A GREEN WALL SYSTEM FOR LAUNDRY GREYWATER TREATMENT

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OUTLINE

Water shortage remains an important issue in our society (WHO & UNICEF, 2017). Poor waste management creates large quantities of wastewater, further adding to the global water shortage. Greywater represents approximately 65% of total household wastewater and is a microbiologically less-polluted category of wastewater, consisting of the outflow from sinks, laundry machines, dishwashers, showers and bathtubs (Gorgich et al., 2020; Vuppaladadiyam et al., 2019). The use of vegetated systems offers a cheap and sustainable option for greywater treatment and reuse. During a series of experiments, we tested the efficiency of a green wall system (Figure 1) for laundry greywater treatment.

METHODS

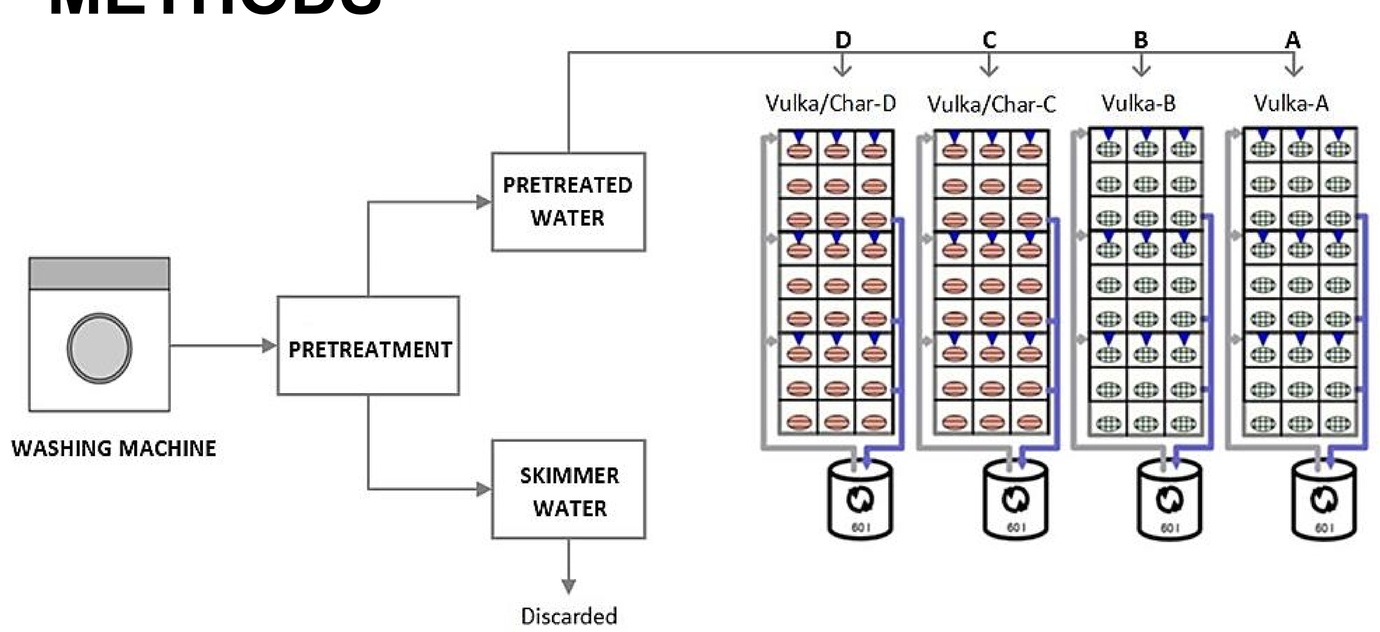

Figure 1: Experiment design

The laundry greywater was treated using the green wall treatment system (Figure 1). The pretreatment consisted of a recirculating sedimentation tank with an included skimmer. The 4 green walls were a modified NatureUP! system (Gardena, Germany) with an adapted top-down irrigation system. They had 2 substrate configurations:

- Walls A and B contained a 100% Vulkaponic substrate (Vulka-AB)
- Walls C and D contained a substrate mixture of 75% Vulkaponic and 25% plant-based Biochar (Vulka/Char-CD)

Water parameters (pH, water temperature, dissolved oxygen and electric conductivity) were measured with a Hach Lange HQ40d Multisonde and turbidity was measured with a Hach Lange 2100Qis Portable Turbidimeter. Water samples were analyzed for chemical oxygen demand (COD) ammonium-nitrogen (NH_4-N), nitrite-nitrogen (NO_2-N), nitrate-nitrogen (NO_3-N) and orthophosphate phosphorus (PO_4-P), using HachLange cuvette tests. Further analysis has been done on the microplastic fiber and microbiological pollutant removal potential.

RESULTS

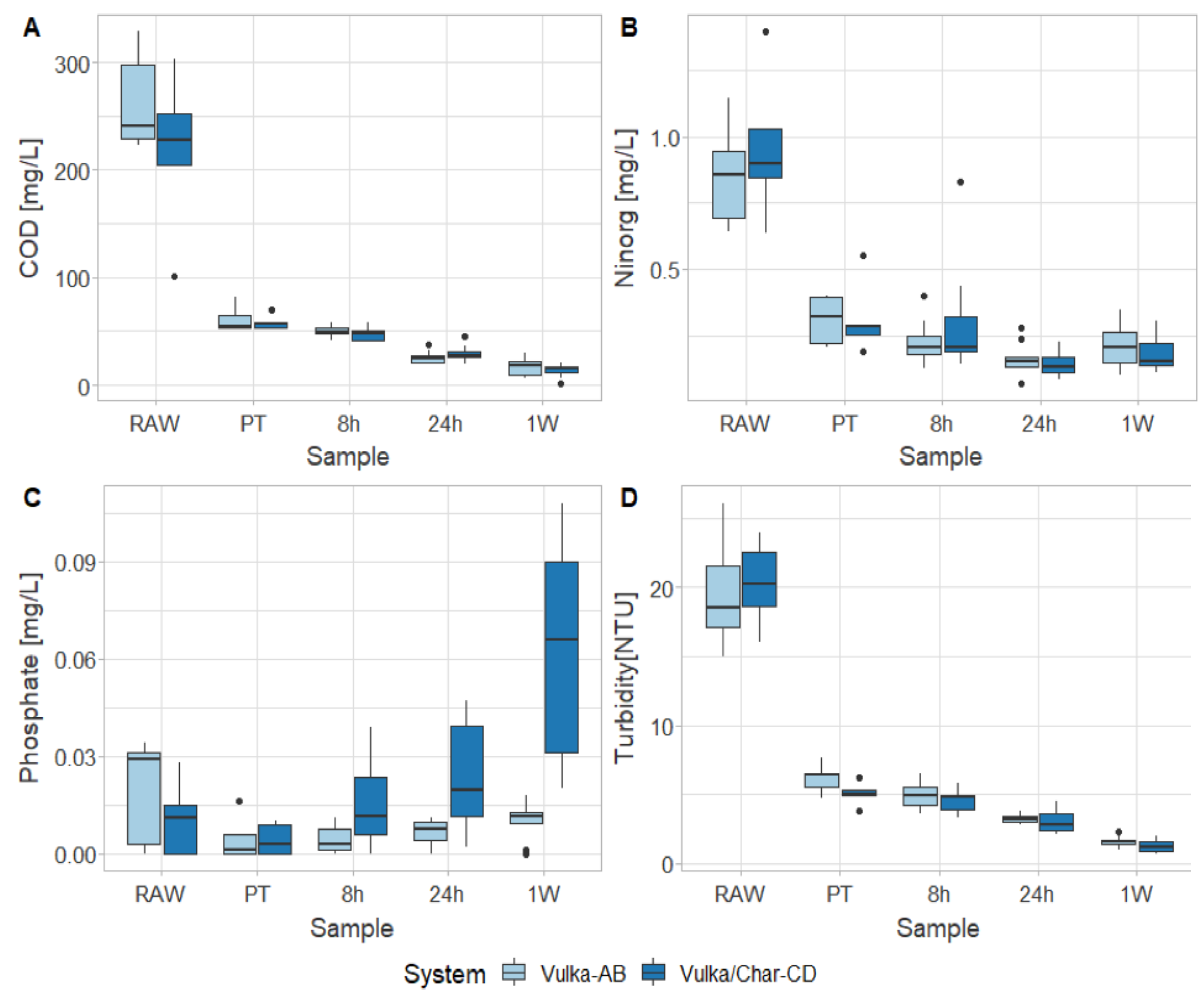

Figure 2: Average COD, N=5 (A); Ninorg, N=5 (B); PO_4-P, N=5 (C) and turbidity, N=5 (D) measured in two different systems (Vulka-AB and Vulka/Char-CD). Measured in raw greywater (RAW), pre-treated greywater (PT), after 8h, 24h and 1 week (1W) of recirculation in the green wall.

Figure 3: Polyester fibers found in laundry greywater

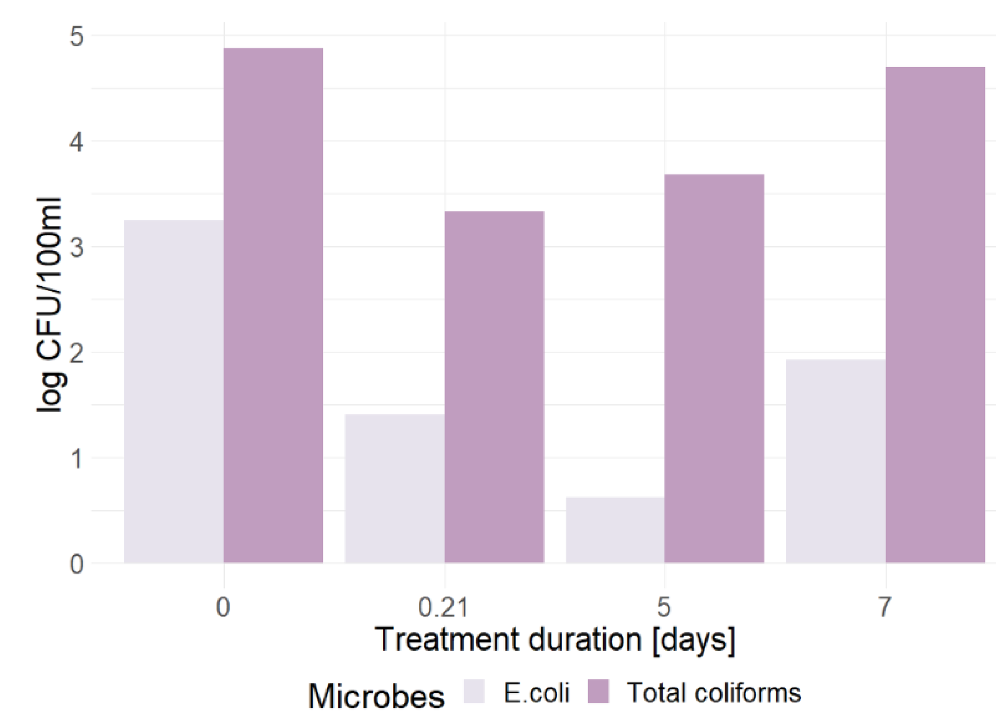

Figure 4: E.coli and total coliforms (log CFU/100ml) measured in greywater treated in a green wall system (Vulka/Char substrate) from raw (0), 5 hours (0.21 days), 5 and 7 days of recirculation

	Vulka-AB				Vulka/Char-CD			
	PT	8h	24h	1w	PT	8h	24h	1w
COD	76,9	81,2	90,4	93,9	73,4	78,0	86,6	93,8
NH4-N	45,1	45,1	51,2	-116,5	75,2	11,8	75,2	70,3
NO2-N	98,2	91,4	94,1	84,2	95,7	88,8	94,7	88,3
NO3-N	63,5	73,7	81,2	78,5	66,5	70,7	85,3	81,8
PO4-P	76,3	78,4	66,5	47,9	59,3	-36,1	-123,1	-477,8
Turbidity	68,6	74,6	83,5	92,0	75,0	77,8	85,1	93,7
Ninorg	64,0	73,6	81,0	74,9	67,3	69,0	85,1	81,6

Table 1: The removal rates (%) of COD, NH_4-N, NO_2-N, NO_3-N, PO_4-P, Turbidity and inorganic nitrogen (N_{inorg}) in systems with two different substrates (Vulka-AB, Vulka/Char-CD). The removal rate was calculated after the pretreatment (PT) of the raw greywater and after 8h, 24h and 1 week of recirculation in the green walls. Negative values indicate the increase of the value.

CONCLUSIONS

The green wall system was effective for the treatment of the laundry greywater, achieving a treatment efficiency of 94% for COD, 80% for Ninorg and 92% for Turbidity.

On the other hand, the PO4-P concentrations increased with prolonged recirculation, especially in the Vulka/Char-CD. This was possibly due to desorption of accumulated PO4-P in the biochar.

According to Kruskal-Wallis wit Post-hoc test ($p<0.05$) the removal of COD, Ninorg and turbidity does not differ significantly between the two different substrates, meaning that both were equally effective in nutrient removal from greywater. Vulkaponic substrate was more effective for PO4 removal.

Later experiments indicated a potential for green wall microbial contamination treatment and microplastic fiber removal. More tests will be done to confirm these findings.

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