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Eel-tailed Catfish Pituitary Gland: A Sustainable Alternative for Induced Spawning in African catfish

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ABSTRACT

The reliance on expensive synthetic hormones and the ethical concerns of sacrificing potential breeders for pituitary gland (PG) extraction in African catfish (*Clarias gariepinus*) induced spawning necessitate exploring cost-effective and ethical alternatives. This study evaluated the efficacy of PG extracts from eel-tailed catfish (*Tandanus tandanus*) and Nile tilapia (*Oreochromis niloticus*) compared to African catfish PG. Twelve mature African catfish (approximately 500 g each) were divided into three treatment groups (n=4 per group), each receiving PG extracts standardized by donor fish weight. Spawning latency was recorded and analyzed using ANOVA and post-hoc tests. Results demonstrated that eel-tailed catfish PG (13.54 h) exhibited comparable spawning latency to African catfish PG (11.88 h), while Nile tilapia PG resulted in significantly longer latency (17.59 h). This suggests that eel-tailed catfish PG is a viable and cost-effective alternative to synthetic hormones and traditional PG extraction, offering a sustainable solution for African catfish hatcheries.

INTRODUCTION

Aquaculture's sustained growth heavily relies on the controlled reproduction of commercially valuable fish species. Fish maturation and spawning are complex physiological processes meticulously orchestrated by a cascade of hormones, with the hypothalamus playing a pivotal role in initiating this hormonal cascade (Zohar & Mylonas, 2001). To overcome the challenges posed by species that do not readily spawn in captive environments, such as the African catfish (*Clarias gariepinus)* and various carp species, induced spawning techniques have become indispensable (De Graaf & Janssen, 1996).

Synthetic hormones, including luteinizing hormone-releasing hormone (LHRH) analogues, have been widely employed to stimulate maturation, spawning, and ovulation by mimicking the natural hormonal signals (Peter & Yu, 1997). LHRH successfully initiates the hormonal chain reaction leading to ovulation, offering a reliable method for inducing reproduction (Mylonas & Zohar, 2000).

Hypophysation, the injection of pituitary gland (PG) extracts, remains a widely practiced and effective method for inducing spawning, especially in species like carp and African catfish (Crim et al., 1976; Gadissa & Devi, 2013). This technique, pioneered by Houssay, demonstrated the efficacy of crude pituitary extracts in stimulating breeding (Houssay, 1931). Induced breeding techniques, when combined with appropriate environmental cues and the assessment of fish physiological conditions, ensure the production of healthy and uniform-sized fish seed for stocking (Bromage & Roberts, 1995). Hypophysation, a technique refined over decades, remains a practical method for inducing spawning (De Graaf & Janssen, 1996). The phylogenetic distance between the PG donor and recipient is a crucial factor influencing the efficacy of hypophysation. Dosage determination often relies on empirical data due to these variations (Donaldson, 1996). For instance, pituitaries from immature marine catfish have been used at five times the homoplastic dosage to induce ovulation in Indian carp, highlighting the need for dosage adjustments based on phylogenetic relationships (Marte, 1989).

However, the traditional practice of PG extraction from African catfish involves sacrificing potential breeders, which not only depletes valuable broodstock but also devalues market-ready fish (De Graaf & Janssen, 1996). Therefore, the search for alternatives to traditional PG extraction methods is imperative. The current study focuses on addressing these challenges by evaluating the efficacy of alternative PG sources, specifically from eel-tailed catfish (*Tandanus tandanus*) and Nile tilapia (*Oreochromis niloticus*), as replacements for African catfish PG. These species are readily available, potentially offering a sustainable solution for African catfish hatcheries. By exploring the potential of alternative PG sources, this research aims to mitigate the concerns surrounding the sacrifice of potential breeders, thereby contributing to the development of sustainable aquaculture practices.

MATERIAL AND METHODS

Experimental Design

This study employed a completely blocked design (CBD) to evaluate the efficacy of PG extracts from three donor fish species: African catfish (*C. gariepinus*), eel-tailed catfish (*T. tandanus*), and Nile tilapia (*O. niloticus*), for inducing spawning in female African catfish (*C. gariepinus*) breeders. Twelve mature female African catfish breeders (approximately 500 g each) were randomly assigned to three treatment groups (n=4 per group). Each group received a PG extract from one of the donor species: Group 1 (African catfish PG - Control), Group 2 (Eel-tailed catfish PG), and Group 3 (Nile tilapia PG).

PG Extract Preparation

Pituitary glands were collected from mature donor fish of approximately equal weight to the recipient breeders (1:1 weight ratio). The glands were immediately removed, minced, and diluted with 0.3 mL water. The dosage administered to the breeders was 0.5 mL of the PG solution.

Injection and Observation

The PG extract was administered intramuscularly at the base of the dorsal fin. The time of injection was recorded. The breeders were then placed individually in 12 separate plastic basins with screened covers, filled with tap water (temperature: 28–29°C, salinity: 0 ppt, pH: 6.6–6.7) sourced from a deep well. The breeders were continuously monitored for signs of spawning, including increased activity, abdominal swelling, and egg release. The time from injection to the initiation of spawning (spawning latency) was recorded for each breeder.

Data Analysis

Spawning latency data were analyzed using one-way analysis of variance (ANOVA) to determine significant differences among treatment groups. A post-hoc (Duncan) test was performed to identify specific differences between group means. Statistical analyses were conducted using SPSS version 20. A significance level of $p < 0.05$ was used for all tests.

RESULTS AND DISCUSSION

Table 1 depicts the mean spawning latency of African catfish injected with PG extracts from different fish donors. ANOVA revealed that there was a significant difference ($p < 0.05$) between the three

treatment groups. The mean spawning latency for African catfish PG was 11.88 h, for eel-tailed catfish PG, it was 13.54 h, while tilapia PG resulted in a latency of 17.59 h. Post-hoc (Duncan) test revealed that African catfish and eel-tailed catfish pituitary gland (PG) extracts induced comparable spawning latencies ($p > 0.05$). This suggests that the PG from eel-tailed catfish possesses similar gonadotropic activity to that of the African catfish, rendering it a potentially effective alternative. This observation aligns with the concept that phylogenetically related species often exhibit similar hormonal profiles, as supported by studies demonstrating the efficacy of homologous or closely related species' PG in inducing spawning (Mylonas & Zohar, 2001). For instance, Elisdiana et al. (2021) suggested that pituitary gland injection from striped catfish (*Pangasius hypophthalmus*) head waste could enhance spawning performance in African catfish, further supporting the idea that using pituitary glands from closely related fish species can effectively stimulate ovulation.

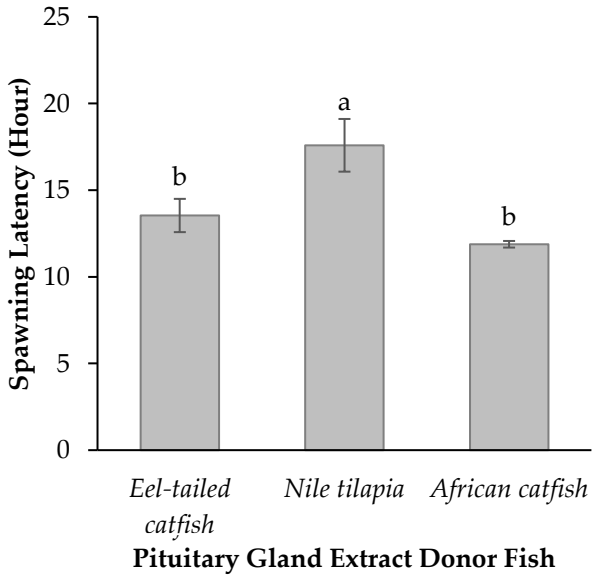

Figure 1. Spawning latency of African catfish using different pituitary gland extracts from different donor fish species

Conversely, Nile tilapia PG resulted in a significantly longer spawning latency of 17.59 h (Table 1), differing substantially from both African catfish and eel-tailed catfish PG extracts ($p < 0.05$). This prolonged latency may be attributed to inherent differences in the molecular structure or concentration of gonadotropins in Nile tilapia compared to the other two species. Gonadotropins, specifically follicle-stimulating hormone (FSH) and luteinizing hormone (LH), play crucial roles in regulating reproductive processes (Oduwole et al., 2021). Differences in the amino acid sequences or glycosylation patterns of these hormones can affect their receptor binding affinity and biological activity (Swanson et al., 2003). It is crucial to note that while this study observed a positive response to Nile tilapia PG, contradicting some previous reports like that of Cortes & Ruaza (2018), who found no egg output, and Gadissa & Devi (2013) that found no effect, it does confirm the ability of the Nile tilapia PG to induce spawning. The observed difference in latency, however, suggests a potentially less efficient or slower stimulation of ovarian maturation in African catfish when using Nile tilapia PG. This discrepancy could also stem from variations in PG preparation methods or the physiological state of the donor fish (Peter & Yu, 1997).

The comparable effectiveness of eel-tailed catfish PG to African catfish PG is particularly significant for aquaculture practices. The use of eel-tailed catfish PG offers a cost-effective and ethically sound alternative, mitigating the need to sacrifice valuable African catfish breeders and reducing reliance on expensive synthetic hormones. This approach is highly practical for small-scale hatcheries, as eel-tailed catfish are readily available and economically viable. The cost-effectiveness of using readily available fish PG compared to synthetic hormones such as HCG or Ovaprim has been a strong consideration for many fish farmers (Olaniyi & Akinbola, 2013).

CONCLUSION

In conclusion, while Nile tilapia PG can induce spawning, the significantly longer latency suggests it may not be optimal for commercial African catfish hatcheries. In contrast, eel-tailed catfish PG emerges as a promising and practical alternative to African catfish PG, offering comparable effectiveness and addressing both economic and ethical concerns. Future research should focus on optimizing PG extraction and dosage protocols for eel-tailed catfish and exploring the underlying mechanisms responsible for the observed differences in spawning latency among the donor species. Detailed molecular

characterization of the gonadotropins in these species, as well as investigations into the effects of different PG preparation and storage methods, would further enhance our understanding and application of these alternative spawning induction techniques.

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Compliance with Ethical Standards

Conflict of Interest

The author declares that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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Not applicable.

Data Availability

The data that support the findings of this study are available from the corresponding author on request.

AI Disclosure

The author confirms that no generative AI was used in writing this manuscript or creating images, tables, or graphics.

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