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Effect of Sweet Potato Leaves Extract on the Survival of Black Nile Tilapia in the Transportation Process

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ABSTRACT

Transportation is a follow-up activity in cultivation that is useful for moving fish to new habitats. The transportation system used is a closed system that relies on oxygen in it. This system has disadvantages, such as fish being easily exposed to stress due to decreased water quality in the media and disruption of fish metabolism. Therefore, an alternative strategy is needed by anesthetizing the fish to reduce movement and metabolism during transportation. The anesthetic used is sweet potato leaves which contain saponins (21,50%), flavonoids (1,30%), and polyphenols (4,0947 mg/g). This research aims to apply the use of *Ipomoea batatas* sweet potato leaf extract mixed into water media in the transportation process of prospective black tilapia broodstock *Oreochromis niloticus*. The research used a completely randomized design (CRD) method consisting of three replications and four treatments, namely treatment C (control), P_2 (2 mg/L), P_4 (4 mg/L), and P_6 (6 mg/L). The results of the research can be concluded that the best treatment in this study was P6 which showed higher survival rates and lower blood glucose levels compared to other treatments ($P<0.05$), while the water quality parameters between treatments did not significant different.

INTRODUCTION

Nile tilapia *Oreochromis niloticus* is one of the most popular freshwater fish commodities among consumers due to its delicious and savory flesh (Iskandar *et al.* 2021). The cultivation of this fish is also very high in Indonesia, as nile tilapia can adapt well and is relatively easy to breed. Nile tilapia has high economic value and is a leading commodity in both domestic and international markets (Siantara *et al.* 2017; Hendriana *et al.* 2023). Indonesia is the second-largest producer of nile tilapia in Asia, having exported 4,700 tons of nile tilapia to the global market in 2023 (FAO 2023).

The availability of nile tilapia fry is closely related to the breeding process, requiring a sufficient stock of broodstock. Therefore, to meet the demand for nile tilapia among consumers, an efficient distribution system for broodstock among fish farmers is necessary. According to Widaryati (2017), the most suitable transportation method for nile tilapia distribution is the closed system, as tilapia have a high metabolic rate during transport. This transportation system ensures high survival rates, allows for high stocking densities, and supports long transport durations of ≥6 hours. The use of a closed transportation system aims to maintain availability and achieve the expected production targets for nile tilapia (Hasan *et al*. 2015). During transportation, stress levels in fish may increase due to physical pressure, changes in water quality, and the potential emergence of diseases (Pramono *et al*. 2022).

The primary principle in fish transportation is to maintain stable water quality in the transport medium. One method to achieve this is by using anesthetics during transportation (Triwulandari *et al*. 2024). Anesthetics offer advantages such as reducing metabolic activity and minimizing stress in fish (Jamaliah *et al*. 2020). Currently, chemical anesthetics are widely used, but they pose potential health risks to humans upon fish consumption. Therefore, alternative herbal-based anesthetics are being explored, including sweet potato leaves *Ipomoea batatas* (Sudirman *et al*. 2022; Sumahiradewi *et al*. 2022; Al Jumadi *et al*. 2024), clove oil *Eugenia aromaticum* (Mikhsalmina *et al*. 2017; Madyowati *et al*. 2021; Wimadani & Fitri 2024), lemongrass oil *Cymbopogon citratus* (Rimadhani *et al*. 2023; Anrose & Alifia 2024), tuba root extract *Derris elliptica* (Prasetyo & Yuniarti 2017; Monica *et al*. 2020), cassava leaves *Manihotes culenta* Crantz (Jamaliah *et al*. 2020; Anrose & Alifia 2024), papaya leaves *Carica papaya* (Budiyanti, 2016; Miranda *et al*. 2025), bandotan leaves *Ageratum conyzoides* (Aini *et al*. 2014; Saputra *et al*. 2020; Chilmawati & Amalia 2022). These plants contain bioactive compounds such as saponins, flavonoids, and polyphenols, which can effectively reduce fish stress during transportation. This study examines the use of sweet potato leaf extract *Ipomoea batatas* as an anesthetic for transporting black nile tilapia *Oreochromis niloticus* broodstock, referring to the findings of Jamaliah *et al*. (2020).

Research on the application of sweet potato leaf extract as an anesthetic in fish transportation has been widely conducted. According to Anggraini *et al*. (2016), administering sweet potato leaves to common carp *Cyprinus carpio* resulted in a survival rate (SR) of 99%. Similarly, a study by Nursida & Putri (2020) on nile tilapia *Oreochromis niloticus* reported an SR of 93%, while Sumahiradewi *et al*. (2022) found that administering sweet potato leaves to african catfish *Clarias gariepinus* resulted in an SR of 96%. Sudirman (2022) stated that sweet potato leaf extract helps reduce stress in fish due to its tannin content, which acts as an antioxidant and inhibits free radicals, thereby reducing insulin resistance and blood glucose levels.

This study will examine the use of sweet potato leaves in the transportation of black nile tilapia.

METHOD

This research was conducted at PT. Suri Tani Pemuka in Banyuwangi, East Java, from October to November, 2023. The study employed a completely randomized design (CRD) with three treatments and one control, each replicated three times. The treatment doses were determined based on the findings of Sudirman (2022). The tested treatments included: Control (A): 0 mg/L, treatment P2: 2 mg/L, P4: 4 mg/L, and treatment P6: 6 mg/L.

The equipment and materials used in the study included nile tilapia broodstock, a dissolved oxygen (DO) meter, a pH meter, a blender, filter paper, sweet potato leaves, plastic bags, a spectrophotometer, styrofoam, an aeration valve, aeration tubing, a syringe, and a glucose test kit.

Survival Rate (SR)

The survival rate (SR) was observed during the transportation treatment and calculated using the following formula:

$$\text{Survival rate (\%)} = \frac{\text{Initial number of fish before transportation}}{\text{Number of fish surviving after transportation}} \times 100$$

Water Quality and Blood Glucose Measurement

Water quality measurements were conducted throughout the transportation process. The tested water quality parameters included temperature, dissolved oxygen (DO), total ammonia nitrogen (TAN), and pH. Blood glucose testing was performed after blood collection. Blood was drawn from the lateral line (linea lateralis) using a 1 mL syringe. The glucose test was conducted using a glucose kit (ElveSense). The collected blood was applied to a test strip inserted into the glucose meter, and the blood glucose value was automatically displayed on the screen.

Data Analysis

The collected data were processed and analyzed using Microsoft Excel 2021. A one-way ANOVA was performed with a 95% confidence interval using SPSS Statistics 26 to evaluate differences among treatments. If significant differences were found, a Duncan's multiple range test (DMRT) was conducted as a post hoc analysis.

RESULT AND DISCUSSION

Survival Rate During Transportation

Figure 1 shows that the highest survival rate (SR) during transportation was observed in treatment P6, with a value of 91.67 ± 14.43%, while the lowest SR was found in control (C), at 66.67 ± 14.43%. Mortality observations were conducted throughout the treatment period. In the control group (C), fish mortality occurred after 8 hours. In treatments P2, P4, and P6, mortality was observed after 16 hours. The ANOVA test, followed by Duncan's multiple range test, revealed significant differences among treatments (P < 0.05). However, the SR in the control group (C) was not significantly different from those in treatments P2, P4, and P6.

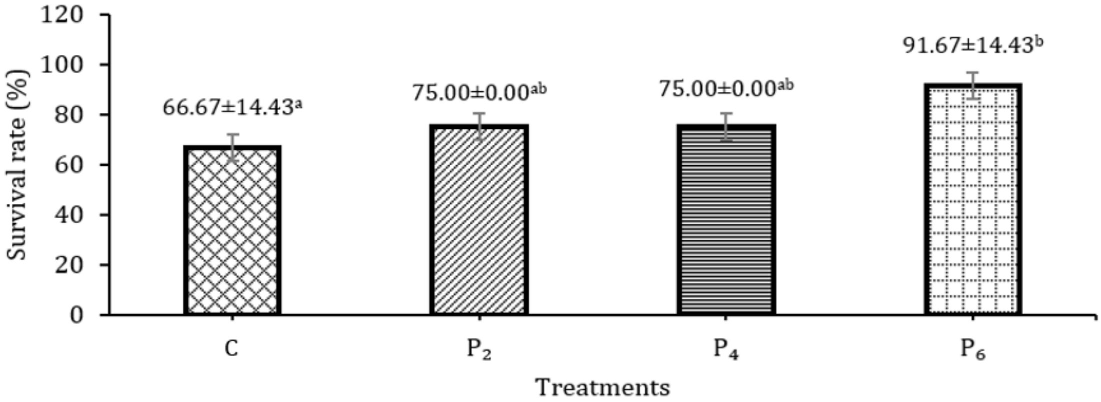

Figure 1. Survival rate of black nile tilapia broodstock during transportation with the administration of sweet potato leaf extract at different doses. Superscript letters on the same observation indicate significant differences (P < 0.05).

The control group (C) had the lowest survival rate (66.67 ± 14.43%), likely due to the absence of special treatments, making the fish more susceptible to stress and mortality. This could also be attributed to suboptimal water quality during transportation, which may have caused stress and impaired metabolic function. In contrast, P6 treatment exhibited the highest survival rate (91.67 ± 14.43%), with minimal mortality. The high SR in this group is believed to be due to better water quality during transportation, reducing stress levels in the fish. Additionally, the administration of sweet potato leaf extract at an optimal dose may have contributed to this outcome. Sweet potato leaves contain antimetabolites, which help suppress metabolic and respiratory activity during transport (Aini *et al*. 2014), reducing stress and ultimately improving the survival rate (SR).

Sweet potato leaves contain saponins (21.50%), flavonoids (1.30%), and polyphenols (4.0947 mg/g), which enhance the fish's immune system and help prevent stress during treatment (Anggraini *et al*. 2016). Flavonoids are compounds known to induce calmness and reduce fish movement to the point of sedation (Firdaus *et al*. 2022). In P6 treatment, which had the highest dose, fish remained in a sedated state for up to 18 hours during transportation. This reduced activity lowered metabolic rates, thereby improving survival rates during transport. However, flavonoids and saponins can be toxic to fish when used in excessive amounts or for prolonged periods, potentially leading to mortality (Arlanda *et al*. 2018; Asep *et al*. 2022).

Blood Glucose Response

Figure 2 shows that the initial blood glucose levels of black nile tilapia broodstock in all treatments (C, P2, P4, and P6) before transportation were 76.00 ± 3.00 mg/dL. After 24 hours of transportation, blood glucose levels increased across all treatments. Control (C): increased to 151.33 ± 8.14 mg/dL, then decreased to 108.67 ± 4.16 mg/dL after 24 hours of recovery. Treatment P2: increased to 147.67 ± 5.51 mg/dL, then decreased to 106.33 ± 8.50 mg/dL after 24 hours of recovery. Treatment P4: increased to 129.67 ± 12.50 mg/dL, then decreased to 106.33 ± 11.02 mg/dL after 24 hours of recovery. Treatment P6: increased to 128.33 ± 16.26 mg/dL, then decreased to 97.33 ± X mg/dL after 24 hours of recovery. The results indicate that the administration of sweet potato leaf extract helped reduce stress-related glucose spikes, with P6 treatment showing the lowest post-transportation glucose levels, suggesting a better stress-reducing effect.

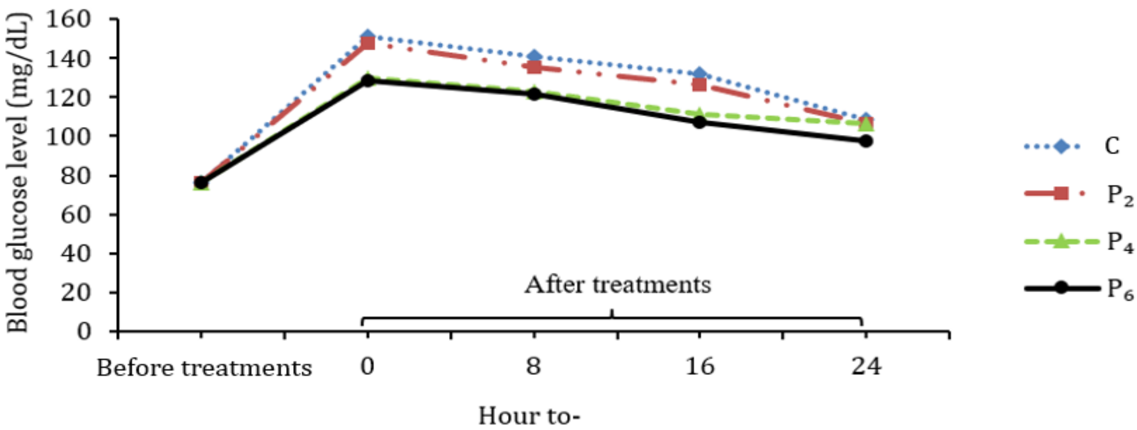

Figure 2. Blood glucose levels of black nile tilapia broodstock transported with different doses of sweet potato leaf extract.

Based on the research findings, blood glucose levels in fish increased during the treatment, indicating that the fish struggled to adapt, leading to a rise in glucose levels. According to Djauhari *et al.* (2019), blood glucose levels play a crucial role in meeting the increased energy demands caused by stress in fish. When fish experience stress, they redirect energy from normal metabolic processes to activate physiological mechanisms that help them withstand stress. The subsequent decline in blood glucose levels is likely due to the depletion of energy reserves, forcing the fish to utilize glycogen stores as an alternative energy source to adapt and respond to stress (Asep *et al*. 2022).

The elevated blood glucose levels observed can also be attributed to the effects of anesthesia, as anesthesia can trigger a stress response in fish. This is supported by Asep *et al.* (2022), who stated that stress response is a physiological state in which the body undergoes changes in reaction to tissue damage caused by anesthesia, surgery, shock, or infection. Among the treatments, P6 exhibited the lowest stress levels, as indicated by its lower blood glucose levels compared to other treatments. This suggests that the administered dose was optimal for anesthetizing black nile tilapia, effectively reducing their metabolic rate. According to Djauhari *et al*. (2019), using appropriate natural anesthetics can suppress metabolism and minimize stress risk in fish.

Water Quality

1. Water Temperature During Transportation

Figure 3 shows that the highest temperature for each treatment occurred after the 16th hour of transportation. This temperature increase is likely due to the activity of the fish, as they began to regain consciousness from sedation between the 16th and 24th hours. Additionally, the rise in temperature may have been influenced by the completion of the transport process during midday (at 13:00 WIB). However, the temperature values across treatments did not vary significantly. At the 24th hour, the recorded temperatures were control (C): 30.3°C, P2: 30.4°C, P4: 30.3°C,P6: 30.2°C. Throughout the experiment, water temperature ranged between 25.6°C and 30.4°C, which remained within the tolerance limits for nile tilapia. According to Munandar *et al*. (2018) and Jamaliah *et al*. (2020), the optimal temperature range for nile tilapia habitats is 25–32°C.

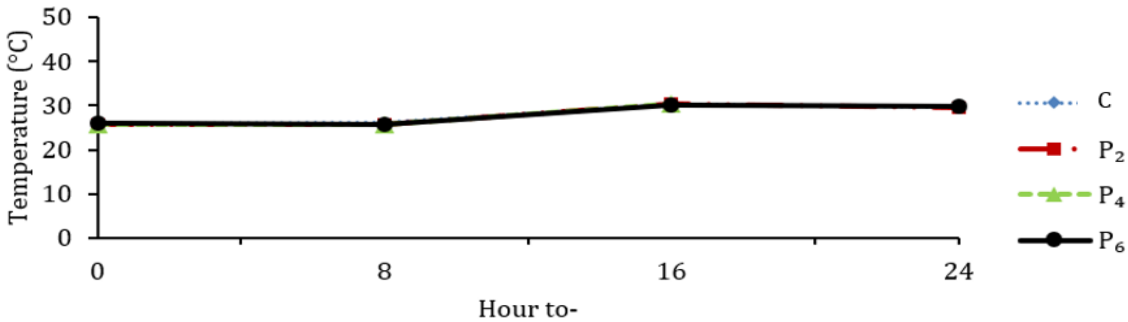

Figure 3. Water temperature of the transport medium for black nile tilapia broodstock transported with different doses of sweet potato leaf extract.

The observed temperature increase during transportation was not significant, as it remained within the optimal range for nile tilapia. Temperature fluctuations can be influenced by environmental factors, such as ambient temperature. According to Nurkholifah *et al*. (2022), temperature fluctuations occur due to external influences, such as sunlight exposure. To maintain stable conditions during transport, ice was added to the Styrofoam container to keep the fish calm and regulate the water temperature (Aini *et al*. 2014). However, after transportation, the water became slimy and odorous, likely due to the temperature increase as the ice melted. The rise in temperature can accelerate organic decomposition, leading to water spoilage and foul odors in the transport medium (Ismi *et al*. 2020).

2. Dissolved Oxygen (DO) During Transportation

The DO testing was conducted by placing the test fish into plastic packaging and adding oxygen at a water-to-oxygen ratio of 1:2 (Iskandar *et al*. 2022). The results indicated a decline in DO levels across all treatments (Figure 4). Lowest DO level at 24 hours: C treatment (4.7 mg/L), highest DO level at 24 hours: treatment P6 (5.5 mg/L), DO levels in P2 and P4: P2 (5.0 mg/L) and P4 (5.1 mg/L). Nile tilapia can survive in oxygen concentrations ranging from 3 mg/L to >5 mg/L (Arifin 2016; Mulqan *et al*. 2017). Thus, the DO levels during the study remained within the optimal range 4.7–6.1 mg/L, ensuring suitable conditions for fish survival during transport.

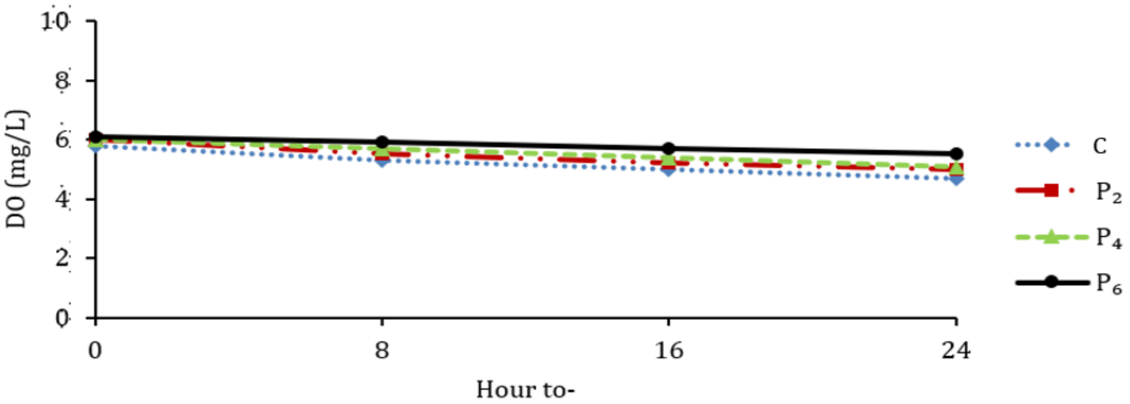

Figure 4. The dissolved oxygen (DO) levels in the transport water of black nile tilapia broodstock transported with the addition of sweet potato leaf extract at different doses.

Based on the research data obtained, DO levels continuously decreased during the transportation process, indicating a relationship between dissolved oxygen content and oxygen uptake (respiratory dependence). As dissolved oxygen decreases, the rate of oxygen uptake also decreases (Djauhari *et al*. 2019). The longer the transportation process, the lower the DO levels due to fish respiration. In a closed and limited container, oxygen pressure continuously decreases as the fish consume oxygen (Hasan *et al*. 2016; Djauhari *et al*. 2019).

Additionally, the decline in DO levels may be caused by limited diffusion from the air to the water surface and elevated temperatures during transport, which reduce oxygen solubility (Riesma *et al*. 2016). Extremely low DO levels negatively impact fish health, potentially causing respiratory stress, anorexia, hypoxia, tissue damage, unconsciousness, or even death (Ismi *et al*. 2020).

3. pH Levels During Transportation

Figure 5 shows that the addition of sweet potato leaf extract influenced the pH levels in the transportation medium. The pH levels gradually decreased as the transportation duration increased. The lowest pH level at the 24-hour mark was observed in P6 treatment, with a value of 7.05, while the highest was in treatment

P4, with a value of 7.10. The optimal pH range for nile tilapia is between 7 and 8 (Fauzia & Suseno 2020; Scabra *et al*. 2022). Therefore, the pH levels during the experiment remained within the optimal range, fluctuating between 7.01 and 7.41.

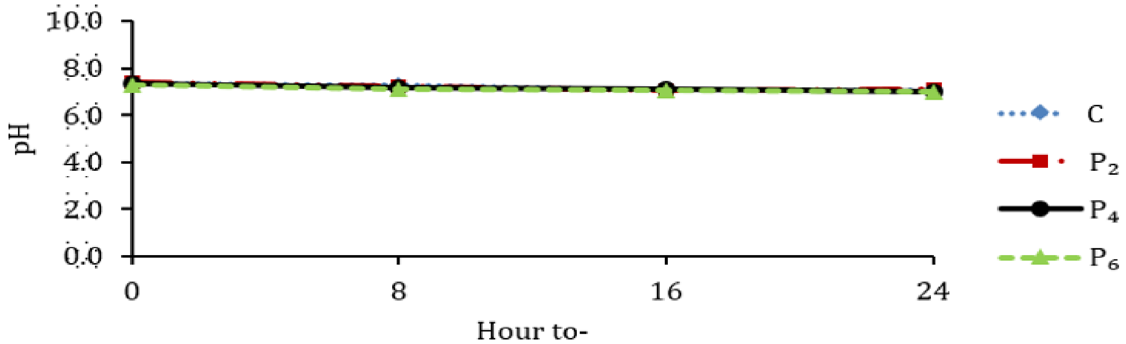

Figure 5. pH levels of the transport water for black nile tilapia broodstock with the addition of sweet potato leaf extract at different doses.

The extract of sweet potato leaves causes changes in pH due to its saponin content. Saponins have acidic properties, which can lower the pH of water. The saponin content in sweet potato leaf extract is relatively high, reaching 21.50% (Widaryati 2017). In general, the pH levels during transportation remained within the optimal range of 7.01–7.41. However, as transportation time increased, pH levels gradually decreased.

The pH level is closely related to temperature and total ammonia nitrogen (TAN) concentration in the transport medium. A decrease in pH may occur due to the inefficient excretion of ammonia, leading to the accumulation of organic matter in the water. This accumulation can become toxic and create an acidic environment that is harmful to fish (Sunardi *et al*. 2016; Nurkholifah *et al*. 2022).

4. Total Amonia Nitrogen (TAN) During Transportation

Figure 6 shows that during transportation, the TAN (Total Ammonia Nitrogen) levels continued to increase. The TAN values for each treatment rose sharply at the 16th hour compared to the 8th hour. The highest TAN level at the 24th hour was observed in C treatment, with a value of 23.266 mg/L, while the lowest TAN level at the 24th hour was found in P6 treatment, with a value of 21.156 mg/L.

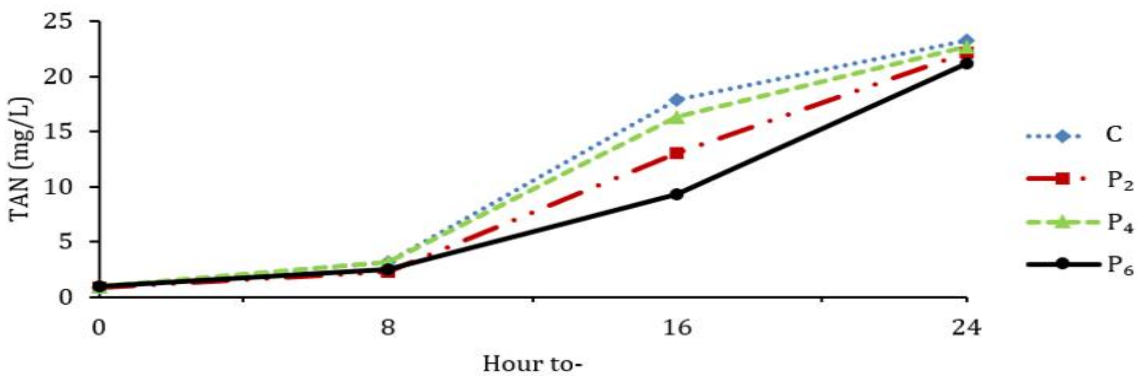

Figure 6. TAN Levels in the transport water of black nile tilapia broodstock with the addition of sweet potato leaf extract at different doses.

Based on the TAN values obtained during the transportation process, the higher the dose of sweet potato leaf extract used, the lower the TAN levels in the transport water. This is likely related to the duration of fish sedation and their metabolic activity during transport. Higher doses of sweet potato leaf extract prolong sedation and reduce metabolic activity, leading to lower excretion levels in the transport medium.

According to Riesma *et al*. (2016), lower TAN levels in transport water were observed when anesthetic concentrations are higher, as they influence sedation duration and metabolic rates. High TAN levels during transportation can also lead to fish mortality, as elevated TAN concentrations can be toxic. Ismi *et al*. (2020) stated that total ammonia nitrogen is toxic because it affects the central nervous system of fish, causing convulsions and ultimately leading to death.

CONCLUSSION

Based on the research findings, the application of sweet potato leaf *Ipomoea batatas* extract during the transportation of black nile tilapia *Oreochromis niloticus* led to the following conclusions that the administration of sweet potato leaf extract had a significant effect ($P<0.05$) on survival rate (SR). However, it did not show a significant difference ($P>0.05$) in blood glucose levels and had no significant effect on water quality parameters. The best treatment in this study was P6 treatment, which used 6 mg/L of sweet potato leaf extract, resulting in the highest survival rate of 91.67±14.43% and blood glucose levels and water quality in this treatment were more stable and favorable compared to the control (C), P2, and P4 treatments.

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