[7]

When it comes to applying the ecological footprint, it is important to relate the level of food processing to the environmental impact caused. Industrialized foods tend to escalate the use of natural resources, because, besides the production itself, they include the use of packaging, a greater demand for energy resources and the production of inorganic waste.

Therefore, it is relevant to point out the possibility of reviewing the menus in collective catering to seek balance between environmental and public health challenges. The importance of exploring the ecological footprint as an element of environmental sustainability justifies this research, especially when it comes to public policies for collective food supply.

Therefore, this study aimed to assess the ecological foot print values of menus of an institutional University Restaurant (UR) by comparing them according to menu types (omnivorous and vegetarian), processing levels and food groups.

## METHOD

This is a cross-sectional study with a quantitative approach, carried out at a University Restaurant at the Realeza Campus of *Universidade Federal da Fronteira Sul* (Federal University of Southern Frontier). The Ecological Footprint (EF) of the inputs used in a monthly menu in the UR was calculated, which tends to be the same in all the other months of the year.

This UR is managed by a third-party company that produces and distributes meals on site. It provides 286 meals a day for lunch and dinner, from Monday to Friday. The menu was requested to the management, and it consisted of a starter, main dish, garnish, side dish, and dessert. Meals are served in a cafeteria with a hybrid distribution model, where only the main dish is portioned out. Thirty-eight menus were assessed, out of which 19 were omnivorous and 19 were vegetarian. The vegetarian menus were ovo-lactovegetarian, as they contained products such as eggs, milk and dairy products.

Technical data sheets (TDS) of the preparations in the menus were provided by the dietician responsible for the UR to be used in this study. Lists of ingredients with the net weight (gross weight minus weight of unused parts) of the lunch and dinner meals were obtained through the TDS.

These technical sheets were prepared by intern undergraduate Nutrition students. They weighed all the used raw ingredients and used the total weight of the meal to formulate a per capita portion based on household measurements and nutritional recommendations for macronutrients and calories for adults. It should be noted that this per capita portion is an approximate average and did not consider the actual consumption by each diner nor leftovers from each day, which may lead to some margin of error. This quantity of food/ingredient per capita was used to calculate the EF values for each daily menu.

The data was organized in an Excel spreadsheet including all the ingredients of each menu, with the respective EFvalues. Data from the study by Garzillo et al. were used as a reference[8]to calculate the EF, considering that each product may show variations depending on specific local characteristics such as soil and climate.

The inputs used in the menus were organized and classified by EF, food group and level of processing by using Menegassi et al.[3] as a reference.

Statistical analyses were performed with the PSPP ® software. Descriptive and frequency analyses (absolute frequency, percentage, mean, median and standard deviation) of the quantitative variables were performed. The Kolmogorov-Smirnov normality test was used, which revealed that the EF variable did not have a normal distribution. For this reason, the Mann-Whitney U test was used, considering $p<0.05$ as an indication of statistical significance, to test quantitative variables with the nominal qualitative variable (omnivorous menu and vegetarian menu; type of vegetable protein; type of animal protein).

After that, the Kruskal-Wallis test was performed, considering $p<0.05$ as an indication of statistical significance, to compare the quantitative variable with the ordinal variable (processing levels, namely, G1:fresh foods and/or minimally processed; G2:culinary ingredients; G3: processed foods; G4: ultra-processed foods), and compare the quantitative variable with the ordinal variable, which consists of the food groups, namely, beans and legumes (black beans, pinto beans, white beans, lentils, chickpea, TSP); grains (white rice, brown rice, white hominy, corn flour, wheat flour, cassava flour, bulgur wheat); roots and tubers (potatoes, sweet potatoes, cassava); vegetables (chard, iceberg lettuce, curly green lettuce, endive, chicory, kale, cauliflower, white cabbage, parsley with spring onions (*cheiroverde*), arugula, zucchini, kabocha squash, chayote, cucumber, green pepper, red pepper, tomato, eggplant, onion, garlic, oregano); fruits (pineapple, silver banana, plantain, orange, sweet orange, apple, Fuji apple, watermelon, raisins); meat, eggs, dairy (ground beef, beef, pork chop, pork, fish fillet, whole chicken, chicken thigh, chicken breast, drumstick, egg, skim milk); culinary ingredients (sugar, soybean oil, salt); processed foods (corn starch, sago, wheat noodles, lasagna noodles, tomato paste, sweet corn, peas, sweet popcorn); ultra-processed foods (gelatin, peanut candy (*paçoca*),soy sauce, sausage, chicken sausage, mozzarella cheese, margarine with salt, straw potatoes). Finally, the non-parametric Mann-Whitney test was used to make comparisons between food groups.

## RESULTS

Table 1 shows the types of preparations/foods of the meals servedat the UR under study, as well as the omnivorous and vegetarian preparations. The difference between the omnivorous menu and the vegetarian menuis the type of preparationof the main dish, so there are no changes regarding other components of the menu. It was found that the main dish in the omnivorous menu consists mainly of meat or meat products made ofbeef, pork, chicken and fish. Main dishes on the vegetarian menu basically consist of dishes made of textured soy protein (TSP), eggs, grains, other legumesand vegetables.

Chart 1. Types of preparations/foodsused in the menus

| Type of preparation | Omnivorous Menu | Vegetarian Menu |
|---|---|---|
| Main Dish | Meatballs insauce; Beef; Ground beef; Pork; Crispy drumstick; Chicken Stew; Beef stroganoff; Chicken stroganoff; Chicken in sauce; Beef strips; Beef lasagna; Chicken sausage; Tuscan sausage; Chicken pancake; Fish stew; Roasted drumstick; Chicken drumstick stew; Pork with onions. | TSP* meatballs in sugo; TSP casserole; TSP Stroganoff; White bean; Chickpea; Rice burger; Bean burger; TSP burger; Zucchini lasagna; TSP lasagna; Eggs on the plate; Scrambled egg; TSP pancake; Textured Soy Protein (TSP*). |
| Legumes | Pinto beans; Black bean; Lentil. | |
| Type of Rice | White rice; Brown rice. | |
| Garnish | Eggplant antipasto; Sweet potato with garlic and oil; Caramelized sweet potato; Straw potatoes; Rustic potato; Grits; Pea cream; Cornmeal with parsley; Vegetable shepherd's pie; Spaghetti in garlic and oil; *Farofa Rica*; Cooked cassava; Noodles with tomato and arugula; Creamy *polenta*; Mashed potatoes; Savory pumpkin stew; Steamed pumpkin; Zucchini stew; Rigatone with herbs. | |
| Salad | Zucchini in vinaigrette; Cooked zucchini; Zucchini with *cheiroverde*; Chard; Chard with pineapple; Lettuce; Endive; Cooked beet; Shredded beet; Kabocha squash with onion; Cooked kabocha squash; Roasted onion with herbs; Carrot with chickpeas; Cooked carrot; Shredded carrot; Chicory; Chayote with *cheiroverde*; Cooked chayote; Kale; Shreddedvegetable duo; Lettuce mix; Mix of leaves; Mix of vegetables; Cucumber; Cucumber with tomato; Colored cabbage; Boiled cabbage; Stewed cabbage with raisins; Arugula; Arugula with orange; Tabbouleh; Tomato; Cabbage vinaigrette. | |
| Dessert | Vanilla cream with caramel; Packaged candy; Fruit; Gelatin; Sweet popcorn and salty popcorn; Sago. | |

Source: Authors, 2022.
*TSP: Textured soy protein

Table 1 shows the EF medians of the omnivorous menu and vegetarian menu compared to the type of preparation offered as the main dish.Within the omnivorous menu and the vegetarian menu, it was found that there are statistically significant differences regarding the EF medians. In the omnivorous menu, the EF medians were higher when red meat was used. In the vegetarian menu, the protein with the highest EF medians was egg, when compared to TSP and other vegetables/legumes/grains.

**Table 1.** Ecological Footprint of omnivorous and vegetarian menus served at the UR (UFFS/Realeza), 2022.

| Variable | EF (g/m²) | | | |
|---|---|---|---|---|
| | N (%) | Median | Standard Deviation | M-W |
| Omnivorous | 19 (50) | 426.74 | 227.74 | 0.000 |
| Vegetarian | 19 (50) | 70.90 | 55.20 | |
| Main Dish | | | | |
| Red meat | 10 (52.6) | 609.88 | 187.00 | 0.027 |
| White meat | 9 (47.3) | 275.59 | 199.76 | |
| Vegetarian Main Dish | | | | |
| TSP | 10 (52.6) | 56.08 | 42.69 | 0.018* |
| Eggs | 3 (15,7) | 189.85 | 39.97 | 0.020** |
| Vegetables/Legumes/Grains | 6 (31.5) | 67.01 | 24.32 | 0.588*** |

* Result of the comparison between the medians of the TSP-based protein dish and the egg-based protein dish.
** Result of the comparison between the medians of the egg-based protein dish and the vegetable/legumes/grain-based protein dish.
*** Result of the comparison between the medians of the vegetable/legumes/grains-based protein dish and the TSP-based protein dish.
Source: Authors, 2022.

Table 2 shows the analyzed EF values according to food processing levels. Based on the Kruskal-Wallis test, the processing level variables did not show statistically significant differences in the EF medians. However, the EF median of fresh and/or minimally processed foods stands out among the processing levels.

**Table 2.** Ecological Footprint of the foods ofthe menus served at the UR (UFFS/Realeza) by food groups, 2022.

| Variable | EF (g/m²) | | | |
|---|---|---|---|---|
| | N (%) | Median | Standard deviation | K-W |
| G1 | | | | |
| Beans and legumes | 6 (7.7) | 56.63 | 72.67 | 0.000 |
| Grains | 7 (9.0) | 48.91 | 742.20 | |
| Roots and tubers | 3 (3.8) | 1505.79 | 622.74 | |
| Vegetables | 23 (29.5) | 48.05 | 70.39 | |
| Fruits | 9 (11.5) | 223.08 | 489.73 | |
| Meat, eggs, dairy | 11 (14.1) | 4758.47 | 6594.81 | |
| G2 | | | | |
| Culinary ingredients | 3 (3.8) | 73.22 | 2194.12 | |
| G3 | | | | |
| Processed food | 8 (10.3) | 80.37 | 123.03 | |
| G4 | | | | |
| Ultra-processed food | 8 (10.3) | 175.03 | 1626.84 | |

Source: Authors, 2022.

For a more in-depth analysis, fresh and minimally processed foods were subdivided into food groups, namely, beans and legumes; grains; roots and tubers; vegetables; fruits; meat, eggs, dairy. With this division, there was a statistically significant difference between the medians of the food groups:the meat, eggs, dairy group had the highestone, with no statistically significant differences between other groups.

## DISCUSSION

It was found that omnivorous preparations had a higher EF median than vegetarian preparations. Studies indicate that replacing meat-based preparations with ones based on greens, legumes and vegetables bring nutritionalbenefits and have a lower environmental impact.[9,10] Furthermore, they would result in potential cost savings on food, considering that meat and fish are more expensive and that thisprice variation would often determine their consumption.[9,10]

Pressures from overpopulation, scarcity of resources and excessive consumption[11] must be considered by the State so that it should review public policy strategies for supplying food to communities that help and enable changes in favor ofa more sustainable and healthy diet. Thus, reducing meat consumption would be a first step towards reducing EF and environmental impacts.

When comparing the types of main dish in omnivorous preparations, beef preparations had higher EF medians than poultry or fish preparations.[12] Dakin et al.[12] and Cunha et al.[13] highlight that consumption of beef in Brazil has had a considerable increase over the decades, along with the country's development, with per capita consumption of 23.06 kg per year, which is higher than the consumption of pork, poultry and fish. Cunha et al.,[13] in their study in the state of Rio de Janeiro, compared the per capita area (0.019 hectares) with the per capita area required to produce beef according to the population's consumption (total of 0.065 hectares). According to this example, it is clear that the hectares available for the production of beef in the state of Rio de Janeiro would be exceeded, given the amount consumed.

Willett, Hu, Rimm and Stampfer[14] point out that excessive consumption of red meat has no benefits for people's health and results in more environmental impacts when compared to vegetable sources of protein. Therefore, in order to reduce the EF, it would be important to reduce the frequency of red meat offered at the UR, by prioritizing white meat such as poultry and fish as well asplant-based proteins.

When analyzing the EF median by typeof main dish in vegetarian preparations, egg-based preparations were higher when compared to TSP-based preparations. Garzillo et al.[8] show that the EF median for 100g of eggs is 2.3g/m², where as the EF for 100g of soy protein is 0.3g/m².

However, although vegetarian main dishes have a lower EF when compared to omnivorous main dishes, the majority of vegetarian preparations are soy-based. The literature shows that Brazil produces GMO soybeans, which uses large amounts of pesticides.[15] Studies highlight that the excessive use of fertilizers and herbicides to produce these foods also has an environmental impact and contributes to the increase in EF and other footprints, such as carbon footprint, nitrogen footprint and energy footprint.[16] Therefore, when thinking about healthy and sustainable diets, just reducing or avoiding meat consumption would not be enough. Furthermore, pesticides are associated with diseases such as cancer, endocrine disruption, congenital malformations, poisoning, among others.[15,17]

When comparing the processing levels of the foods in the preparations, it was found that G1 (referring to fresh products) has the highest EF median. When G1 is subdivided, the subgroup including meat, eggs, milk and dairy products is found to have the highest EF median than the other subgroups. In addition, it was found that G4 (ultra-processed foods group) has a higher EF median when compared to the other groups and subgroups (the fourth highest median).

Studies indicate that the consumption of ultra-processed foods in Brazil has had a large increasein the last three decades, which contributes to a significant increase in the EF.[10] The availability of ultra-processed foods has been growing, and some of the reasons are its massive supply and affordable prices for the majority of people.

According to Anastasiou et al.,[16] changes in dietary patterns, such as greater consumption of industrialized products, intensified environmental effects. The acquisition of foods from G1 (fresh and/or minimally processed) and G2 (culinary ingredients) has reduced, whereas the acquisition of foods from G3 (processed foods) and G4 (ultra-processed foods) has increased in recent years.[10] The increased intake of ultra-processed foods is related to the increase in obesity and other chronic non-communicable diseases.[18] This production is based on a food system with few agricultural species, which are cultivated in large deforested areas, resulting in negative effects such as chemical pollution, loss of biodiversity and reduced land renewal.

In this study, one can observe that there are few ultra-processed products to prepare the menus, which may have contributed to the lack of statistically significant differences between the other groups and them. However, foods such as processed meat are still offered.

In the production of processed meat, for example, a vast area of land is used to produce animal feed such as soybeans and corn, commonly using pesticides, GMO and fertilizers. In addition, other areas of land are used for livestock farming, as well as other natural resources such as water and energy. There is also waste disposal, leading to the emission of greenhouse gases and pollution of land and water. Finally, processing, packaging, transportation, use of cold chain, among others, impact the environment too.[16] Anastasiou et al.[16] presented evidence indicating that ultra-processed foods have an environmental impact which significantly contributes to degradation and loss of biodiversity, for their production requires a considerable amount of land, which is associated with deforestation in areas of biodiversity.

In addition to the loss of biodiversity, massive production affects soil quality, which is a threat to the ecosystem. The excessive use of fertilizers and herbicides for accelerated production of these foods also causes problems for the ecosystem and health. Excessive use of nitrogen and phosphorus fertilizers can lead to nutrient imbalances in the soil and also eutrophication in the river ecosystem.[16]

Added to this is the reduction in dietary diversity. The *Guia Alimentar para a População Brasileira* (Dietary Guidelines for the Brazilian Population) highlights the loss of eating and cooking habits caused by the unbridled growth in the production and consumption of ultra-processed and standardized foods.[4,18] Furthermore, Peres, Matioli, Swindurn[19] show that there is a connection between the level offood processing and the concept of global syndemic. They mention that healthy and sustainable food systems present a rather complex idea, but that guidelines based on sustainable foods are a very concrete step towards reducing EF and the global syndemic. They also highlight that the way the food industry is encouraged to produce processed and ultra-processed foods leads to future problems, such as the increase in chronic non-communicable diseases (NCDs) including obesity, heart diseases, and diabetes, along with climate change and loss of biodiversity.

## CONCLUSION

This study found that the vegetarian menus had a lower EF median when compared to the omnivorous menus. Another highlight is the difference within the types of main dishes, as red meat preparations have a higher median when compared to white meat ones. These values are in line with the literature, which points out that excessive consumption of red meat has no benefits for human health and results in a greater environmental impact.

It was possible to verify that, within vegetarian main dishes, egg-based preparations had a higher EF when compared to TSP-based main dishes. However, vegetarian TSP-based diets should be reconsidered because soy production requires pesticides, GMO products, fertilizers and herbicides, causing harm to both the environment and population health.

Increased consumption of fast and processed foods and high meat intake has raised concerns in recent decades regarding the population health and its environmental impacts. In this study, the number and quantity of ultra-processed products are low, which is a positive aspect in menu planning at this UR. This may have been the reason why no statistically significant differences were found between this group and the others.

When aiming for a lower ecological footprint, it is of great importance to rethink institutional menus, especially those with the potential to change the eating habits of the population they serve, such as the URs, which feed thousands of university students every day. Therefore, replacing meat-based menus with plant-based preparations such as vegetables is a first step. Yet changes in the production and processing systems of these foods are essential for having healthier and more sustainable diets.

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Contributors

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