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Environmental impacts of the water footprint and waste generation from inputs used in the meals of workers in a Brazilian public hospital

Impactos ambientais da pegada hídrica e geração de resíduos de alimentos utilizados na refeição de trabalhadores de um hospital público brasileiro

Impactos ambientales de la huella hídrica y la generación de residuos de alimentos utilizados en las comidas de los trabajadores de un hospital público brasileño

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Abstract
This study aimed to assess the environmental impacts of waste generation and the WF of raw materials used to provide meals to workers in a public hospital in southern Brazil over the course of the four seasons. This is a descriptive case study with a quantitative approach. The food raw materials that composed meals during 2019 were grouped by type of input. The items included from each food group were those which represented at least 85% (Multiple Criteria ABC Analysis) of the total amount used in kilograms within the respective group, in each month. The generation of residues from fruits, vegetables, and meat was estimated, as well as the WF of the items. For the statistical analysis, the Kruskal-Wallis test was used with a significance of 5%. Out of the 96 food inputs used, 49 items represented 86% of the total in kg, being the ones from which the environmental impacts were calculated. During the year, 435,411 meals were served. As for the number of diners, the highest frequency was observed in the winter and lowest in the summer. The annual waste percentage of the fruits acquired was 33.8%, being higher in the summer than in other seasons. Animal products were responsible for 64.2% of the WF, being higher in the winter. Assessing user frequencies, climatic conditions, and raw-material selection are important measures for the appropriate management of foodservices, as well as for assessing their environmental impacts.
Keywords: Environmental impact; Production of meals; Sustainability.

Resumo
Este estudo teve como objetivo avaliar os impactos ambientais da geração de resíduos e da pegada hídrica (PH) das matérias-primas utilizadas na alimentação dos trabalhadores de um hospital público do sul do Brasil ao longo das quatro estações. Trata-se de um estudo de caso descritivo com abordagem quantitativa. As matérias-primas alimentares que compunham as refeições durante 2019 foram agrupadas por tipo de insumo. Os itens incluídos de cada grupo de alimentos foram aqueles que representaram pelo menos 85% (Análise Curva ABC) da quantidade total utilizada em quilogramas (kg) dentro do respectivo grupo, em cada mês. Foi estimada a geração de resíduos de frutas,

hortaliças e carnes, bem como a PH dos itens. Para a análise estatística, foi utilizado o teste de Kruskal-Wallis com significância de 5%. Dos 96 insumos alimentares utilizados, 49 itens representaram 86% do total em kg, sendo aqueles a partir dos quais foram calculados os impactos ambientais. No ano, foram servidas 435.411 refeições. Quanto ao número de comensais, a maior frequência foi observada no inverno e a menor no verão. As frutas tiveram um total de 33,8% de desperdício, sendo que no verão foi observado a maior quantidade. Os produtos de origem animal foram responsáveis por 64,2% da PH, e no inverno foi identificado os maiores valores. A avaliação das frequências dos usuários, as condições climáticas e a seleção de matérias-primas são medidas importantes para o gerenciamento adequado dos serviços de alimentação, bem como para avaliar seus impactos ambientais.
Palavras-chave: Impacto ambiental; Produção de refeições; Sustentabilidade.

Resumen

Este estudio tuvo como objetivo evaluar los impactos ambientales de la generación de residuos y el huela hídrica (HH) de las materias primas utilizadas para proporcionar alimentos a los trabajadores de un hospital público en el sur de Brasil durante las cuatro estaciones Del año. Este es un estudio de caso descriptivo con un enfoque cuantitativo. Las materias primas alimentarias que componían las comidas durante 2019 se agruparon por tipo de insumo. Los ítems incluidos de cada grupo de alimentos fueron aquellos que representaron al menos el 85% (Análisis ABC) de la cantidad total utilizada en kilogramos (kg) dentro del grupo respectivo, en cada mes. Se estimó la generación de residuos de frutas, verduras y carnes, así como la HH de los artículos. Para el análisis estadístico se utilizó la prueba de Kruskal-Wallis con una significancia del 5%. De los 96 insumos alimentarios utilizados, 49 ítems representaron el 86% del total en kg, siendo a partir de los cuales se calcularon los impactos ambientales. Durante el año se sirvieron 435,411 comidas. En cuanto al número de comensales, la mayor frecuencia se observó en invierno y la menor en verano. El porcentaje de desperdicio anual de los frutos adquiridos fue del 33,8%, siendo mayor en verano que en otras temporadas. Los productos animales fueron responsables del 64,2% de la HH, siendo mayor en invierno. La evaluación de la frecuencia de los usuarios, las condiciones climáticas y la selección de materias primas son medidas importantes para la gestión adecuada de los servicios alimentarios, así como para evaluar sus impactos ambientales.
Palabras clave: Impacto ambiental; Producción de comidas; Sustentabilidad.

1. Introduction

Sustainable food systems must be so across all of the activities – from food production to consumption, including the materials used to produce food. Indeed, a number of issues pose specific challenges to ensure that inputs (both materials and services) are sustainable (FAO & INRAE, 2020).

Food production, processing stages, distribution, and consumption are inherent activities for guaranteeing human nutrition and consequently for the development of a country (van der Werf et al., 2014). Especially in recent decades, food production has been evaluated in relation to the standardization of consumption habits and also due to environmental impacts. Within these environmental impacts are listed air pollution, scarcity and contamination of water resources, deforestation, erosion, loss of biodiversity, among others (Willett et al., 2019).

The 2030 Sustainable Development Agenda proposed by the United Nations (United Nations, 2015) sets 17 global objectives, and their respective action plans, among which two are directly related to sustainable food production: Goals 2 (end hunger, achieve food security and improved nutrition and promote sustainable agriculture) and 12 (ensure sustainable consumption and production patterns).

Given the expectation of an increase in the population, it is necessary to reorganize and rethink the forms of food production, since, according to the Food and Agriculture Organization (FAO), in 2050 the world will need to increase food production by 60% to guarantee sufficient food supply (FAO, 2015a). Another aspect to be considered is food waste throughout the supply chain. This waste takes into account the quantity and quality of the inputs used, as well as the adequate use of food for human consumption (FAO, 2015b).

Facing the exposed, the meal production segment plays an important role. In Brazil, the establishments where such activities take place are usually referred to as Food and Nutrition Unit, Meal Production Unit or "Collective" Foodservice (Santos and Strasburg, 2016). In a broader approach, the market expression 'foodservice' is usually used as a reference. The term 'foodservice' is applied to designate the provision of meals outside the house (Rodgers, 2017). In Brazil, the meal supply segment shows a great economic and social impact. In 2020, 22.3 million meals were estimated with a turnover of BRL 36.9 billion (Brazilian real) and approximately 250 thousand workers in the sector (ABERC, 2021).

Nevertheless, this sector also causes environmental impacts, especially related to residue generation from unusable parts of food and packaging, in addition to the use of natural resources (Harmon and Gerald, 2007; Pérez-Mesa et al., 2019). In the Brazilian scenario, the study by Strasburg and Jahno (2017a) displayed that in the meal production segment, environmental actions are more strongly related to waste generation and to the use of water and electricity.

The use of indicators for sustainability may be used when considering the impacts in an environmental management context. The use of indicators or indexes provides quantitative information that allow the establishment of objectives or goals for a given period (Feil & Schreiber, 2017). There are several indicators for the assessment of environmental impacts, among which are the carbon footprint and the Water Footprint.

Water is indispensable for life on Earth, being a physiological constituent for living beings. It is essential for economic activities, especially those related to agriculture, livestock and industry (Aivazidou et al., 2016). On the other hand, the use and consumption of drinking water in the food production segment also has an environmental impact (Lovarelli et al., 2018). World food production is estimated to account for 26% of global greenhouse gases (GHG) emissions. Agricultural production consumes 70% of the world's total fresh water (Ritchie & Roser, 2020).

The water footprint (WF) concept emerged in 2002 with researchers Hoekstra and Huang at the University of Twente (Netherlands), as a way of assessing water consumption by humanity. The WF is defined as the total volume of freshwater used during production and consumption of goods and services as well as direct water consumption by humans. The WF assessment applies to various products, from food and clothing to electronic devices. Water is not only consumed directly but also indirectly in production processes (Yu et al., 2010).

In view of this, this study was conducted in the restaurant of a federal public hospital, and aimed to assess the environmental impacts of waste generation and the WF of the raw materials used to provide meals to workers during the four seasons of a year.

2. Methodology

This research consists of a descriptive case study, with a quantitative approach and using secondary data (Prodanov & Freitas, 2013).

General characterization

The municipality of Porto Alegre is the capital of the Rio Grande do Sul (RS) State and is located in the extreme south of Brazil. It has a total area of 495,390 km² and an estimated population of 1,488 million inhabitants (IBGE, 2020). In Figure 1, Porto Alegre’s location is highlighted in red among the 497 municipalities in RS.

Figure 1. Location of Porto Alegre in the state of Rio Grande do Sul, Brazil.

Source: Wikipedia.

The city's climate is humid subtropical and, although it has defined seasons, since it is located in a transition zone, it has a characteristic of great variability of meteorological elements (PMPA, 2020). Its average annual temperature is 19.5ºC, varying between 10ºC and 25ºC in autumn, 2ºC and 20ºC in winter, 15ºC and 30ºC in spring, and 25ºC and 35ºC in summer (PMPA, 2020).

Data collect

This study was conducted in the nutrition and dietary service of a federal public hospital in the city of Porto Alegre, in which there are approximately 6,000 workers among employees, residents and interns. In the 350-seat hospital cafeteria are served breakfast, lunch, afternoon snack, and dinner. Regarding residues, the recyclable ones were collected by a third-party company while the non-recyclable were collected by the public administration to a local landfill site.

Regarding the foodservice for hospital workers, the standard lunch and dinner menus are composed of two types of rice (white and brown), a legume (beans or lentils), a type of meat, a garnish, two types of salads and dessert (fruit). Of these items, only the meat serving was controlled (1 serving per person), while the other dished were served in a self-service style.

All food inputs were included on the data collection, being distributed into six groups according to their characteristics: 1) animal origin products (meat, eggs and cheese), 2) cereals, 3) legumes, 4) vegetables (for garnish and salads), 5) fruits, and 6) culinary ingredients, such as soy oil and tomato extract and others, used to prepare, season and cook meals.

WF and the Edible Parts Index (EPI) were calculated over the foods that composed the monthly menus of the lunch and dinner meals served to the hospital employees in 2019. The quantifying of the food was done based on each month's ingredient purchase requisition.

The calculations were done for each food product in each of the groups for each month. Afterwards, the values were summed by season (3-month periods). The following equations were used:

WF = food product (monthly purchase in kg) x product reference value (Mekonnen & Hoekstra, 2011, 2012). As described in the section 'inclusion criteria'.

Ex.: If the white rice purchase in January was 1,590 kg, and the product's WF reference value is 2,497, then WF = 1,590 x 2,497, resulting in 3,970,230 L.

EPI = food product (monthly purchase in kg) ÷ product yield factor (MenuControl, 2020). As described in the section 'inclusion criteria'.

Ex.: If 1,793 kg of tomato were purchased in January, and the tomato's yield factor is 1.43, then EPI = 1,793 ÷ 1.43 = 1,253.85 kg. Therefore, residues would be the different (1,793 – 1,253.85), 539.15 kg.

Inclusion criteria

The selection of the items investigated for the calculations of this study considered the ABC analysis criterion, following the model used by Strasburg and Jahno (2017b). The conceptualization and use of the ABC curve method emerged in the 19th century with the Italian Vilfredo Paretto. In the classification by the ABC analysis criterion, the items are separated by greater importance or impact in relation to those that are used in smaller amounts (Yan et al., 2013).

Thus, the items of each of the groups were included until reaching a minimum amount of 85% of the total consumption (kg) within the respective group, in each month. Table 1 presents the statement according to the food groups.

Table 1. Evaluation of the characterization of food groups through the months. Porto Alegre, 2019.

	Number of items		Number of A-B items		A-B items
Food Groups	Max	Min	Max	Min	% min
Animal Origin	21	15	12	9	2.84
Cereals	12	9	7	4	5.92
Legumes	3	2	2	2	15.63
Fruits	10	7	8	4	7.28
Vegetables	28	24	18	10	2.32
Culinary ingredients	3	2	2	2	17.63
Miscellaneous inputs	19	15	NA	NA	4.61
Total	**96**	**74**	**49**	**31**	**NA**

NA= Not applicable. Source: Authors.

The 'Miscellaneous inputs' group was not taken into account in the calculations because the sum of all items used in this group kept between 0.8% and 1.5% of the raw materials in their totality.

To collect the WF information for food, the data from the studies by Mekonnen and Hoekstra were used as a reference for products of plant (2011) and animal (2012) origin, respectively. Then, the total contribution of the items of each food group was evaluated for each season of the year, considering the WF. The *per capita* WF and weight of each food group were also calculated.

To calculate the generation of residues from inedible parts of food, the EPI information from the MenuControl website (2020) was used. The EPI corresponds to the difference in the removal of inedible parts of the food, being the result of dividing the gross weight by the net weight of a food (Abreu and Spinelli, 2016). The residues generation was also calculated from fresh fruit, vegetable, and cuts of bone-in meat. In view of the fact that the investigated service acquires minimally processed vegetables (MPV), the EPI was calculated to identify the non-generation of waste at the site due to the purchase of these types of inputs.

Data analysis

The results of the data found were transcribed to the Microsoft Excel © 2010 software, in which were calculated the absolute frequencies, percentages, means, and standard deviation. The SPSS 18.0 software (2009) Kruskal-Wallis test was used for non-parametric tests (data asymmetry), with a 5% significance.

Ethical issues

There was no direct interaction with patients at the study site, so the use of Free and Informed Consent Term was waived. The project was approved by the Nossa Senhora da Conceição hospital coordination of the nutrition service and Research Committee, and by the Research Committee of the Federal University of Rio Grande do Sul School of Medicine under nº 37906/2019.

Study limitations

The WF and EPI databases can be cited as limitations of this study. According to Carmo et al., (2007), the WF determination for each product may vary depending on specific regional characteristics, such as soil and climate, especially rainfall. Thus, the WF reference of a food expresses a tendency, not an exact value.

The same principle applies to the EPI determination. The values used are references from the literature that were applied to calculate the estimated waste generation. The amount of loss of part of the food can be affected by variables like the input quality, and also other factors such as the types of utensils and the food handler's skills (Strasburg and Jahno, 2016).

3. Results and Discussion

The results of Table 2 highlight that the seasons with the highest and lowest number of meals were respectively winter and summer. Summer is often the period when most employees choose to take annual leave from work.

Table 2. Distribution of meals by season. Porto Alegre, 2019.

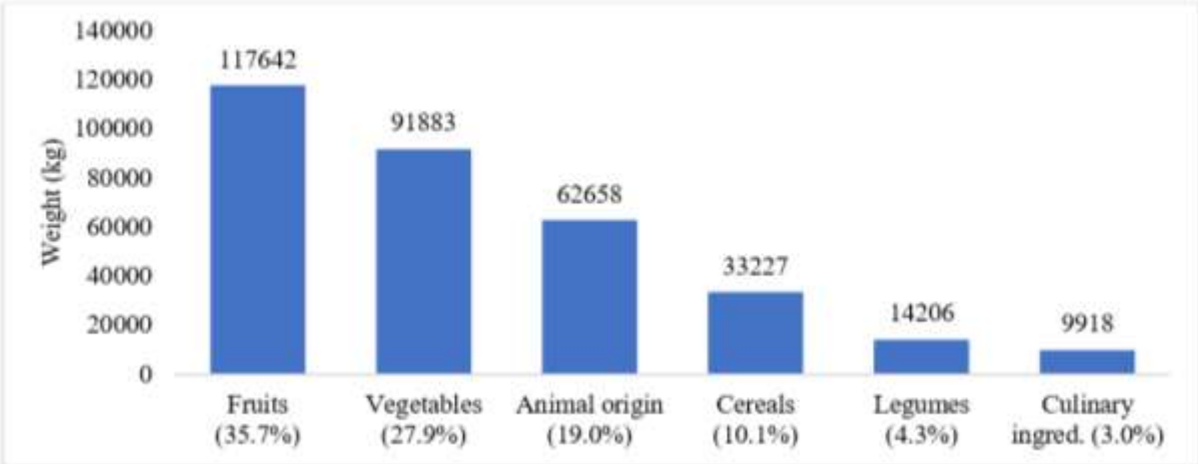
Season	Number of Meals	%
Autumn	108.491	24.9
Winter	111.267	25.6
Spring	109.295	25.1
Summer	106.358	24.4
Total	**435.411**	**100**

Source: Authors.

Figure 2 presents that the Fruits (fresh) and Vegetables are the most consumed input groups - which are used for the preparation of salads and garnishes. These two groups represented 63.6% of the total of purchased inputs. More than three-fourths (77.3%) of the items in the vegetable group were minimally processed vegetables (MPV). Although fruits are used only as dessert, it was found that several users consumed them at mealtime and also took them for later consumption, which justifies the fact that it is the group with the highest quantity acquired.

Animal products included cuts of beef, chicken, pork and fish, as well as eggs and cheese. The items in this group represent the third largest quantity acquired (19%), however in financial terms, they are the ones with the greatest impact.

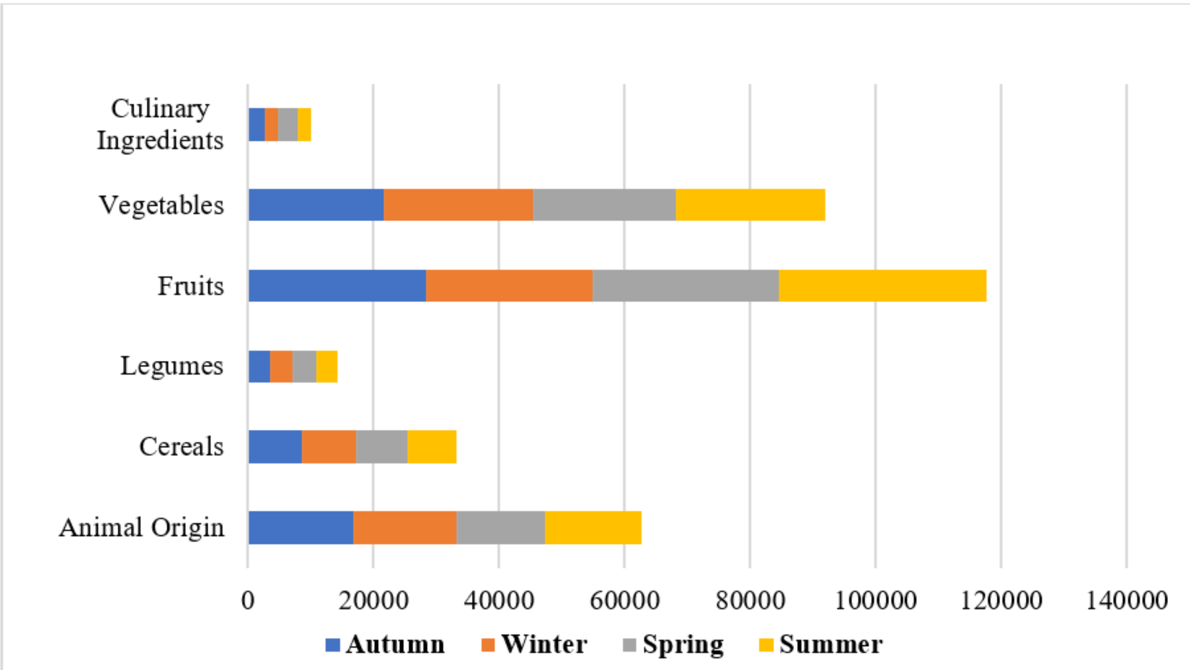
Figure 2. Quantities and percentage distribution of the different groups of inputs.



Source: Authors.

The products of the groups of cereals and legumes (14.4%) are used to prepare the daily basic dish of Brazilians: rice and beans. In the group of cereals in addition to the types of rice (used daily), were also included varieties of flours (wheat and corn) and pasta used in the preparation of some garnishes. Culinary ingredients used include soybean oil and tomato extract, which are used for cooking food and preparing sauces. Figure 3 and Table 3 show the distribution of food groups according to the acquisition in each season of the year.

Figure 3. Distribution of raw materials by season (in kg).



Source: Authors.

Table 3. Percentage distribution of different food groups by season.

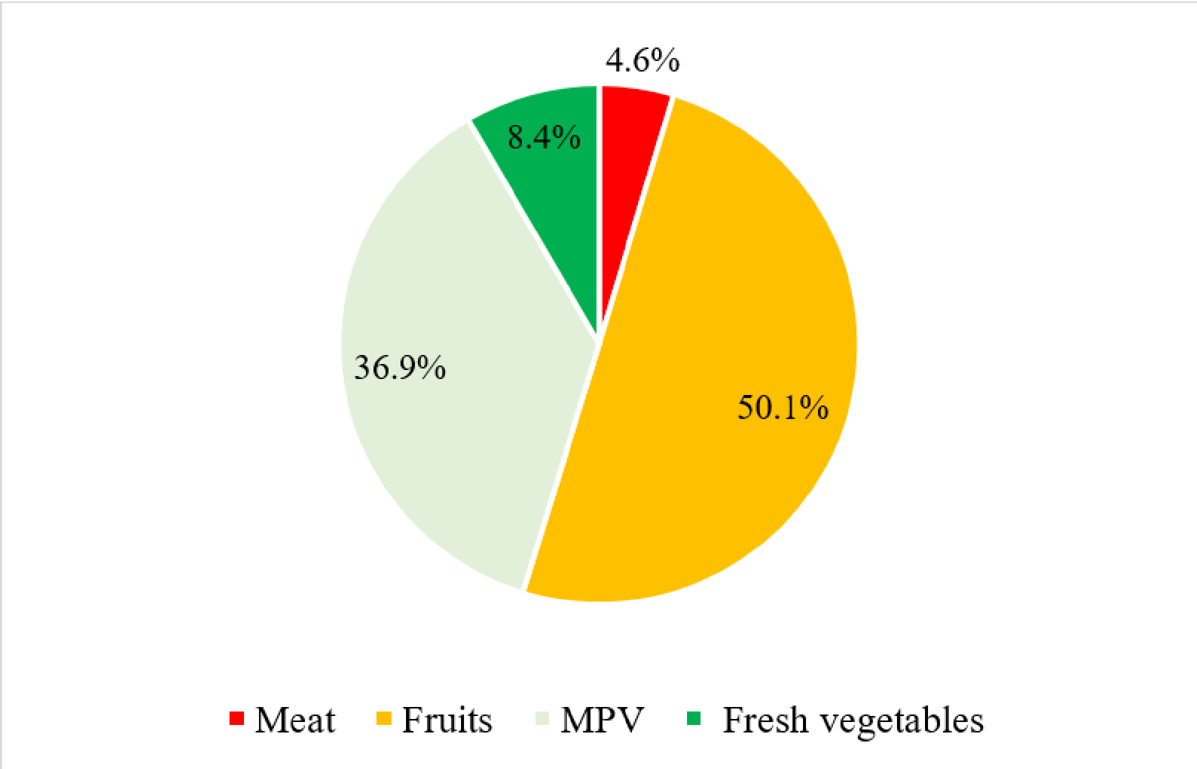
Season	Animal origin	Cereals	Legumes	Fruits	Vegetables	Culinary ingredients
Autumn	26.9	25.6	24.3	24.1	23.5	26,2
Winter	26.0	26.4	25.6	22.5	25.8	22.5
Spring	22.7	24.6	26.7	25.4	24.8	31.8
Summer	24.5	23.4	23.4	28.1	25.8	19.5
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Authors.

Generation of waste

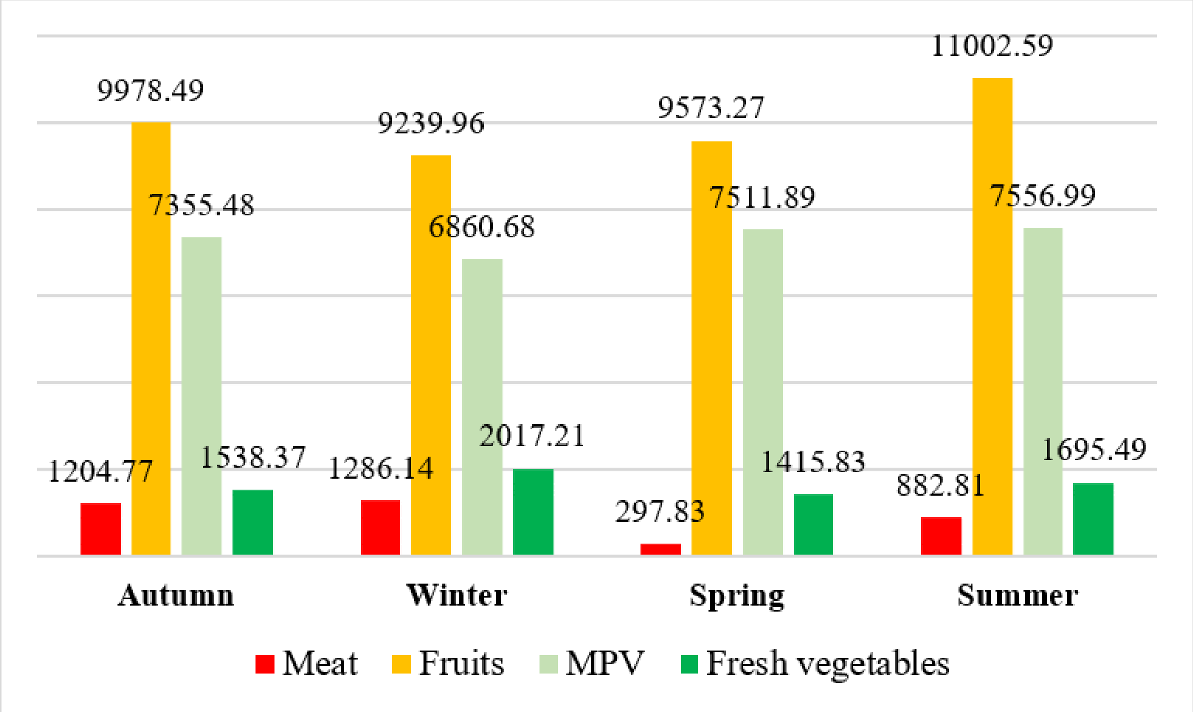
In foodservices, especially the use of fruits and vegetables generates waste due to the unusable parts of the food. At the investigated site, the estimated generation of waste was calculated from these items, as well as from cuts of meat with bones (which also have inedible parts). The waste generation from these items is shown for the year studied (Figure 4) and by season (Figure 5).

Figure 4. Percentage distribution of waste generation by food group.



Source: Authors.

Figure 5. Generation of waste (kg) by food group and season.



Source: Authors.

The fruit group generated the most waste (33.8%) of total of residues in relation to the acquisition of inputs (Figure 2). This value is due to the fact that all fruits are purchased fresh, which requires the peeling and removal of inedible parts. Out of the fruits that were analyzed in this study (n= 9), four (bananas, oranges, apples and papayas) were used year-round, while the others (plum, watermelon, peach, melon and tangerine) were seasonal.

Regarding waste, two different situations should be highlighted for the vegetable group. Most items (n = 14) corresponded to 77.3% of the quantity in kg used for meals. Such items were classified as MPV, thus not requiring peeling or cleaning in the foodservices. The value included in this calculation considered the estimate of residues that would be generated in the service in case the raw materials were acquired fresh (as specified in the methodology inclusion criteria section). The fresh vegetables acquired and classified in this study were only six items (zucchini, cucumber, peppers, radish, cabbage and tomatoes) and of these, only tomatoes and cabbage were used more frequently (12 and 8 times respectively). Fresh products represented 18.5% of the total waste estimated by the vegetable group.

Regarding fruits, the results of this study are similar to those found by Melo and Strasburg (2020), which was conducted in another public hospital, also in Porto Alegre. The inputs used were also similar in relation to the frequency of use in the monthly menus. Besides that, the authors identified that if the hospital were to buy all vegetables items fresh, 25.6% more raw materials would be needed per year (Melo & Strasburg, 2020). Menezes et al., (2020) observed in their work that there was an increase of 246.2% in the acquisition of MPV in restaurants of a public university in a period of five years. According to their study, 22.2% more raw materials would be necessary if all vegetables were purchased fresh.

Foodservices cause environmental impacts, especially due to the use of large amounts of water and energy, and also the generation of solid waste, mostly when fresh fruits and vegetables are used (Abreu & Spinelli, 2016; Almeida et al., 2015). In this sense, it is necessary to constantly monitor these actions. Strasburg and Jahno (2017c) proposed a verification checklist to assess the impacts and conditions of the facilities related to the meal production environment.

In a study in an institutional restaurant in Brazil, the authors identified that 55.2% of organic waste generation occurred in the preparation of meals and another 39% in distribution to users (Araújo & Carvalho, 2015). According to Van Waning (2010), food waste represented 60.3% of the total generation of waste from hotel and restaurant services.

In the study by Principato et al., (2018) with 127 restaurants in two touristic regions of Italy, the managers of the establishments reported that the most generated waste in the kitchens was bread, raw vegetables and fruits. From another perspective, Wang et al., (2017) found that vegetables were the greatest part of the plate waste (29%) generated by diners of Chinese restaurants.

One of the aspects that corroborates for which foodservices acquired MPV is the fact that in restaurants with a higher production of meals, employees do not always take due care when peeling and cutting food, neglecting parts that could be used, and with that, may be increase the amount of waste generated (Papargyropolou et al., 2019).

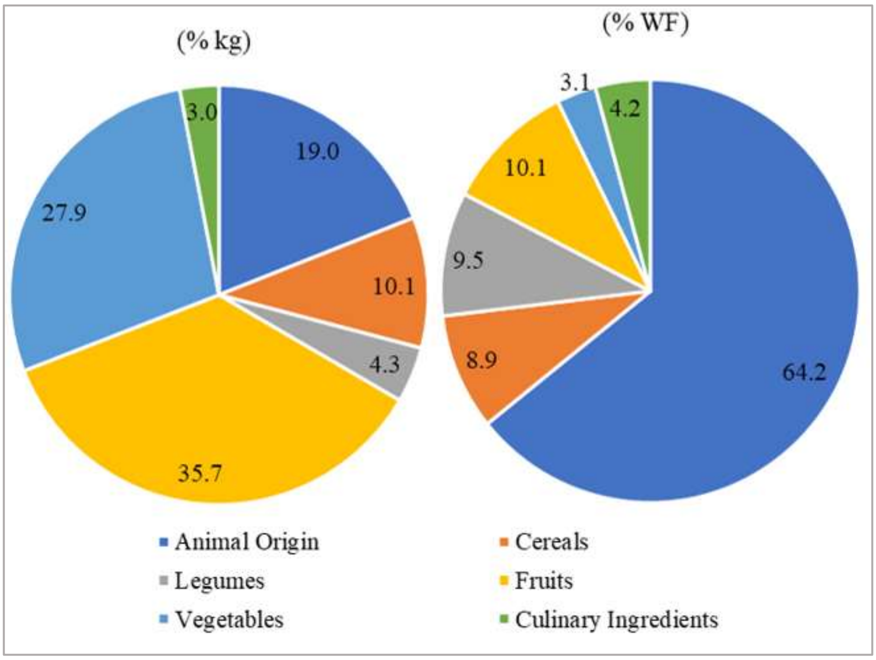
As in foodservices, at home, fresh fruit and vegetable scraps were the most common waste reported by consumers in Uruguay (Aschemann-Witzel et al., 2019) and in Canada (von Massow et al., 2019). In the Netherlands, van Dooren et al., (2019) reported that household waste from fruits and vegetables is as high as 50%, and in Hong Kong, fruits represent 50% of waste and vegetables another 20% (Zan et al., 2018). A survey on food consumption habits conducted with 1,764 families in Brazil showed a *per capita* waste of 114 grams per day. This study also presented that the the most wasted foods were rice (22%), beef (20%), beans (16%) and chicken (15%); while vegetables and fruits had the same percentage: 4% each (Porpino et al., 2018).

In a broader view, waste causes environmental impacts, especially if disposed inappropriately. Its decomposition will generate emissions of methane, a powerful greenhouse gas (GHG). De Laurentiis et al., (2017) highlighted that food waste is one of the main elements that influence GHG emissions.

Water Footprint

In Figure 6 are presented, by food group, the proportion and the annual results of Water Footprint, while in Figure 7 can be observed a comparison between food groups by the seasons.

Figure 6. Ratio of kg and WF by food groups.



Source: Authors.

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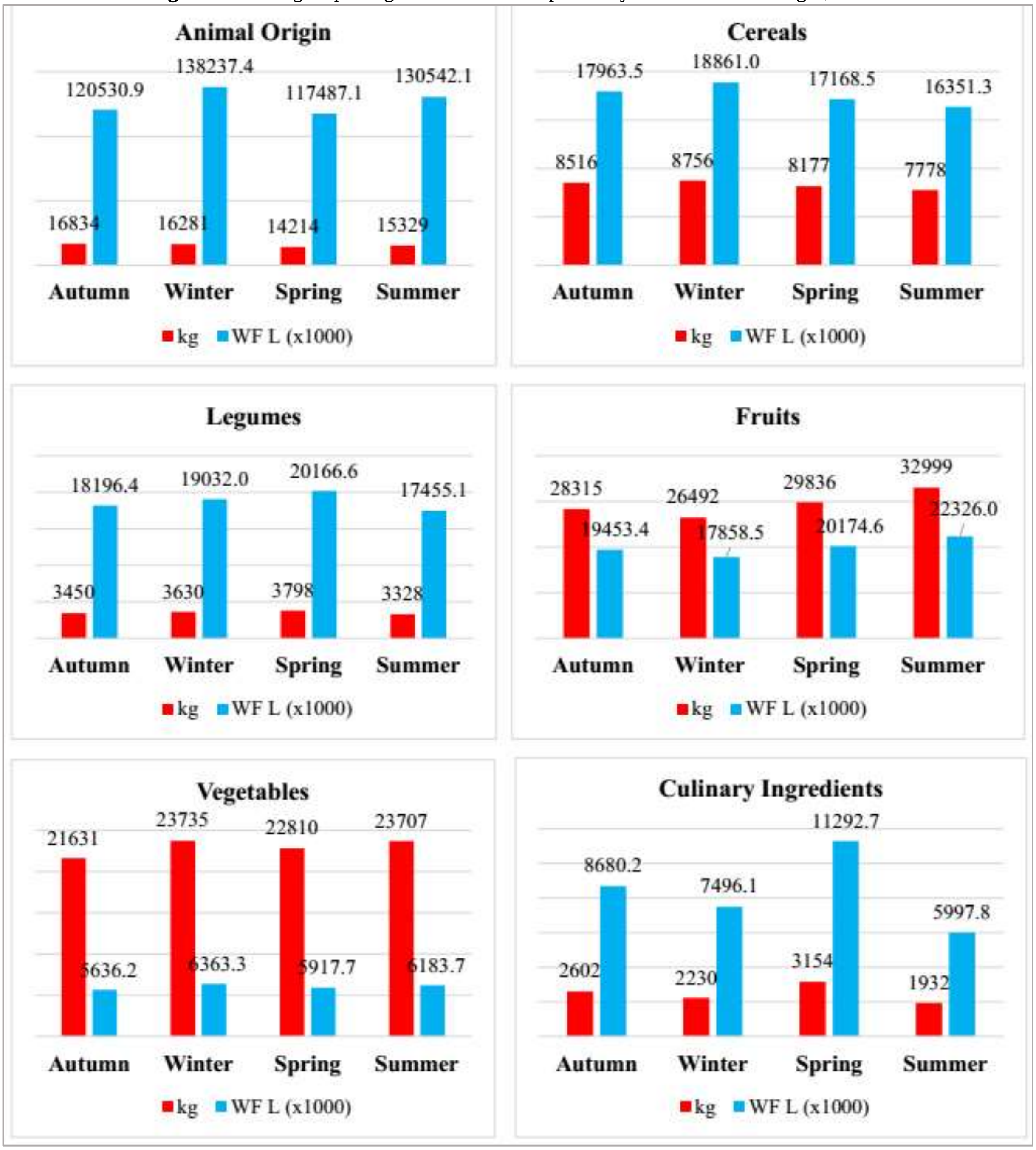
Figure 7. Food group weight and water footprint* by season. Porto Alegre, 2019.



*The WF values expressed in the figures should be multiplied by 1000. Source: Authors.

From the figures presented, the inverse relationship between animal and plant products is highlighted. Five of the six groups evaluated contain plant origin products in their composition. Quantitatively, these groups represent 81% of the total inputs in kg, but in relation to WF, only 35.8%.

Similarity between the weight and WF of the food groups was also identified considering the seasons. It should also be noted that, among all products of plant origin, the fruits and vegetables groups have an inverse relationship between their weight and WF.

The application of the Kruskal-Wallis test showed that there was no difference between seasons for any of the food groups in terms of quantity and WF as shown in Table 4.

Table 4. Kruskal-Wallis test P values for comparison between seasons for each food group. Porto Alegre, 2019.

Food Group	kg	PH
Animal origin	0.587	0.734
Cereals	0.668	0.724
Legumes	0.916	0.916
Fruits	0.101	0.252
Vegetables	0.700	0.784
Culinary ingredients	0.763	0.763

Source: Authors.

The per capita distribution of each food group by season is described in Table 5.

Table 5. *Per capita* assessment by season. Porto Alegre, 2019.

Food Group	AUT	WIN	SPR	SUM	%
Animal Origin (kg)	0.155	0.146	0.130	0.144	19.0
Cereals (kg)	0.078	0.079	0.075	0.073	10.1
Legumes (kg)	0.032	0.033	0.035	0.031	4.3
Fruits (kg)	0.261	0.238	0.273	0.310	35.7
Vegetables (kg)	0.199	0.213	0.209	0.223	27.9
Culinary ingredients (kg)	0.024	0.020	0.029	0.018	3.0
Total (kg)	**0.750**	**0.729**	**0.750**	**0.800**	**100.0**
Food Group	**AUT**	**WIN**	**SPR**	**SUM**	**%**
Animal Origin (WF)	1.111	1.242	1.075	1.227	63.8
Cereals (WF)	0.166	0.170	0.157	0.154	9.1
Legumes (WF)	0.168	0.171	0.185	0.164	9.7
Fruits (WF)	0.179	0.161	0.185	0.210	9.8
Vegetables (WF)	0.052	0.057	0.054	0.058	3.0
Culinary ingredients (WF)	0.080	0.067	0.103	0.056	4.6
Total (WF)	**1.756**	**1.868**	**1.759**	**1.870**	**100.0**

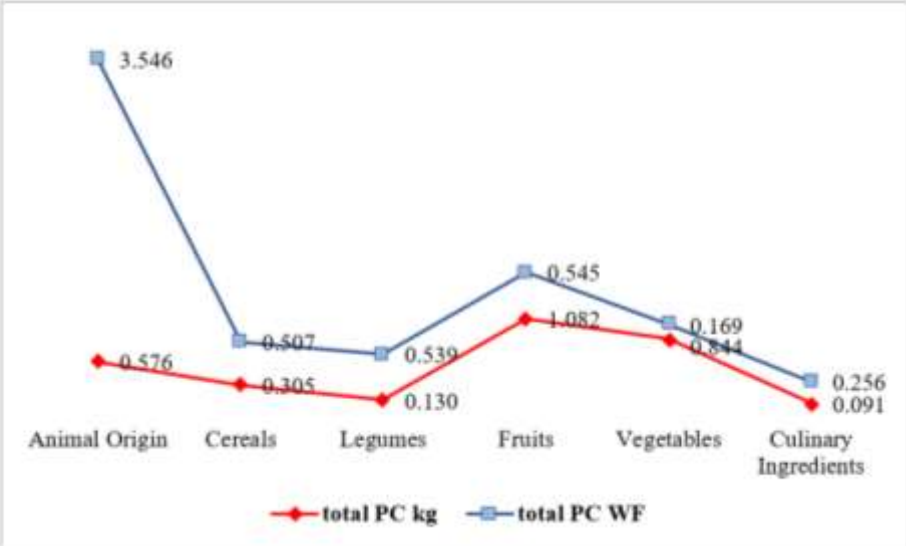
AUT= Autumn; WIN= Winter; SPR= Spring; SUM= Summer. Source: Authors.

Despite the fact that the highest amount *per capita* of meats occurred in the autumn, it was in the winter that the highest WF value was observed, which was identified to be due to the greater use of beef. In Brazil, the state of Rio Grande do Sul (which borders Uruguay and Argentina) has the consumption of beef as a strong cultural habit, being the main source of animal protein (Strasburg & Jahno, 2017b). It should be noted that for the production of one kilogram of beef, a total of more than 15 thousand liters of water is estimated (Mekonnen & Hoekstra, 2012). Figure 8 shows the WF per capita by food group.

Strasburg and Jahno (2015) when evaluating the WF of the monthly menu at a university restaurant in southern Brazil, identified that the WF of animal products was 77.9% of the total, however, although they represented 34.5 % of the total in kg. Hatjiathanassiadou et al., (2019) who evaluated two types of menus offered at a university restaurant found a daily WF of 2,752.4 L *per capita* in the composition of traditional lunch menus (meat, cereal, legumes, garnish, salad and dessert), which was 2.47 times greater than the vegetarian menu (without animal protein) meal.

Furthermore, Aleksandrowicz et al., (2016) showed in their study that the smaller the amount of animal foods in the diet, the smaller the impact in relation to GHG emissions, land use and energy demand. Bengtsson, et al., (2019) also highlight extensive land use and energy demand, loss of biodiversity, excess nitrogen, water use and carbon footprint as some of the negative impacts of animal food consumption, endorsing the fact that these foods cause much more impact on the environment than the production of plant foods. In general, food production accounts for 26% of global GHG emissions; agriculture consumes 70% of the total fresh water in the world and the production of food for livestock is responsible for the use of 77% of agricultural land (Ritchie & Roser, 2020).

Figure 8. Annual *per capita* consumption and water footprint for each food group.



*PC = *Per Capita* consumption. Source: Authors.

For Aleksandrowicz et al., (2016), the production of food of animal origin is, under the evaluation of several environmental indicators, more adverse to the environment than the production of food of vegetable origin. Hölker et al., (2019) support the need to considerably reduce the consumption of food of animal origin for reasons involving animal welfare, human health and environmental issues, and Macdiarmid et al., (2016) highlight that reducing meat consumption is a fundamental factor to produce more sustainable diets.

Willet et al., (2019) propose that this reduction should be 50-75% of current consumption in developed countries. In a study of the projection of future scenarios for Earth in 2050, Ercin and Hoekstra (2014) suggest that changes in consumption patterns – including food – are necessary to reduce the impact of WF to levels considered sustainable. Still in relation to the current food production system, other authors (Steffen et al., 2015; Willett et al., 2019) state that if no changes take place by the year of 2050, there will be a series of problems for the planet related to increased GHG emissions, the use of agricultural land and fresh water consumption.

4. Final Considerations

Important environmental impacts are linked to the meal production segment, especially regarding the generation of waste and water footprint. In the results of this study, the generation of residues from inedible parts of food, especially fruits, stands out. It was identified that, in the summer, the amount of the fruit group, and consequently, waste, was higher despite that being the season that had the lowest frequency of diners.

Similarly, the WF impact of animal products should be highlighted. Although the items in this group represent less than 20% of the total acquisition of food inputs, their WF was 64.2% of the total (being higher in the winter). The remaining five groups evaluated were composed of items of plant origin and had a WF of 35.8%.

A little variety of inputs were observed be used, and so were the environmental impacts in the study site. The critical evaluation of the results may serve as an instrument for change at the study site for reevaluation of the practices and development of action regarding environmental impacts in users' meal supply.

It is emphatic that this study's findings should impact the management of foodservices to reflect on constantly evaluating menu planning and composition, considering aspects such as user frequency, season's climate conditions and peculiarities, and raw-material selection.

Therefore, studies of this nature may be used by services in the food production and food supply segment for not only evaluation, but also for developing interventions for the reduction of environmental impacts.

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