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Effects of Treated Greywater on Mineral Contents and Proximate Compositions of Pepper Fruits

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Abstract: *This study investigates the effects of treated greywater on the mineral and proximate compositions of pepper grown in Akure, Nigeria. Greywater was treated using a filtration system including sand and gravels with common reed, to remove contaminants and reduce potential health risks. The treated greywater was then used to irrigate pepper plants. Minerals and proximate analysis were conducted on the fresh pepper fruits. For 2016, 2017 and 2018 dry seasons, samples from treated greywater irrigation plots showed nitrogen (N) values of 0.37, 0.37, and 0.37 mg/kg, phosphorus values of 0.10, 0.19, and 0.11 mg/kg, and potassium values of 129.00, 130.00, and 128.00 mg/kg, respectively. Samples from plots watered with treated greywater also had 2.30, 2.26, and 2.28% protein, 1.36, 1.41, and 1.38% fat, and 2.00, 3.15, and 3.06% carbohydrates in the dry seasons of 2016, 2017, and 2018, respectively, based on the proximate analysis of hot pepper. These also indicate that irrigation with treated greywater can significantly enhance food supplements needed for human growth and does not affect the quality of pepper for human consumption. Notably, no significant accumulation of heavy metals was detected in the fruits. Continued monitoring and optimized treatment processes are recommended to ensure long-term safety.*

Keywords: *Agriculture, Mineral Contents, Pepper Fruits, Proximate Composition, Treated Greywater*

1. INTRODUCTION

Water scarcity is a gradually recurrent issue, principally in arid and semi-arid regions, motivating the investigation of other water sources for maintainable agriculture. One such alternative is the use of greywater, which refers to domestic wastewater primarily from sources like showers, sinks, and laundry, excluding toilet water. Properly treated greywater has revealed very prospective as an additional irrigation source due to its relatively low pathogen load and high nutrient content [1, 2]. Greywater reuse may impact soil fertility and crop quality as well as helps in water conservation. The nutrient-rich composition of treated greywater, especially nitrogen, phosphorus, and potassium, could have valuable effects on vegetal growth and fruit improvement [3]. Concerns have arisen regarding the existence of left over pollutants, for example; salts, surfactants, and heavy metals, which may impact crop health and quality [4]. Peppers are rich in vitamins, principally vitamin C, and minerals such as calcium, magnesium, and potassium, hence they are rich in economic and nutritional value. They include [5]. The fruit's proximate composition is a key contributor to its dietetic value, and this comprised of moisture, ash, crude protein, fat, fiber, and carbs. Similarly, mineral and proximate contents of pepper fruits are subjective by soil and water quality [6]. However, it is important to understand how these features are impacted for evaluating the sustainability of treated greywater irrigation for food crop growth. Some studies, however, have forewarned people on the dangers of plant toxicity and salt accumulations. Others have call attention to the fact that greywater can enrich the absorption of nutrients [1, 7]. It's then critical to balance the advantages and disadvantages of greywater reuse in

agriculture with the intention of doing it safely and sustainably. Even though treated greywater can be a reliable irrigation alternative, pepper quality is also considerably impacted by soil type, treatment amount, and application frequency. Therefore, good supervision and observing are vital to lessen risks and improve crop quality. In order to consider the sustainability of treated greywater irrigation for crop production and food safety, this study examines the effects it has on the nutritional composition and mineral content of pepper fruits.

2. METHODOLOGY

The study was conducted at the Jadesola hostel of the Federal University of Technology, Akure (FUTA), Nigeria. FUTA has a tropical moist climate with two distinctive seasons and is sited in the moist region of Nigeria at latitude 7.3043^0N and longitude 5.1370^0E. The greywater used for the study was obtained from the hostel and treated in a wetland using common reed for sifting and organic processes (Figure 1).

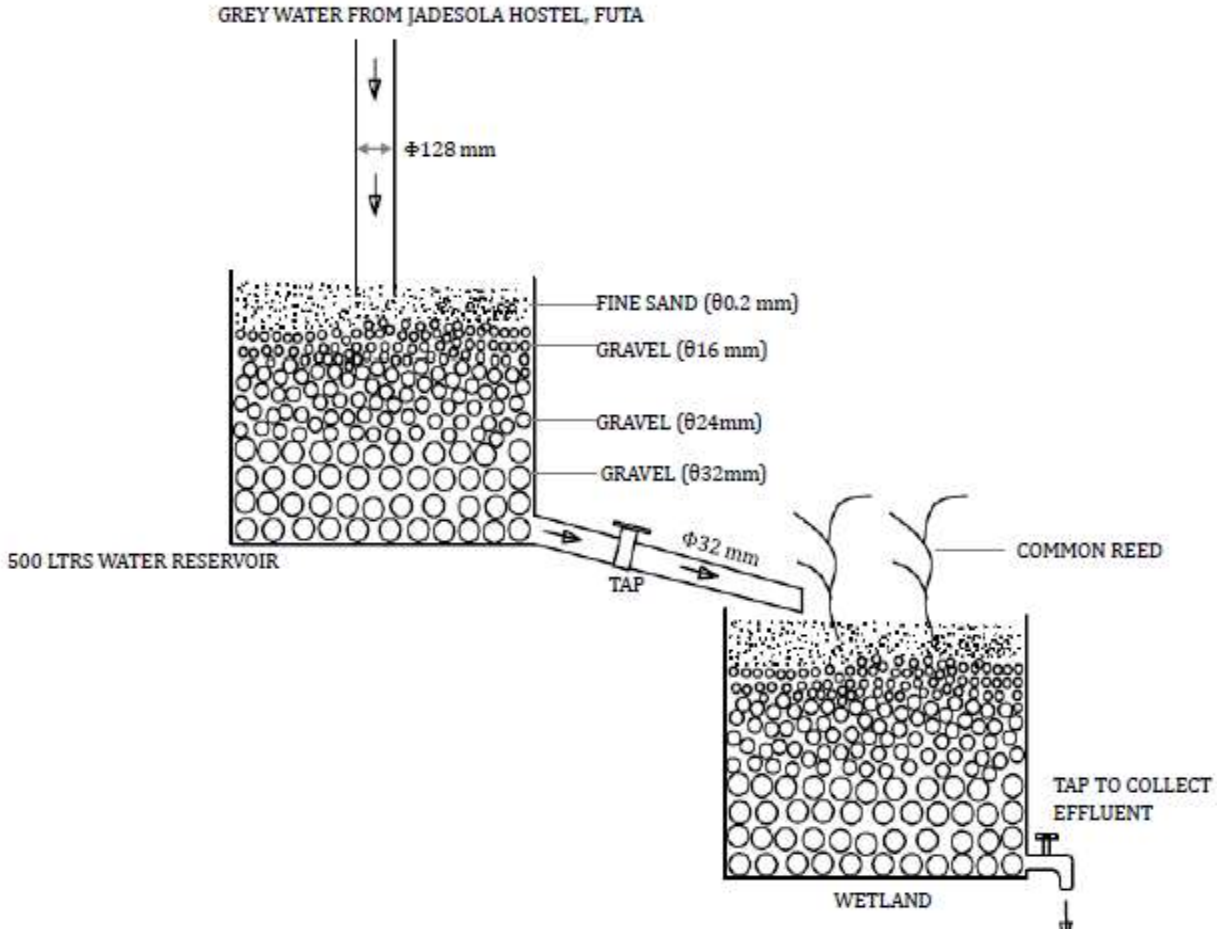
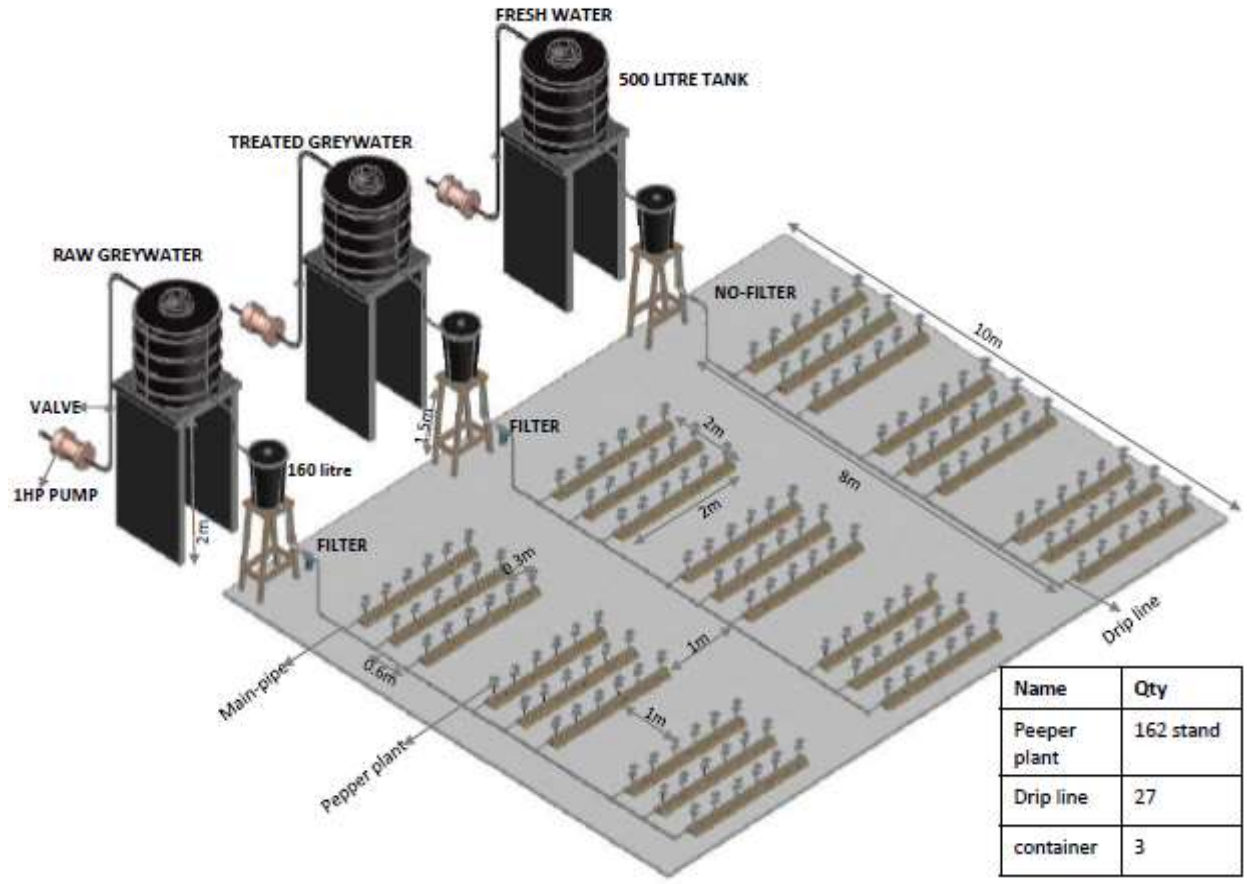


Figure 1: Greywater treatment setup

Field trials were conducted across the dry seasons of 2016, 2017, and 2018. A Randomized Complete Block Design (RCBD) was used for the experiment, incorporating three irrigation treatments and simulated three times. The first treatment involved the use of raw (untreated) greywater, the second used treated greywater, and the third served as a control, receiving clean freshwater for irrigation. The type of irrigation system used was drip irrigation. Each treatment plot was connected to separate supplies (0.16 m^3 capacity reservoirs) placed adjacent to each of the beds at uniform pressure head of 1.5 m. Irrigations were carried out at 1-day interval based on calculation of irrigation interval. The drought-resistant hybrid hot pepper (*Capsicum annuum L.*) variety, AVENIR F1, was purchased from the Agritropic store in Ibadan, Nigeria. The pepper seeds were manually transplanted at a distance of 0.6 m x 0.3 m between stands after being nursed on seedbeds for eight weeks (Figure 2). The matured red pepper at the experimental site was displayed in Figure 3. After pepper fruits were gathered, analysis of variance was performed on the data using Tukey Test (DMRT) at 5% level of significance. For nutrient and proximate analysis, pepper samples were taken from each treatment plots; the nutrient parameters that were examined are nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), and chloride; the proximate parameters that were examined are crude fiber, crude protein, lipid, percentage ash, and carbohydrates. The analysis was conducted at the Chemistry and Analytical Laboratory of the University.



Name	Qty
Peeper plant	162 stand
Drip line	27
container	3

Figure 2: Field experimental layout for planting pepper using different treatment

Figure 3: Red pepper at the experimental field

2. RESULTS AND DISCUSSION

2.1 Macronutrients in Hot Pepper at the Experimental Site

The acceptability of this treated greywater's quality for irrigation in the research area was examined in earlier papers by Alao *et al.* [8]. According to this report, the quality is appropriate for irrigation. Zinc (Zn) values of 2.80, 2.70, and 2.90 mg/kg, copper (Cu) values of 0.11, 0.12, and 0.10 mg/kg, nitrogen (N) values of 0.37, 0.37, and 0.37 mg/kg, phosphorus values of 0.10, 0.19, and 0.11 mg/kg, and potassium values of 129.00, 130.00, and 128.00 mg/kg were found in samples taken from treated greywater irrigation plots during the dry seasons of 2016, 2017, and 2018. The buildup of nutrients in the soil may be the basis of the higher nutrient contents in hot pepper when irrigated with treated greywater, as shown in Table 1. These findings demonstrated that applying treated greywater to agricultural lands improved the nutrients of crops grown and subsequently enriching the soils with nutrients comparable to those found in samples taken from freshwater irrigation plots [9]. Studies by Zavadil [10], Rehman *et al.* [11], and Anwar *et al.* [12] found that vegetables grown in wastewater acquired more heavy metals than vegetables watered with fresh water. These findings run counter to those findings. The prior treatment techniques that the greywater went through before being used for irrigation may be accountable for the declined buildup of heavy metals in the irrigation water. By removing or drastically lowering the concentration of heavy metals, these treatment methods probably improved the quality of the greywater and decreased the possibility that it would contaminate the crop when it was irrigated [13]. Pepper's high potassium content could be utilized to prevent hypertension and other cardiovascular illnesses, and it could be endorsed as a protein supplement in underserved rural areas [12]. The issue of micronutrient deficiencies can be avoided due to the comparatively high amounts of iron, calcium and zinc according to Anwar *et al.* [12].

Table 1: Mineral composition (Nutrients) of hot pepper after harvesting in 2016, 2017 and 2018 at the experimental site

	Samples from treated greywater irrgation plots			**Samples from fresh water irrigation plots**		
Elements (ppm)	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**
Zn	2.80	2.70	2.90	2.90	2.98	3.00
Cu	0.11	0.12	0.10	0.15	0.14	0.16
Fe	27.24	27.14	27.34	26.94	26.84	27.04
N	0.37	0.37	0.37	0.39	0.39	0.39
P	0.10	0.10	0.11	0.11	0.11	0.11
K	129.00	130.00	128.00	217.00	215.00	219.00
Ca	2.60	2.60	2.60	1.70	1.70	1.70
Cl	11.70	11.70	11.80	11.10	11.20	11.10

2.2 Proximate Results of Hot Pepper at the Experimental Site

Results gotten from the proximate analysis of hot pepper samples nurtured during the dry seasons of 2016, 2017 and 2018 showed that the nutritional composition of the crops irrigated with treated greywater revealed steadily higher values across numerous significant nutritional components. Specifically, protein content was chronicled at 2.30% in 2016, considerably decreased to 2.26% in 2017, and rose again to 2.28% in 2018. Fat content followed a like trend, with values of 1.36%, 1.41%, and 1.38% over the three years, respectively. The carbohydrate content indicated more variability, increasing from 2.00% in 2016 to 3.15% in 2017, and then slightly declining to 3.06% in 2018. As shown in Table 2, these results indicate a remarkable improvement in the dietary profile of hot peppers grown with treated greywater likened to those irrigated with freshwater sources. The results is in tandem with the findings by Ashfaq *et al.* [14], that showed an increase in protein, ash, fiber, and carbohydrate levels in fifteen different vegetable varieties which were irrigated with different applications of municipal wastewater. The enhancement experienced in the plots that were irrigated with treated greywater mostly comes from its supplemented composition. The origin of this greywater is from household activities like cooking, bathing, and washing. Consequently, it often comprises advanced levels of dissolved minerals, organic materials, and crucial plant nutrients that may be absent in much reduced amounts in freshwater sources. Including these beneficial compounds in treated greywater ultimately improves plant uptake. This, however, results in better nutrient mixture and buildup in plant tissues, which boosts the output and dietetic quality of crops like hot pepper. In contrast, freshwater is cleaner and generally preferred for irrigation, but it may not provide the same nutrient benefits, especially in soils needing nutrients.

Additionally, this study's results validate those of Gorgich *et al.* [15] and Du *et al.* [16], who reported that the use of treated greywater in agriculture can increase the amount of nutrients in reaped crops. Importantly, this study also shows that the well-being and quality of peppers for human ingestion are unpretentious by the use of treated greywater for irrigation. Essentially, the peppers' improved nutritional value suggests that treated greywater would be a good alternative for irrigation. This is predominantly correct in regions with inadequate freshwater resources and a strong demand for foods that are rich in nutrients. Hence, there may be a chance for maintainable farming and amplified food security over the judicious use of treated greywater

Table 2: Proximate results of hot pepper after harvesting in 2016, 2017 and 2018 dry seasons at the experimental site

	Samples from treated greywater irrigation plots			Samples from fresh water irrigation plots			Deviations		
Composition (%)	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**
Moisture	89.73	89.73	89.73	91.34	90.47	90.35	-1.61	-0.74	-0.62
Ash	1.19	1.13	1.15	0.98	0.99	0.98	+0.21	+0.14	+0.17
Fat	1.36	1.41	1.38	1.24	1.26	1.25	+0.12	+0.15	+0.13
Fibre	2.32	2.43	2.38	2.29	2.32	2.30	+0.03	+0.11	+0.09
Protein	2.30	2.26	2.28	2.28	2.22	2.25	+0.02	+0.04	+0.03
Carbohydrates (CHO)	2.99	3.15	3.06	1.78	2.44	2.05	+1.21	+0.71	+1.01

4. CONCLUSION

This study investigated the effects of treated greywater on the mineral and proximate compositions of pepper grown in Akure, Nigeria. Greywater was treated using a filtration system including sand and gravels with biological method, to remove contaminants and reduce potential health risks. Minerals and proximate analysis were conducted on the fresh pepper fruits after harvesting. It was discovered that for 2016, 2017 and 2018 dry seasons, samples from treated greywater irrigation plots showed zinc (Zn) values of 2.80, 2.70, and 2.90 mg/kg, copper (Cu) values of 0.11, 0.12, and 0.10 mg/kg, nitrogen (N) values of 0.37, 0.37, and 0.37 mg/kg, phosphorus values of 0.10, 0.19, and 0.11 mg/kg, and potassium values of 129.00, 130.00, and 128.00 mg/kg, respectively. Samples from plots watered with treated greywater also had 2.30, 2.26, and 2.28% protein, 1.36, 1.41, and 1.38% fat, and 2.00, 3.15, and 3.06% carbohydrates in the dry seasons of 2016, 2017, and 2018, respectively, based on the proximate analysis of hot pepper. These also indicated that irrigation with treated greywater can significantly enhance food supplements needed for human growth and does not affect the quality of pepper for human consumption. Remarkably, no significant accumulation of heavy metals or harmful pathogens was detected in the fruits. Therefore, continued monitoring and optimized treatment processes are recommended to ensure long-term safety and soil fertility.

REFERENCES

[1] Al-Hamaiedeh, H. D., & Bino, M. (2010). Effect of treated greywater reuse in irrigation on soil and plants. *Desalination*, 256(1-3): 115–119. (https://doi.org/10.1016/j.desal.2010.02.004)

[2] Maimon, A., Tal, A., Friedler, E., & Gross, A. (2010). Safe on-site reuse of greywater for irrigation—a critical review of current guidelines. *Environmental Science & Technology*, 44(9): (https://doi.org/10.1021/es902646g)

[3] Finley, S., Barrington, S., & Lyew, D. (2009). Reuse of domestic greywater for the irrigation of food crops. *Water, Air, and Soil Pollution*, 199(1): 235–245. (https://doi.org/10.1007/s11270-008-9888-4)

[4] Misra, R. K., Sivongxay, A., & Smith, D. (2010). Impact of greywater irrigation on plant growth and soil properties. *Water Practice and Technology*, 5(2), wpt2010041, (https://doi.org/10.2166/wpt.2010.041)

[5] Olatunji, T. L., & Afolayan, A. J. (2019). The suitability of wild and cultivated Capsicum species for food and medicinal applications. *Plants*, 8(1), 31, (https://doi.org/10.3390/plants8010031)

[6] Adeleye, S. A., Ayeni, L. S., & Ojeniyi, S. O. (2014). Effects of organic and NPK fertilizers on soil properties, growth, yield and mineral content of pepper. *Journal of Agricultural Science*, 6(1): 71–78, (https://doi.org/10.5539/jas.v6n1p71)

[7] Qadir, M., Wichelns, D., Raschid-Sally, L., McCornick, P. G., Drechsel, P., Bahri, A., & Minhas, P. S. (2007). Agricultural use of marginal-quality water—Opportunities and challenges. *Advances in Agronomy*, 97: 75–144, (https://doi.org/10.1016/S0065-2113%2807%2900003-2)

[8] Alao, F., Olanipekun, A. A., Oloruntade, A. J., Olofintoye, O. O., Oke, A. M., Idusuyi, D. U., Bayode, O., Saka, Q. O. & Ojewole, D. A. (2025). Suitability of Grey-water Treated with Common Reed in Constructed Wetland for Irrigation Purposes in Akure, Nigeria. *American Journal of Environment and Climate* (AJEC), 4(2): 7 – 14, https://doi.org/10.54536/ajec.v4i2.4503

[9] Ajewole, T. O., Ayesa, A. S., Popoola, K. M., Oluwole, B. R., Aladekoye, D. & Robinson, E. (2022). Effect of effluents (treated and untreated) on the vegetative growth of *Amaranthus cruentus L.* and *Amaranthus hybridus L. Journal of Innovation Science and Technology*, *2*(1): 120 – 130

[10] Zavadil, J. (2009). The effect of municipal wastewater irrigation on the yield and quality of vegetables and crops. *Soil & Water Res.*, 4(3): 91–103

[11] Rehman, K., Ashraf, S., Rashid, U., Ibrahim, M., Hina, S., Iftikhar, T., & Ramzan, S. (2013). Comparison of proximate and heavy metal contents of vegetables grown with fresh and wastewater. *Pak. J. Bot*, *45*(2): 391-400

[12] Anwar, F., Bhutto, M. A., Riaz, S., & Sitara, U. (2022). Rational sewage water utilization and its impact on the proximate and nutritional quality of cabbage (Brassica oleracea L.). *Applied Ecology & Environmental Research*, *20*(6).

[13] Vanmarcke, H., Tuytschaever, T., Everaert, B., De Cuypere, T. & Sampers, I. (2024). Impact of using stored treated municipal wastewater for irrigation on the microbial quality and safety of vegetable crops. *Agricultural Water Management*, *297*, 108842

[14] Ashfaq, A., Khan, Z. I., Arif, M., Abbas, G., Abbas, T., Gatasheh, M. K., & Shah, A. A. (2024). The proximate composition of vegetables enriched by incorporation of municipal solid waste into fertilizers and its impacts on environment and human health. *BMC Plant Biology*, *24*(1), 887. https://doi.org/10.1186/s12870-024-05581-9

[15] Gorgich, M., Mata, T. M., Martins, A., Caetano, N. S. & Formigo, N. (2020). Application of Domestic Greywater for Irrigating Agricultural Products: A brief study. *Energy Reports*, *6*, 811 - 817.

[16] Du, Z., Zhao, S., She, Y., Zhang, Y., Yuan, J., Rahman, S. U. & Li, P. (2022). Effects of different wastewater irrigation on soil properties and vegetable productivity in the North China Plain. *Agriculture*, *12*(8), 1106. https://doi.org/10.3390/agriculture12081106