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DOI: 10.12957/demetra.2020.37978

DEMETRA
Alimentação, Nutrição & Saúde

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Proposal for reuse of water for the pre-preparation of fruit and vegetables and the sanitization of dishes and flatware in a university restaurant in the state of Rio de Janeiro

Proposta de reuso da água utilizada no pré-preparo de hortifrutigranjeiros e na higienização de pratos e talheres em um restaurante universitário no Estado do Rio de Janeiro

Abstract

Objective: The aim of the present study was to propose the reuse of water in a university restaurant in the state of Rio de Janeiro, as well as measures to reduce consumption. ***Methods***: A form was applied to quantify water consumption during the pre-preparation of fresh produce and the sanitization of dishes and flatware, within a period of 9 and 13 days, respectively. Later, the volume of potable water used daily was estimated in liters. ***Results:*** The estimated volume of water used per day was 2.400 liters for pre-preparation of fresh produce and 478 liters of water per day for sanitization of dishes and flatware. Thus, a total volume of 2.878 liters of water per day for non-potable reuse was estimated, such as, for example, for the sanitization of the dining hall floor of the restaurant. In addition, the quantification of water points for possible installation of faucet aerators was made aiming to reduce consumption. Next, a project of the storage container for the reuse of water was developed. ***Conclusion:*** It may be concluded that the importance of the proposal is related to the significant quantity of daily wasted water that could be reused and thus, contribute to environmental preservation and decrease the water expenses of the university restaurant.

Keywords: Environmental Administration. Wastewater Use. Water Consumption. Quality Management.

Resumo

Objetivo: O presente estudo teve como objetivo elaborar uma proposta para o reuso de água em um restaurante universitário no Estado do Rio de Janeiro, além de propor medidas para redução do seu consumo. ***Metodologia***: Foi aplicado um formulário para quantificação do consumo de água nas etapas de pré-preparo de hortifrutigranjeiros e na higienização de pratos e talheres, em um período de 9 e 13 dias, respectivamente. Em seguida, foi estimado o volume, em litros, de água potável utilizado diariamente em cada etapa. ***Resultados***: Na etapa de pré-preparo de hortifrutigranjeiros, calculou-se que são utilizados 2.400 litros por dia; e na etapa de higienização de pratos e talheres, estimou-se o uso de 478 litros por dia. Desta forma, pôde-se calcular o volume total de 2.878 litros por dia que ficarão armazenados para o reuso com fins não potáveis, como por exemplo, a higienização do piso dos refeitórios do restaurante, o que representa 31,97% da quantidade necessária para limpeza de todo o restaurante universitário. Além disso, realizou-se a quantificação dos pontos de água

para possível instalação de arejadores nas torneiras, no intuito de reduzir o consumo. Em seguida, elaborou-se o projeto do reservatório de água para reuso. ***Conclusão:*** Por fim, atestou-se a importância da proposta apresentada, tendo em vista a significativa quantidade de água com possibilidade de reuso que é desperdiçada diariamente, contribuindo-se assim com a preservação ambiental e diminuição dos custos do restaurante universitário.

Palavras-chave: Gestão Ambiental. Água de Reuso. Consumo Hídrico. Gestão de Qualidade.

INTRODUCTION

The fast pace of industrialization and the concentration of population groups in urban areas has had a profound impact on the environment, both physical, economic, and social. Environmental concern is relevant to the quality of life of the population and thus, companies have been required to adopt different procedures regarding their interaction with the environment.[1]

Environmental management can be defined as managing the environment, whether in workplaces or factories, domestic environment or in broader contexts, such as neighborhoods, cities, or regions. Because environmental management is a common good, it is a task for society.[2]

The meal production system is complex. According to the American Dietetic Association (ADA), to encourage environmentally responsible practices, natural resources must be preserved, and the amount of waste generated in the food production, transformation, distribution, access and consumption must be reduced.[3]

According to the United Nations Environment Program,[4] water, as a natural resource, has been a challenge in different local, regional, and global regions. It is noteworthy that the use of water is related to economic growth and geopolitics. In recent years, water has become a strategic issue for companies worldwide due to the growing concern regarding water scarcity or the lack of access to it to fulfill basic human needs, the degraded ecosystem, and the implications of climate change on the hydrological cycle.

There are more economical ways of using water through recirculation or recycling in industries, which means making a new use for this resource, when quality is adequate. For example, recycled water can be used for equipment cooling, cleaning of facilities and sanitary discharge. Recycled water can also be used to produce metals, in tanneries, and in textile, chemical and paper industries.[5]

According to Article 27 of Resolution No. 430/2011,[6]

> [...] potentially or effectively polluting activities of the water resources should seek effluent management systems for the efficient use of water, application of techniques for generating and improving the quality of generated effluents and, whenever possible and appropriate, the reuse of water.[7]

Recycling or reuse involves the return of processed materials and input and, thus, transformed into the process that originated them or into another process, located within the same plant. However, these changes may require technological changes to be viable. In Brazil, there are experiences of water reuse by modifying facilities to close the water circuit and thus provide consumption savings.[8]

The reuse of water is the use of previously used water once or more times from any activity to supply the needs of other uses.[9] Graywaters have the greatest potential for reuse, since they can reduce demand in public systems.[10]

The following steps are necessary for the development of Preservation Plans and Water Reuse (PCRA) for the adequate adaptations of different types of industries: survey and data compilation; identifying options for demand management and optimization of water use; determining the potential for water reuse; and using rainwater.[11]

According to Fiori et al.,[12] graywater destined for reuse are considered domestic effluents, which do not include wastewater from sanitary sources, that come from bathtubs, showers, washbasins, washing machines and kitchen sinks in homes, commercial offices, schools, among others.

Reused graywater is part of nonpotable reuse that may be used for agricultural, industrial, domestic, recreational purposes, flow maintenance and aquaculture. Domestic (irrigation of residential gardens, washing of vehicles and of impermeable areas, toilet flushing) and agricultural reuse are noteworthy.[13]

Reused water for nonpotable use is common in countries such as Japan, USA, Canada, Germany, United Kingdom and Israel.[14] If the water is properly treated, it has a great potential for nonpotable reuse. Unlike rainwater, in which the volume produced directly depends on the region's rainfall, graywater results from the use of potable water in buildings, and it is easy to measure supply, collection and use.[15]

Eriksson et al.[16] claim that the system of graywater reuse is related to the following advantages: it encourages the rational use and conservation of potable water; allows maximization of the water supply and sewage treatment infrastructure due to the multiple use of reduced water; and provides environmental education. According to the above, reused water can be used in activities such as floor cleaning and in sanitary facilities of employees and users of university restaurants (UR). The UR provide meals for the academic community (students, teachers, civil servants), as well as to visitors to federal universities. It should be noted that the cost of the meal is different for each type of person served at the university restaurant.

Due to the scarcity of water resources on our planet, the development of strategies to minimize the use of water can promote sustainability and encourage environmental education when these concepts are disseminated among the academic community of the university.

The aim of the present study was to quantify the water available for reuse in a university restaurant located in the state of Rio de Janeiro and to prepare a proposal for the construction of water reservoirs, including the system required for collection, filtration and pumping, as well as the installation of faucet aerators.

MATERIAL AND METHODS

The research method used in the present study is quantitative, observational, descriptive, exploratory, and propositional.

The exploratory research refers to the empirical aspect on operational and environmental management of the productive process of meals, focusing on the interpretation of the reality of the reuse of water, observation of the productive process of meals, and procedures adopted.

The descriptive study aims to describe the characteristics of a given population or phenomenon and establish relationships between variables and standardized data collection techniques will be used.[17]

The research included both investigative and propositional phases. Thus, the methodology adopted was composed of the following steps:

- Fieldwork in a UR in the state of Rio de Janeiro that has an average daily production of 7,500 meals (lunch and dinner).
- A form prepared by the authors of the study was used to quantify the water used for cleaning dishes and flatware and pre-preparation of fresh produce. The form recorded the type of use, volume of compartments, number of cycles and final amount of water used by each dishwasher, as well as the amount of water used in the pre-preparation tanks for fresh produce.
- Water points for the installation of faucet aerators were identified throughout the different stages of the production process of meals and sanitary facilities.

- The survey was conducted in March and April 2018. To calculate water consumption for cleaning dishes and flatware, that is, in dishwashers, the form was used over a period of 13 days, during which the number of complete cycles of dishwashers was quantified. The average number of liters spent, considering the number of meals served on campus during the lunch period, was calculated.
- To calculate water consumption for the pre-preparation of fresh produce, the form was used over a period of nine days, during which the number times the hygiene tanks were filled with water was quantified. For data interpretation, the volume of water used for the pre-preparation was estimated by the difference between the capacity of the tanks and amount of the fresh produce. The amount of fruits and vegetables was based on an average of the different types of vegetables used in menu of the UR. Based on these data, the means were calculated according to the number of meals produced on campus where data collection was carried out, including meals served at the UR and those transported to other places through the university food service.
- Plastic containers and stainless-steel containers used for the pre-preparation of fresh produce were used as reference for quantifying the daily volume of water consumed.
- The tabulation of the data obtained by monitoring food hygiene and water consumption (in liters) was performed. The data was stored in control spreadsheet prepared in Microsoft Excel® 2013 for later descriptive analysis of the data.

From the data collection and their tabulation, an average production of daily meals (lunch and dinner) was calculated that were prepared in the UR studied. It is worth mentioning that the UR has a central kitchen, in which water consumption data were collected from dishwashing machines and tanks for the pre-preparation of fresh produce and has four places where the meals produced are distributed. Therefore, only the data of the sanitization for dishes and flatware in the UR were considered, as it produces all meals and there is a greater amount of meal distribution.

In addition, the average daily consumption of potable water in dishwashers was also estimated, based on the number of times that the complete cleaning cycles occurred daily and the amount of water used in each cycle, taking into account the number of meals, potential for filling dishwashers and the number of times these cycles occurred.

Subsequently, we proposed the building of a water reservoir for storing water from the hygiene and sanitizing stages of fresh produce and water from dishwashers, which cleaned dishes and flatware, as well as a the installation of pipes and channels with a final filtration system of the water from the sanitization stage of fresh produce.

Forms were used to quantify water in liters of the sanitization of plates and flatware (dishwashers) and pre-preparation of fresh produce. The employees responsible for the stages of the production process were trained to quantify water consumption by filling out the forms.

As for the dishwashers, an employee responsible for the washers filled out a form to record whenever they were turned on during the day; thus, it was possible to estimate the amount of liters of water used for the sanitization of dishes and flatware. For fresh produce, forms were used to record the number of times the hygiene tanks were filled up with water. This step of the process was done in tanks of 125L, 200L and/or 50L. Thus, there was a description of the capacity of each tank on the form.

According to the ethical aspects in this research, all those involved were informed about the objectives, stages, and methodology of the study after obtaining institutional consent for the development of the activities planned.

RESULTS AND DISCUSSION

The period of data collection related to the water consumption in the dishwasherswas 13 days, and the main following dishes in the menu were prepared at the UR: Silveirinha's minced meat, Spanish chicken, minced meat in sauce, meat baits, chicken skewers, pork scallop in mustard sauce, chicken with sausage, meat in red wine sauce, dogfish in sauce, sausage and onions, chicken filet in sauce and pork in sauce.

It is noteworthy that the potential for filling dishwashers was considered, as it was observed that, due to the accelerated work routine of employees, some data were sometimes not recorded. It must be pointed out that the racks of the dishwashers were not always filled due to the high demand and reduced work time.

According to the values shown in Table 1, the estimated daily consumption of potable water per capita by dishwashers was 0.1 L.

Table 1. Potable water consumption in dishwashers of a university restaurant located in the city of Niterói-RJ, 2018. Source: the authors

	Daily	*Monthly*	*Anually*
Average of meals per day (lunch and dinner)	4,670	102,740	1,232,880
Total amount of water consumption of dishwashers (L)	478	10,516	126,192

In the pre-preparation of fresh produce, data collection was carried out over a period of nine days, and the produce in the menu prepared by the UR studied that required cleaning and sanitization in the tanks were: broccoli, cabbage, carrots, beets, green beans, chard, tomato, cucumber, cauliflower, cassava and arugula.

Table 2 shows that the per capita consumption of potable water at this stage of the production process was estimated at 0.4L.

Tabela 2. Potable water consumption in pre-preparation of fresh produce in a university restaurant located in the city of Niterói-RJ, 2018. Source: the authors

	Daily	*Monthly*	*Anually*
Average of meals prepared per day (lunch and dinner)	6,584	144,848	1,738,176
Water consumption for the pre-preparation of fresh produce (L)	2,4	52,8	633,6

According to Nascimento,[18] the average consumption for cleaning the kitchen and dining areas was about 3.0L/m²/day. Thus, based on the size of the UR, it was possible to estimate the amount of water needed to clean the entire physical space, including the kitchen and dining hall would be 9,000L/day, taking into account that the UR facility is 3,000m².

According to the means shown in Tables 1 and 2, the amount of daily water with potential for reuse was estimated based on the sanitization stages of dishes and flatware and pre-preparation of fresh produce. Thus, it was possible to calculate the amount of potable water that can be replaced by reused water, which would be 2,878L/day, that would be stored in the reservoir. This proposal for water reuse would be for activities that do not require potable water, such as cleaning the floor of physical areas, such as the dining hall and external areas.

Therefore, the percentage of possible substitution of potable water for reused water, from the pre-preparation areas of fresh produce and dishwasher, for cleaning floors was 31.97%. This water resource would have to be filtered through a system consisting of a retention box and sedimentation of solids, followed by a 50-micron filter (unit of measurement of length that corresponds to the millionth part of the meter).

According to the equipment manufacturer shown in Figure 1, the filter has a medium resin filter for nitrate removal, and the resin is regenerated by backwashing.

Figure 1. Model of reservoir for water reuse for non-potable purposes. Rio de Janeiro, 2018.
Source: http://www.sanearpara.com.br/filtros.htm

This proposal suggests that the size of the lower and upper reservoir should be 3,000L each; therefore, the total storage capacity for surplus would be 6,000L. The pump must have a 2HP (horsepower) metering device to ensure the removal of particles.

The entire system must be connected by piping that allows pumping to the upper reservoir and/or pressurizing the water for cleaning the floor. Water from the network connected to the system could be used to supplement water demand for floor washing.

It is worth noting that, in order to estimate the size of the reservoirs, the amount of water with potential for reuse in all stages of meal production was considered. It is important to point out that, as previously mentioned, reused water will be stored for later nonpotable purposes, such as for cleaning the dining hall.

As shown in Figure 2, the proposal for installing the reservoir for reused water should be carried out in the RU of the campus where the data collection was conducted, where all meal production takes place.

Figure 2. Schematic drawing to exemplify the position of the upper reservoir. Rio de Janeiro, 2018. Source: Adapted from Google Earth.

In this research, the identification and quantification of water points in the UR were carried out in order to propose the installation of faucet aerators to reduce waste. Thus, 40 faucets were identified at all stages of the meal production process (for receiving goods, pre-preparation of meat, pre-preparation of fresh produce, cleaning of utensils, preparation and cooking, cleaning of dishes and flatware, washing hands), in the employees' lavatories, changing rooms, dining halls and two pantry areas for employees.

As a result, it was suggested to purchase 40 faucet aerators, as they are simple corrective measures that can minimize water waste and can be easily installed in the stages of meal production process. Water consumption from faucets is variable, but, according to Albuquerque Neto & De Julio M,[19] the flow can be reduced if aerators are used and water dispersion can be controlled, which would reduce water consumption in 50%.

Much has been said about sustainability; however, practical actions must be implemented. Evidence of the adverse effects caused by humanity on the environment and ecosystems is worrying and, decades ago, it has triggered discussions about the need for a sustainable development model. However, little progress in terms of results has been observed.[20] And, according to the present study, the importance of actions in favor of the environment, considering the amount of water that is wasted daily and that could be reused for less noble activities, such as, for example, floor cleaning of the dining halls, as well as the installation of faucet aerators, are easily implemented and effective measures for water reduction.

According to Pospischek, Spinelli & Matias,[21] regarding environmental management, it is important to raise awareness of those who work in the UR. The quality in this sector is not restricted to healthy, hygienic, and sanitary meals; its scope is much greater, and it involves several factors, including socio-environmental responsibility. Thus, it is important that employees understand attitudes related to sustainability. As Laranjeira & Rodrigues state,[22] one can discuss sustainability with all age groups, as long as it starts with the daily lives of people and the community.

Araújo & Carvalho[23] also highlighted the impact of sustainable actions regarding financial aspect. The purpose of this study is to promote water reduction and expenses, as these are directly connected. When water waste is reduced through reuse, storage and faucet aerators, expenses are reduced.

According to Oliveira, Silva & Carneiro,[24] water reuse is a viable alternative for saving water resources, conserving available resources; the environmental advantages will occur in the long term, as it will benefit the environment and the living beings who interact in it, as well as future generations.

Therefore, the application of the proposal can be considered of utmost importance, considering the advantages presented, both for expense reduction and environmental preservation.

CONCLUSION

Water reuse is considered a current and relevant topic. According to the activities carried out and discussed, there is a significant amount of water with potential for reuse in the university restaurant studied. An average of 2,878 liters of water is wasted per day, representing 31.97% of the amount of water needed for daily cleaning the entire physical area. In this sense, a monthly estimate of 57,560 liters of water could be reused in approximately 20 days.

There are advantages, both economic and sustainable, if the proposal in this research was to be implemented. Potable water would be saved, and water waste would be optimized, considering that it can be used to clean the dining hall floors (non-noble use). It is also worth noting that there would be a possible reduction in UR expenses regarding the water bill.

It is noteworthy that water is a finite natural resource on our planet, and attitudes to save it must begin somewhere somehow. Environmental management must be considered in the meal production process and UR managers and employees should reflect on the implementation of water reuse. Thus, water waste would be minimized, contributing to environmental preservation, as well as reducing UR expenses.

The decision making of managers regarding sustainability interferes directly and indirectly in society and in the lives of employees, as it generates awareness among them. Thus, it would reduce negative environmental impacts, not only in the workplace, but also in the daily routine at their homes.

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Contributors

Gomes NBL, Carvalho LR and Lourenço MS contributed to all the stages of the manuscript since the conception of the study to the revision of the final version; MR Cavalcanti contributed to the data collection of the study; LV Pontual participated in the study design, data collection, data analysis, data interpretation and writing of the article; JVC Mello participated in the data collection, data analysis and interpretation.

Conflict of Interest: The authors declare no conflict of interest.

Received: September 6, 2019
Accepted: November 10, 2019