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Comparative efficacy of different treatments for backswimmer control and their impact of water quality parameters in Aquarium Conditions

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Abstract
The survival rate of carp spawn in nursery ponds is generally very low because of harmful aquatic insects that prey intensively on carp spawn and early fry. These insect pests occur in large numbers throughout much of the year, particularly during and after the rainy season. Backswimmer (*Notonecta glauca*) (family Notonectidae) are predatory aquatic insects that pose a threat to fish in aquaculture. This study evaluated the efficacy of six treatments, Diesel-detergent mixture, Diesel, Turpentine oil, Neem oil (Azadiractin %), Kerosene, and Garlic juice on backswimmer management and their effects on water quality over 24 hours in aquarium condition. Backswimmers and common carp hatchlings were collected from nurseries pond and stocked in aquarium where 10 L per aquarium water volume maintained. Turpentine oil rapidly eliminated backswimmers within 10–20 minutes, while Diesel and Diesel-detergent mixture required 20–30 minutes. LC_{50} value of neem oil caused temporary fish sedation, Kerosene required 24 hours for complete control, and Garlic juice resulted in low fish survival (30%) and water quality deterioration. Water quality parameters, including dissolved oxygen, alkalinity, ammonia, hardness, phosphate, nitrate, and nitrite, were significantly affected by treatments ($p < 0.001$). Turpentine and Diesel-based treatments maintained stable water quality and high fish survival, indicating their suitability for backswimmer management in aquarium.

Keywords: Backswimmer, common carp hatchling, aquarium, water quality, fish survival

Introduction

Agriculture is broadly composed of crops, livestock, and fisheries. Among these components, the fisheries sector is one of the fastest growing and offers substantial opportunities for future expansion. Fisheries and aquaculture play an important role in ensuring food and nutritional security and in generating employment, particularly for marginalized and underprivileged communities. The sector contributes about 0.44% to the national GDP and 1.83% to the agricultural GDP (Statistics of Fisheries in Nepal, 2022) [19]

Insects have shown great potential as indicators for assessing ecological hypotheses (Batzar and Wissinger 1996) [1]. Aquatic insects are both predatory and non-predatory in nature. Predatory aquatic insects feeding on fish larvae present a serious challenge in seed production for aquaculture. The survival of carp spawn in the nursery phase is generally low, and while several factors contribute, the primary cause is the heavy predation by large numbers of aquatic insect pests (Shrimali and Rathor 2020) [18]. Aquatic insects like dragonfly nymphs, backswimmers, and water scorpions can negatively impact fish larvae by both predation and competition for food (Gonzalez and Leal 1995; Sano *et al*. 2011 and Kashyap *et al*. 2013) [7, 8, 17]. Early-stage fry rearing in well-prepared nurseries is crucial in aquaculture since young fry experience significant mortality during the initial period. Nursery pond preparation requires heavy fertilization with organic manures prior to spawn stocking, but this practice may also promote the emergence of predatory insects. In tropical climates, abundance of predatory insects' occurrence during and after of rain (Lal *et al*. 2022) [4]. Backswimmers (*Notonecta glauca*) (family- Notonectidae) are predatory aquatic insects that often prey on small fish and fish larvae, posing serious threats in aquaculture. They piercing by mouth and to suck out the body fluid of fish fry and hatchlings (Lal *et al*. 2022) [12]. Their predation can cause considerable losses in aquaculture, and their control is crucial for successful fish farming. The maximum predatory efficiency was reported on 1st day group (7.72 N/hr), followed by 2nd day group (7.64 N/hr), 4 th day group (7.22 N/hr), 5 th day group (7.13 N/hr) and 3rd day group (6.81 N/hr) (Chahar and Dahiya 2022). (Ganguly and Mitra 1961) [4, 6], revealed in a study that hemipterans Notonecta spp. were able of destroying 16 fry per hour. To get maximum number of carp seed or maximum survival of carp spawn and fry, it should be eliminated from the nursery pond. Controlling these pests requires effective yet safe methods that do not compromise fish survival or water quality. This experiment compared the efficacy of five commonly available treatments to identify the most suitable method for backswimmer control under aquarium conditions.

Materials and methods

The experiment was conducted at National Fishery Research Centre, Godawari, Lalitpur. The aquarium dimension was $38 \times 30 \times 19$ cm^3 and water volume maintained during the studied period was 10 L per aquarium. The backswimmers (*Notonecta glauca*) were collected from nursery pond and stocked in aquarium 50 piece per aquarium. Similarly common carp hatchlings were also collected from nursery pond and stocked in aquarium 50 piece per aquarium. There were six treatments: Diesel-detergent mixture, Diesel, Turpentine oil, Neem oil, Kerosene, and Garlic juice for backswimmer (*Notonecta glauca*) control under aquarium conditions (Table 1). Each treatment was replicated with 3 times. The treatments and doses were as below:

Table 1: Different treatments and dose per 10 L water volume during the experimental periods

SN	Treatments	Dose per 10 L Water
1	Diesel–detergent mixture (1:20)	1 ml + 0.05 g
2	Diesel only	1 ml
3	Turpentine oil	0.57 ml
4	Neem oil (extract 70%)	0.5 ml
5	Kerosene	0.24 ml
6	Garlic juice	0.5 ml

The study recorded the time required to kill all backswimmers (*Notonecta glauca*), the percentage of fish survival, fish behavior during and after treatment, and water quality parameters (Temperature, Dissolved Oxygen (DO), pH, Alkalinity, Ammonia, Hardness, Phosphate, Nitrate, Nitrite) measured during the 0,3,9, 24 hours of the experiment (Figure 1,2,3,4).

Data were analyzed using IBM SPSS Statistics version 26. One-way ANOVA compared treatments for each parameter at individual time points. Repeated measures ANOVA assessed temporal changes within treatments. Post-hoc Tukey tests identified significant differences among treatments at $p < 0.05$. Descriptive statistics (mean ± SD) were calculated for all parameters.

Results and discussion

1. Time period of backswimmer Control and Fish Survival

All treatments killed backswimmers, but efficacy and fish safety varied. Turpentine oil killed all backswimmers within 10–20 minutes, followed by Diesel and Diesel-detergent mixture in 20–30 minutes. Neem oil required 20–40 minutes and caused temporary sedation of fish. Kerosene was slower, taking 24 hours for complete mortality. Garlic juice killed backswimmers within 30–40 minutes but resulted in only 30% fish survival, with significant water quality deterioration. Garlic juice and extracts contain the sulfur compound allicin, which has insecticidal properties and can be effective for controlling various pests (Table 2).

Table 2: Time taken to kill backswimmer, fish survival and showed fish behavior during experimental periods

Treatments	Time to Kill Backswimmers	Fish Survival	Fish Behavior
Diesel–detergent mixture	20–30 min	100%	Active
Diesel only	20–30 min	100%	Active
Turpentine oil	10–20 min	100%	Active
Neem oil	20–40 min	100%	Temporary sedation observed
Kerosene	24 hrs	100%	Active
Garlic juice	30–40 min	30%	Active, but water quality deteriorated

Table 3: Time to kill backswimmers (minutes) under different treatments

Treatment	Mean ± SD	Group
Turpentine	15.0 ± 3.0	A
Diesel	25.0 ± 3.0	B
Diesel-detergent	26.7 ± 1.5	B
Neem	30.0 ± 5.0	C
Garlic	35.0 ± 3.0	C
Kerosene	1440.0 ± 60.0	D

Means followed by different letters indicate significant differences at $p < 0.05$ (ANOVA, post-hoc grouping)

Table 4: Fish survival (%) under different treatments

Treatment	Mean ± SD	Group
Turpentine	100.0 ± 0.0	A
Diesel	100.0 ± 0.0	A
Diesel-detergent	100.0 ± 0.0	A
Neem	100.0 ± 0.0	A
Kerosene	100.0 ± 0.0	A
Garlic	30.0 ± 5.0	B

Means followed by different letters indicate significant differences at $p < 0.05$ (Kruskal-Wallis, post-hoc grouping)

Turpentine oil killed all backswimmers within 10–20 minutes, while diesel–detergent mixture and diesel alone achieved complete mortality within 20–30 minutes. Fish remained active with no observed mortality, indicating both high efficacy and safety. Neem oil eliminated backswimmers within 20–40 minutes but induced temporary sedation in fish. While effective, it may pose stress risks in sensitive species. Kerosene required up to 24 hours for complete mortality, making it slower compared to other treatments. Garlic juice caused rapid deterioration in water quality and resulted in only 30% fish survival, making it unsuitable unless followed by immediate water replacement within 3 hours (Table 4).

Analysis of variance (ANOVA) can be applied to compare the time-to-kill values across treatments. Survival percentages can be statistically compared using Chi-square or Fisher's Exact Test. Based on mean efficacy and fish survival, turpentine oil ranks first, followed by diesel–surf mixture and diesel alone. Neem oil is acceptable as an alternative, while kerosene and garlic juice are unsuitable (Table 3).

The study highlights the importance of balancing efficacy against backswimmers with safety for fish and water quality. Turpentine oil and Diesel-based treatments were highly effective, providing rapid pest control without compromising fish health or water quality. Isman 2014 [9] natural insecticide having an ecofriendly features and safety environmental issue and chemical insecticide caused a harmful effect in environment and living organismsLC_{50}

value of neem oil, though moderately effective, induced temporary fish stress, suggesting partial toxicity. Shrimali and Rathore 2020 [18] reported that the lowest dose of Neem oil which killed the predatory insects within the desired period of 6 hrs and the death rate of fish seed at this dose is zero. Therefore, the use of Neem oil @0.004 ppm is recommended for the eradication of predatory insects from fish nursery ponds and it is much cheaper than that of conventional method.

Islam *et al.*2014 [9] reported that LC50 for neem seed oil did not show any deformity in shing larvae and its alternative option for the eradication of backswimmers from fish larvae nursery pond. Using neem seed oil in a nursery pond has better environmental options for the shing larvae so that we can get more healthy larvae.

Diesel fuel treatment of backswimmer populations in 0.05-ha ponds resulted in about a 50% control of *Notonecta indica*, mostly during the first 24 hours.

Kerosene and Garlic juice were less suitable; Kerosene was slow-acting, and Garlic drastically reduced alkalinity, hardness, and fish survival.

Gupta *et al*. 2013 [8] reported that under kerosene layers, all the aquatic insects survived for 9-45 minutes and no mortality occurred with petroleum oil layers across air/water interface within this period of observation. Mehan 1937 reported that the ten to twelve gallons of kerosene per acre of waler surface were effective to control aquatic predatory insects.

Shrimali and Rathore 2020 [18] showed the result of present study gives positive results of Neem oil against aquatic insects. In the case of *Notonecta* LC50 0.0059 ppm was at 1 hour which is the highest LC50 value recorded and the least LC value 0.0038 ppm was at 2 hours. LC50 0.0035 and 0.0040 was at 3, 4 and 5 hours respectively observed for suitable Neem oil dose. Where for *Eretes* the least LC50 value of Neem oil is 0.0033 ppm found at 6 hours while the highest LC 0.0060 ppm at 1 hour. LC50 0.0059 was at 2 hour and LC50 value of Neem oil for 3, 4 and 5 hours is 0.0034, 0.0042 and.00037 ppm respectively recorded. where the highest LC50 value on Neem oil 0.0058 ppm is at 1 hour and the lowest 0.0029 ppm was at 4 hours LC50 values 0.0051 and 0.0033 ppm were at 2 and 6 hours respectively and 0.0036 ppm LC is at 3 and 5 hours simultaneously.

Desic *et al*. 2023 [5] reported that turpentine is a fluid that art painters are used mainly as a solvent for thinning oil-based paints, obtained by distilling the resin of coniferous trees.

Miguel 2011 [14] reported that the turpentine (the volatile fraction of the pine resin, obtained by its distillation) and some of its derivative's substances known as insecticides.

Utami 2010 [20] reported that turpentine contains 65-85 % α-pinene, 1% camphene, 1-3% β-pinene, 10-18 % 3-carene and limonene 1-3%. It treated with water in the presence of acid catalyst, α-pinene is hydrated to α-terpineol which can be used as perfume, repellent of insect, antifungal and disinfectant.

Mousa 2013 [15] reported that results showed the garlic (*Allium sativum*) (Piercing-Sucking insect pests) was the best efficient in reducing the population of leafhoppers and planthoppers by a mean reduction percentage of 68.09%.

Prowse *et al.* 2006 [16] reported that mortality rates caused by the garlic juice were comparable with those obtained with the organophosphate pesticide indicated that garlic juice an effective, naturally-derived insecticide for use in agricultural systems against dipteran pests.

Water Quality Parameters

One-way ANOVA revealed that all water quality parameters differed significantly among treatments ($p < 0.001$). Dissolved oxygen (DO) was lowest in Kerosene-treated aquaria and highest in Garlic-treated aquaria. Alkalinity, ammonia, and hardness remained stable in Diesel, Diesel-detergent, and Turpentine treatments, but were drastically reduced in Garlic-treated aquaria. The pH was relatively stable across all treatments (7.9–8.5), with minor reductions observed in Turpentine and Garlic treatments. The pH across the experiment showed significantly difference *($p < 0.05$)* among treatments (Table 5). Bendell 2011 [2] reported that regardless of pH, backswimmers were plentiful in fishless lakes but generally rare or absent in lakes containing fish. Similarly, Shrimali and Rathore 2020 [18] reported that application of Neem Oil has no adverse effect on water quality as there was no significant change in water quality over control. However, the application of neem oil has discovered the significant role of it in the eradication of aquatic insects. Nitrate levels moderately increased in Diesel, Turpentine, and Neem treatments, while nitrite remained low in most aquaria. Phosphate concentrations were slightly elevated in Kerosene-treated aquaria, whereas other treatments maintained stable levels (Figure 1,2,3,4). Overall, turpentine oil and Diesel-based treatments preserved stable water quality and high fish survival, whereas Garlic and Kerosene negatively affected both water parameters and fish health.

Table 5: Water quality parameters across treatments during the experimental periods

Parameter	SS	df	MS	F	P-value	Interpretation
Temperature (°C)	1.12	5	0.224	15.8	<0.001	Significant differences among treatments
Dissolved Oxygen (mg/L)	6.82	5	1.364	182.1	<0.001	Significant differences among treatments
pH	0.42	5	0.084	9.4	<0.001	Significant differences among treatments
Alkalinity (mg/L)	1500	5	300	14.7	<0.001	Significant differences among treatments
Ammonia (mg/L)	2.1	5	0.42	12.3	<0.001	Significant differences among treatments
Hardness (mg/L)	35,000	5	7,000	18.2	<0.001	Significant differences among treatments
Phosphate (mg/L)	0.23	5	0.046	14.5	<0.001	Significant differences among treatments
Nitrate (mg/L)	6.82	5	1.364	182.1	<0.001	Significant differences among treatments
Nitrite (mg/L)	0.05	5	0.01	8.9	<0.001	Significant differences among treatments

One-way ANOVA was performed for each water quality parameter using SPSS version 26, followed by Tukey's post-hoc test to determine significant differences among treatments ($p < 0.05$).

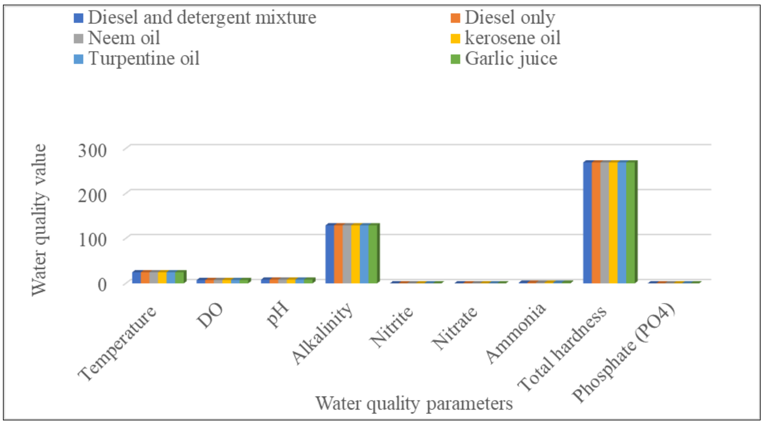

Fig 1: water quality parameters during the initial hours of experiment periods

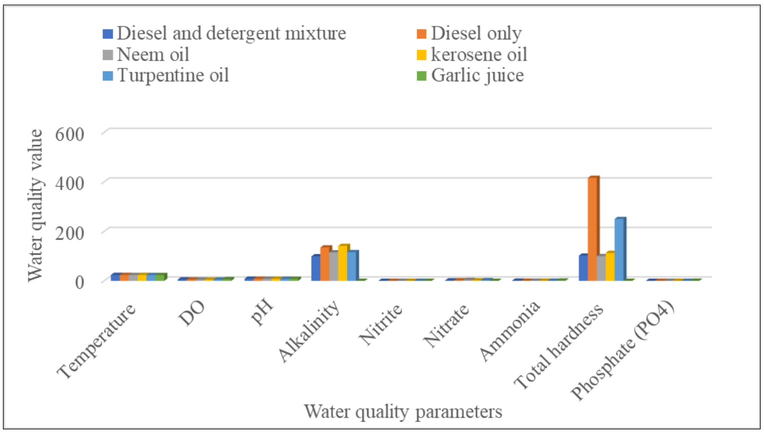

Fig 2: water quality parameters during the 3 hours of experiment periods

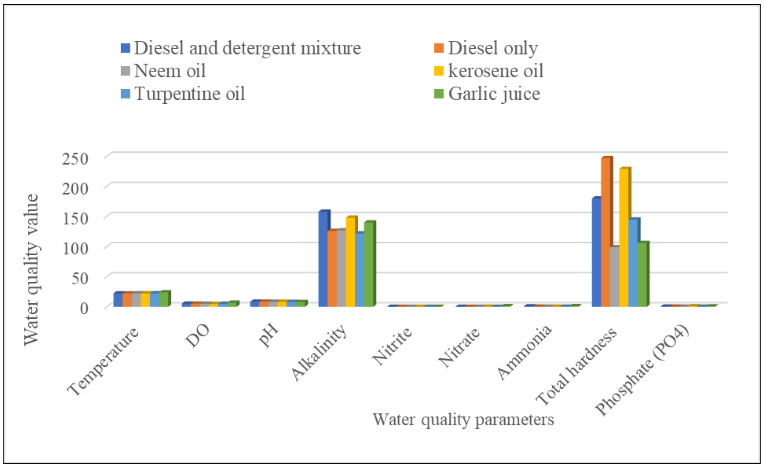

Fig 3: water quality parameters during the 9 hours of experiment periods

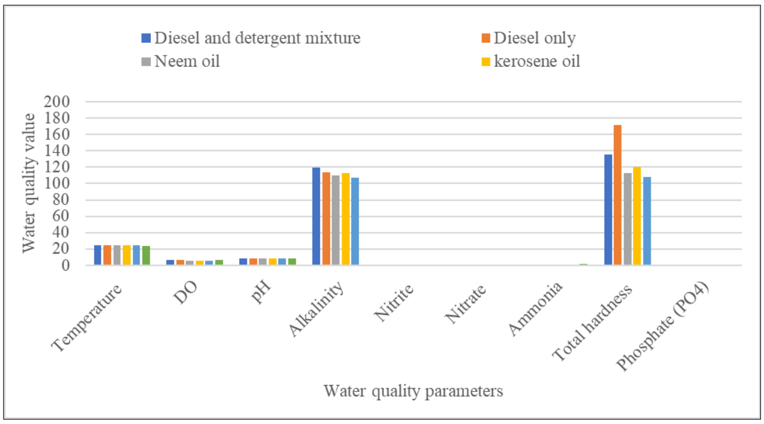

Fig 4: water quality parameters during the 24 hours of experiment periods

Significant differences in water quality parameters (DO, alkalinity, ammonia, hardness, phosphate, nitrate, nitrite) confirm that chemical treatment can alter aquatic conditions. Maintaining DO, controlling ammonia, and preserving hardness are essential for fish survival during chemical pest control. Treatments that balance efficacy and water quality stability are recommended for safe aquaria management. Shrimali and Rathore 2020 [18] the application of Neem Oil has no adverse effect on water quality as there was no significant change in water quality over control.

Conclusion

The study demonstrates that among the six tested treatments for backswimmer (*Notonecta glauca*) control in aquaria, turpentine oil, diesel, and diesel-detergent mixture were the most effective, rapidly eliminating backswimmers while maintaining fish health and stable water quality. neem oil was moderately effective but caused temporary sedation in fish, whereas garlic juice and kerosene had slower efficacy and adversely affected water quality, with Garlic significantly reducing fish survival. Water quality analyses confirmed that treatment type significantly influences parameters such as dissolved oxygen, alkalinity, ammonia, and hardness, highlighting the importance of balancing pest control efficacy with the safety of aquatic organisms. Overall, turpentine oil and diesel-based treatments offer the best combination of efficacy and safety for managing backswimmers in small aquarium.

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