



Received: 21 February 2026; Accepted: 23 February 2026; Published: 28 September 2026

**THE QUALITY OF PIG SLAUGHTERHOUSE WASTE TREATED WITH WATER
HYACINTH (*Eichhornia crassipes* (Mart) Solm) IN TERM OF PH AND BOD₅ VALUE**

Maria Vani Guntur¹, I Wayan Suardana^{2*}, Romy Muhammad Dary Mufa²

¹Veterinary Education Student, Faculty of Veterinary Medicine, Udayana University;

²Veterinary Public Health Laboratory, Faculty of Veterinary Medicine, Udayana University;

*Corresponding author: wayan_suardana@unud.ac.id

How to cite: Guntur MV, Suarda IW, Mufa RMD. 2026. The Quality of Pig Slaughterhouse Waste Treated with Water Hyacinth (*Eichhornia crassipes* (Mart.) Solms) in Terms of pH and BOD₅ Values. JVAS, 8(2): 37-45: DOI: <https://doi.org/10.24843/JVAS.2026.v08.i02.p05>

Abstract

Pig slaughtering is an industrial activity to produce quality meat for consumption. In addition, pig slaughtering activities also produce waste. Waste generated as remnants of pig slaughtering activities. To overcome of this problem, the countermeasures were made using alternative technology methods, namely phytoremediation, and one of them is the use of water hyacinth plants (*Crassipes* (Mart) Solm). This study aims to determine the effect of density and contact time of water hyacinth as one of the biological waste treatment techniques in terms of pH value and BOD₅ value. The research method is experimental, with four treatments of water hyacinth density i.e. 0%, 30%, 60%, and 90% with observation time, namely days 0, 7, 14, and 28. The results showed that the density of the water hyacinth had no significant effect ($p>0.05$) on the decrease of pH value of the waste, but the contact time of the water hyacinth had a genuine impact ($p<0.05$). Likewise, the density of water hyacinth also had no significant effect ($p>0.05$) on the decrease of BOD₅ value, but the contact time had a significant impact ($p<0.05$) on the reduction of BOD₅ value.

Keywords: BOD₅, water hyacinth, Phytoremediation, wastewater treatment, pH

INTRODUCTION

Pig slaughtering is an industrial activity that aims to produce quality meat for consumption. In addition to producing meat, pig slaughtering activities also produce waste. Waste is generated as remnants of pig slaughtering activities that must be disposed of the waste causing an inevitable negative impact on the environmental balance and significantly decreasing water quality. Slaughterhouse waste, as organic waste containing proteins, carbohydrates, fats, and mineral salts, can act as a medium for microbial growth. The decomposition process in wastewater causes an increase in BOD₅, COD, NH₃, and H₂S, changes in pH, and causes foul odors such as the smell of urea and sulfur. Excessive dissolved oxygen utilization can lead to water quality degradation (Ahmad and Adiningsih 2019) (Ningsih et al. 2019). One of the pig slaughterhouses that has not been optimal in waste treatment is the Pig Slaughterhouse that located in Banjar Ulapan, Blahkiuh Village, Abiansemal District, Badung Regency. This slaughterhouse has been operated since 2016 with 40 to 90 pigs are slaughtered daily, and the volume of waste generated is 0.65 m³ /head/day. The pig'slaughtered come from Buleleng, Bangli, Klungkung Regencies and are processed into babi guling. Furthermore, the babi giling

will be distributed to food stalls according to orders, such as in the Sanur area, Nusa Dua, Gianyar, and various regions of the island of Bali. On the other hand, the waste generated from the slaughtering is directly disposed into the irrigation canal just west of the pig slaughterhouse. Furthermore, surrounding community of the slaughterhouse uses the irrigation canal to irrigate rice fields, water crops, and also bathing or washing activities. Waste passing through the irrigation potential to cause air, water, and health problems. So, processing efforts must be made to avoid polluting the environment (Hendrasarie and Trilita 2019).

Phytoremediation is an alternative or complementary technology that combines traditional mechanical cleanup techniques, often requiring significant capital investments and high labour and energy consumption (Ahmad and Adiningsih 2019). Phytoremediation uses plants and their components to eliminate waste and pollution problems by using artificial ponds and reactors or directly on local soil or sites contaminated with waste (Vidyawati and Fitrihidajati 2019). *Phytoremediation* is the uptake of pollutants by plants such as trees, grasses and aquatic plants. Cleaning means destroying, inactivating, or immobilising contaminants so that they will be non-harmfully (Utomoa and Kholifah 2018). Several phytoremediation methods have been used commercially and are still being researched based on their ability to accumulate pollutants (plant extraction) or to absorb and drain water from the soil. The ability of roots to absorb pollutants in tissues (plant transformation) is also used in phytoremediation strategies. Phytoremediation also has the ability of plants to stimulate biodegradation by root-associated microorganisms (plant stimulation), immobilisation of pollutants in soil by root exudates (plant stabilisation), and uptake of metals from soil. It is used in large quantities and economically to rehabilitate problematic soils (phytoremediation) (Kundu, Debsarkar, and Mukherjee 2015).

Water hyacinth has phytoremediation properties that can reduce the content of harmful compounds in liquid waste through absorption and accumulation. Compounds that can be remediated include hydrocarbons, heavy metals, organic chemicals, dyes and pesticides. This dilution method is carried out to reduce the concentration of each pollutant in wastewater and to neutralise the pH in wastewater, as well as reduce NH_3 , NO_2 , and NO_3 levels so that it is safe to use according to its needs (Utami and Gischa 2021) (Vidyawati and Fitrihidajati 2019). The speed absorption of pollutants by water hyacinth is influenced by several factors, including the composition and levels of substances contained in wastewater, density of water hyacinth, and duration of water hyacinth live in wastewater. Based on these considerations, the research on the quality of pig slaughterhouse waste with water hyacinth (*Eichhornia crassipes* (Mart) Solm) treatment in terms of pH and BOD_5 values is interestingly presented.

MATERIALS AND METHODS

Research Subjects

The research object is the wastewater from the slaughterhouse belonging to the businessman who slaughters suckling pigs in Banjar Ulapan, Blahkiuh Village, Abiansemal, Badung. The wastewater is taken from the first reservoir.

Research Materials

The materials used in this study were pig slaughtering wastewater, water hyacinth, and distilled water. The equipment used was four 52-litre water tanks, spectrophotometer, 50-ml Nessler tube, 1-ml pipette, pH meter electrode, and plastic bottle.

Research Design

The research was conducted using a in time complete randome design with four treatments: water hyacinth density 0%, 30%, 60%, and 90%, and four observation times: days 0, 7, 14, and 28.

Sampling Procedure

Samples were taken from water tanks filled with wastewater from the last reservoir, as much as 600 ml/water tank. Sampling was collected five times in each water tank on days 0, 7, 14, 21 and 28. Samples were putted in plastic bottles and then taken to the laboratory. Furthermore, pH measurements were carried out using the electrometric method, and BOD₅ values were measured based on the difference in dissolved oxygen concentration on day 0 (zero) compared to day 5 using the winkler method.

Data Analysis

The data were analysed with variance analysis, and if there were significant differences between treatments and observation times, the data were theb analyzed with Duncan Range Test.

RESULTS AND DISCUSSION

Results

pH value on pig slaughterhouse wastewater

The results of the study about the effect of water hyacinth treatment on the pH value of wastewater treated with water hyacinth at Banjar Ulapan pig slaughterhouse, Blakiuh Village, are shown in Table 1.

Table 1. Effect of Treatment on Changes in Wastewater pH at Pig Slaughterhouse, Banjar Ulapan, Blakiuh Village

Treatment	Time (Day)				Standard Deviation (SD)
	0	7	14	21	
0%	6,45	7,43	7,13	6,79	6,95(±0,42)
30%	6,45	7,4	7,33	6,58	6,94(±0.49)
60%	6,45	7,38	7,22	6,51	6,89(±0.47)
90%	6,45	7,38	7,07	6,05	6,73(±0.58)
Mean (SD)	6,45(±0)	7,40(±0.2)	7,17(±0.13)	6,48(±0.31)	

Table 1 shows a change in the pH value of wastewater between the control and the treatment, namely the decrease in pH value by the increase of water hyacinth density., The pH value of 6.95 for the control to 6.94; 6.89 and 6.73 for the treatment of water hyacinth with density of 30, 60 and 90%, respectively Furthermore, the results of the ANOVA test on the water hyacinth density showed a significance effect with value of 0.246 or greater than 0.05 ($p > 0.05$), that means the water hyacinth density does not significant affect to the decrease of pH value of wastewater. Unlike the case with the observation time, which shows a significance value of 0.000, which means $p < 0.05$. This means the time of observation has a significant effect on reducing of the pH value of wastewater. The following is a graphic description of the density pattern and duration contact of water hyacinth on the pH of wastewater at Blahkiuh Village slaughterhouse (Figure 1).

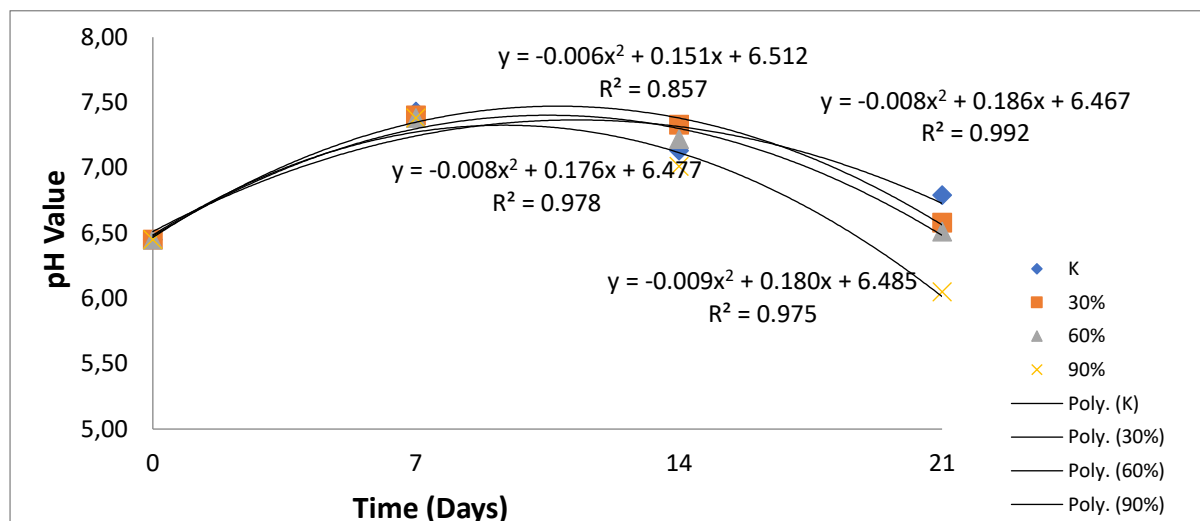


Figure 1. The graph of the density and duration of contact time of water hyacinth on waste water.

Figure 1 shows that the pH value of the control and treatments form a sigmoid pattern, namely an increase in the pH value on the 7th day, and the 14th day followed by a decrease on day 21. Moreover, the Duncan test of the data in Table 1 showed the results in Table 2.

Table 2. Results of Duncan's Test on the Effect of Observation Time on the Changes of pH Value of Pig Slaughterhouse Wastewater treated with Water Hyacinth.

Time	N	Subset		
		1	2	3
0	4	6.4500		
21	4	6.5350		
14	4		7.1225	
7	4			7.4050
Sig.		.491	1.000	1.000

Duncan test results on Table 2 shows that pH value between day 0 and day 7 and 14 was significant difference ($p < 0.05$) as well as between day 7 and 14. However, on day 21, there was a decrease in pH value, which was not significantly different from day 0 ($p > 0.05$). The increase in pH from day 7 to day 14 is due to the decomposition of organic matter contained in wastewater (Kundu, Debsarkar, and Mukherjee 2015). This decomposition process produces alkaline compounds, such as ammonia (NH_3), bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}). These alkaline compounds can increase the pH value of wastewater (Kundu, Debsarkar, and Mukherjee 2015). In addition to the decomposition of organic matter, the increase in pH value is also caused by the volatilisation of acidic compounds. Pig wastewater contains acidic compounds such as acetic acid and propionic acid. These acidic compounds will evaporate into the air when pH conditions are low and increase pH. Meanwhile, after day 14, there is a decrease in pH value due to the process of decomposing organic material decreasing, so the pH value becomes more acidic compared to days 7 and 14. Even so, the pH value in this study is still feasible because it is still within the range according to the quality standard for organic waste according to the Regulation of the Minister of Environment Number 02 2006 concerning Wastewater Quality Standards for Animal Slaughterhouse Activities, which is 6-9. The

increase in pH value associated with the increasing number of pond surfaces covered by water hyacinths will provide optimum conditions for the growth and development of decomposing microorganisms, especially those attached to the roots and stems of water hyacinths in water. With so many decomposing microorganisms, the breakdown of organic matter will increase. The process of breaking down organic matter will produce carbon dioxide (CO₂) where CO₂ is an acidic gas {acidic gas) so that CO₂ produced from the breakdown of organic matter will reduce the pH value of wastewater. Based on the results of research, water hyacinth plants can be used as biological waste control; this is evidenced in Ratnani's research (Kundu, Debsarkar, and Mukherjee 2015) where this study used water hyacinth plants, the results of which showed an increase in pH, a decrease in COD levels, a change in color and odor that arose during observation for eight days.

BOD₅ Value of Pig Slaughterhouse Wastewater

Table 3 shows the results of the study of the effect of water hyacinth treatment on the BOD₅ value of wastewater at the Banjar Ulanan pig slaughterhouse, Blakiuh Village.

Table 3. Effect of Treatment on the Changes of Wastewater BOD₅ at Pig Slaughterhouse, Banjar Ulanan, Blakiuh Village

Treatment	Time (Day)				Average
	0	7	14	21	
K	191.52	30.64	24.192	12.6	64.73(±9,14)
30%	191.52	23.384	21.168	12.096	62.04(±5,98)
60%	191.52	15.625	16.128	11.592	58.71 (±2,48)
90%	191.52	12.5	20.16	8.064	58.06(±6,11)
Average (SD)	191,52 (±0)	20,53 (±8.14)	20,41 (±3,33)	11,08 (±2,05)	

Table 3 shows a change in the value of BOD₅ wastewater between the control compared with the treatments, namely the decrease in the value of BOD₅ by the increase in water hyacinth density. The BOD₅ values were 64.73 for the control to 62.04; 58.71 and 58.06 respectively for the treatment of 30, 60and 90% of water hyacinth density.The ANOVA test on water hyacinth density showed a significance value of 0.110 or greater than 0.05 ($p > 0.05$), which means that water hyacinth density does not has significant effect on the BOD₅ value of wastewater. Unlike the case with the observation time, which shows a significance value of 0.000 or smaller than 0.05 ($p < 0.05$). This means that the observation time has a significant effect on reducing the BOD₅ value of wastewater. The following graphic description of the density pattern and length of contact time of water hyacinth against BOD₅ wastewater (Figure 2)

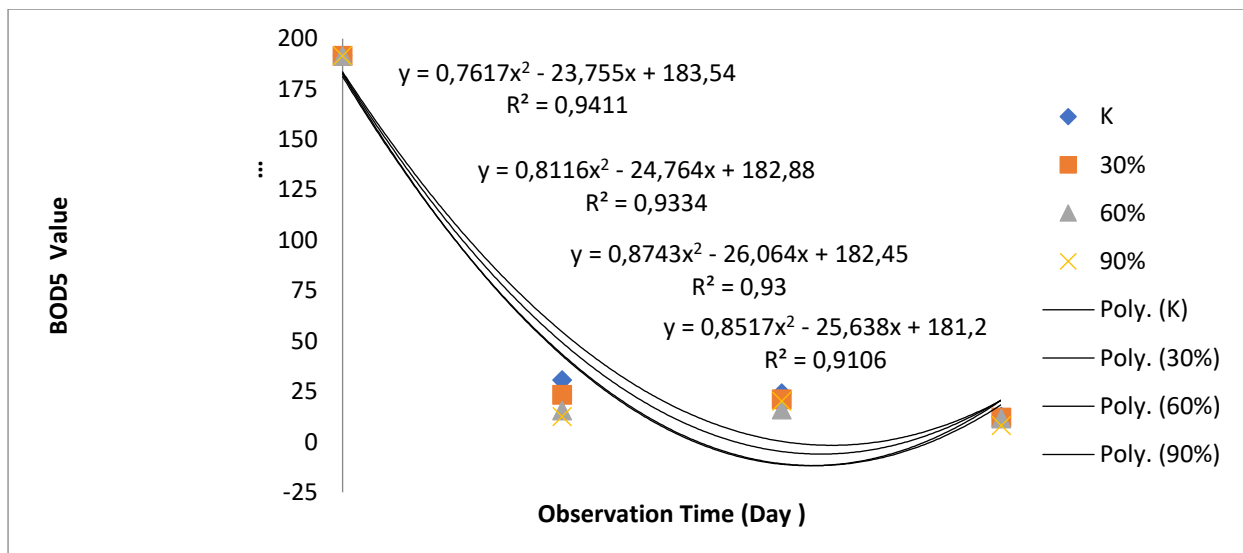


Figure 2. presents a graphic description of the pattern of density and length of contact time of water hyacinth on the value of BOD₅.

Figure 2 shows that the changes in BOD₅ pattern, namely a consistent decrease in the value of BOD₅ over time specifically until day 14. The results of further tests of changes in the pH value of wastewater according to the observation time with Duncan's test as in Table 4

Table 4. Duncan test of the effect of time on the decrease in BOD₅ value of wastewater from pig slaughterhouse.

Time	N	Subset		
		1	2	3
21	4	11.0880		
14	4		20.4120	
7	4		20.5372	
0	4			1.9152E2
Sig.		1.000	.964	1.000

Based on the results of Duncan's test, day 21 was significantly different ($p < 0.05$) from day 14 and day 7, while day 14 and day 7 were not significantly different ($p > 0.05$). The amount of water hyacinth plants used in the treatment can affect the decrease in BOD₅. Water hyacinth has a dual ability to absorb various organic materials in the form of ions from the breakdown of microorganisms. Also, it liberates oxygen microorganisms need for the oxidation process of decomposing microorganisms. Previous studies state that water hyacinths can absorb large quantities of nutrients, organic compounds, and other chemicals from wastewater. Suardana's research (Kundu, Debsarkar, and Mukherjee 2015) strengthens that treatment with 90% water hyacinth closure causes a decrease in BOD₅ up to 52% of the initial value, and Yulita's research (Kundu, Debsarkar, and Mukherjee 2015) with the resulting effectiveness of reducing BOD₅ compounds on average of 52.12% for waste without aeration and 29.18% for waste with water hyacinth plants.

Correlation between time contact and density of waterhyacinth on the pig slaughterhouse wastewater parameters

The following is the correlation between observation time and density of water hyacinth on the slaughterhouse wastewater parameters at the Pig Slaughterhouse,

Table 5. Correlation between observation time and density of water hyacinth in wastewater from pig slaughterhouse in Blakiuh village.

		Density	Time
Density	Pearson		
	Correlation	1	-.185
	Sig. (2-tailed)		.493
	N	16	16
Time	Pearson		
	Correlation	-.185	1
	Sig. (2-tailed)	.493	
	N	16	16

Table 5 above shows that the correlation value between density and time is (-0.185). This correlation number is in the range of 0.00 to 0.199, which means the closeness of the water hyacinth density and observation time. The negative sign (-) means that the relationship between density and observation time is harmful. The negative sign (-) means that the relationship between density and observation time is negative, which means that if the observation time increases, the density decreases and vice versa. In the table, sign. (2-tailed) shows a p-value of 0.493. This value is greater than 5% alpha, which means that observation time and water hyacinth density have insignificant correlation statistically.

Discussion

Dynamics of pH Changes in Pig Slaughterhouse Wastewater Testing of the pH value in pig slaughterhouse wastewater revealed a sigmoidal pattern over the observation period. The initial pH value of 6.45 increased on day 7 (mean 7.40) and day 14 (mean 7.17), before eventually declining on day 21 (mean 6.48). The increase in pH from day 7 to day 14 is attributed to the decomposition of organic matter by microorganisms, which produces basic compounds such as ammonia, bicarbonate, and carbonate (Kundu et al., 2015), as well as the volatilization of acidic organic compounds such as acetic acid and propionic acid. After day 14, the rate of organic matter decomposition diminishes, and decomposer microorganisms attached to the root system of water hyacinths release carbon dioxide gas, an acidic compound that lowers the pH. The ANOVA test indicated that water hyacinth density had no significant effect on pH changes ($p = 0.246 > 0.05$), whereas contact time exerted a highly significant influence ($p = 0.000 < 0.05$). Duncan's post-hoc test confirmed that pH levels on days 7 and 14 differed significantly from day 0, whereas the pH on day 21 returned closer to the initial level. Throughout the experiment, all pH values (ranging from 6.05 to 7.43) remained well within the permissible limits set by the Regulation of the Minister of Environment No. 02 Year 2006 concerning Wastewater Quality Standards for Animal Slaughterhouse Activities (pH 6–9). These observations are consistent with Ratnani's findings regarding the capability of water hyacinth to alter the physicochemical characteristics of organic wastewater (Kundu et al., 2015).

BOD (Biochemical Oxygen Demand) of the wastewater exhibited a marked reduction over time. The initial BOD value of 191.52 mg/L was drastically reduced to an average of 20.53 mg/L on day 7, 20.41 mg/L on day 14, and reached its lowest level of 11.08 mg/L on day 21. Statistically, this reduction was significantly influenced by observation contact time ($p = 0.000 < 0.05$), while plant density did not show a statistically significant effect ($p = 0.110 > 0.05$). Duncan's test demonstrated that the BOD level on day 21 was significantly lower ($p < 0.05$) compared to days 7 and 14. The ability of water hyacinth (*Eichhornia crassipes*) to reduce

BOD operates through a dual mechanism: absorbing ionic decomposition products of organic matter and releasing dissolved oxygen required by microorganisms for aerobic oxidation (Utomo & Kholifah, 2018; Vidyawati & Fitrihidajati, 2019). These results corroborate earlier studies referenced in the manuscript, such as Suardana's research showing up to a 52% reduction in BOD under 90% water hyacinth coverage, and Yulita's research reporting average BOD reduction efficiencies of 52.12% for wastewater without aeration and 29.18% with water hyacinth treatment (Kundu et al., 2015).

Correlation Analysis Between Plant Density and Contact Duration Pearson correlation analysis between water hyacinth density and observation contact time yielded a correlation coefficient of $r = -0.185$ with a two-tailed significance of $p = 0.493 > 0.05$. Falling within the coefficient range of 0.00 to 0.199, this value denotes a very weak and statistically non-significant correlation between plant density and exposure duration. The negative sign (-) indicates an inverse relationship, highlighting that extended contact time serves as the primary determining factor in pollutant reduction rather than merely increasing plant density. This finding underlines that the processes of pollutant absorption, accumulation, and neutralization by the root matrix of water hyacinths require adequate hydraulic retention time to allow root-associated microflora to degrade the organic load effectively (Kundu et al., 2015; Utomo & Kholifah, 2018).

Environmental and Waste Management Implications Applying water hyacinth phytoremediation offers an economical and eco-friendly technology for managing pig slaughterhouse wastewater, particularly in local facilities such as the Banjar Ulan Pig Slaughterhouse in Blahkiuh Village (Ahmad et al., 2019). Prior to treatment, untreated wastewater discharged directly into adjacent irrigation canals poses severe risks of water pollution, agricultural soil degradation, and offensive odors (Hendrasarie & Trilta, 2019; Ningsih et al., 2019). Through nutrient uptake and biological processing by water hyacinth, wastewater quality is substantially upgraded in terms of both pH stabilization and BOD load reduction (Utami & Gischa, 2021; Vidyawati & Fitrihidajati, 2019). Ultimately, this study demonstrates that water hyacinth functions as an effective biological control agent to mitigate the environmental impact of livestock and slaughterhouse effluent.

CONCLUSIONS AND SUGGESTIONS

Conclusions

Based on the study's results, the density of water hyacinth has not significantly effect in the pH value of wastewater. However, the length of contact time of water hyacinth gives a significant effect ($p < 0.05$). Water hyacinth density showed a significant effect ($p < 0.05$) on changes in BOD₅ values, especially at a density of 90% compared to densities of 60 and 30%, as well as the length of contact time of water hyacinth, which gave a significant effect ($p < 0.05$) on reducing BOD₅ values. The results showed an unreal negative correlation or interaction between the density and contact time of water hyacinth on the pH and BOD₅ values of the pig slaughterhouse wastewater.

Suggestions

Water hyacinth plants as phytoremediation can be used for treating of pig waste water. Nevertheless further research needs to be done with different parameters such as Ammonia, TSS, COD and so on.

ACKNOWLEDGMENTS

The authors would like to thank Prof.drh. Dr. I Wayan Suardana, thank you for all the facilities provided for the smooth implementation of the research, and Mrs Trisna at the Analytical Lab Bukit Jimbaran Campus for all her help and cooperation.

REFERENCES

- Ahmad, H., & Adiningsih, R. (2019). Efektivitas metode fitoremediasi menggunakan tanaman eceng gondok dan kangkung air dalam menurunkan kadar BOD dan TSS pada limbah cair industri tahu. *Jurnal Farmasetis*, 8(2), 31–38. <https://doi.org/10.32583/farmasetis.v8i2.599>
- Hendrasarie, N., & Trilta, M. N. (2019). Removal of nitrogen-phosphorus in food wastewater treatment by the Anaerobic Baffled Reactor (ABR) and Rotating Biological Contactor (RBC). *IOP Conference Series: Earth and Environmental Science*, 245(1), Article 012017. <https://doi.org/10.1088/1755-1315/245/1/012017>
- Kundu, P., Debsarkar, A., & Mukherjee, S. (2015). Treatment of slaughter house wastewater in a sequencing batch reactor: Performance evaluation and biodegradation kinetics. In *Efficient management of wastewater from manufacturing: New treatment technologies* (pp. 83–112). CRC Press. <https://doi.org/10.1201/b18616-11>
- Ningsih, Y. W., Kurniawan, T., Rahmawati, A. N., Permatasari, D. A., Ghunarso, D. A.-H., Pratama, R. A., Sanjaya, A. M., & Widiyatmoko, W. (2019). Persepsi masyarakat terhadap tanaman eceng gondok Rawa Pening di Desa Banyubiru Kabupaten Semarang. *Jurnal Geografi, Edukasi dan Lingkungan (JGEL)*, 3(2), 83–92. <https://doi.org/10.29405/jgel.v3i2.3488>
- Utami, S. N., & Gischa, S. (2021, November 23). *Contoh komoditas pertanian mulai dari perkebunan, peternakan, dan tanaman pangan*. Kompas.com. <https://www.kompas.com/skola/read/2021/11/23/110000769/contoh-komoditas-pertanian-mulai-dari-perkebunan-peternakan-dan-tanaman>
- Utomo, D., & Kholifah, S. (2018). Uji efektivitas fitoremediasi eceng gondok dalam menurunkan kadar polutan air limbah. *Jurnal Teknologi Pangan*, 9(1), 10–19.
- Vidyawati, D. S., & Fitrihidajati, H. (2019). Pengaruh fitoremediasi eceng gondok (*Eichhornia crassipes*) melalui pengenceran terhadap kualitas limbah cair industri tahu. *LenteraBio: Berkala Ilmiah Biologi*, 8(1), 39–44.