JURNAL BIOSHELL
e-ISSN: 2623-0321
DOI: 10.56013/bio.v14i2.4330
http://ejurnal.uij.ac.id/index.php/BIO

The Effect of *Pangasius hypophthalmus* Oil on the Memory of Mice (*Mus musculus*)

Robiatun[1]*, Rian Oktiansyah[1], Izon Iktibar[2]
*Email of Corresponding Author's: robirobi_andalausi68@radenfatah.ac.id
[1]Universitas Islam Negeri Raden Fatah Palembang, South Sumatera, Indonesia
[2]SMP Negeri 1 Rambang Kuang, Ogan Ilir, South Sumatra, Indonesia

Article History
Received: June 16, 2025
Revised: June 27, 2025
Accepted: June 29, 2025
Available Online: June 30, 2025

ABSTRACT

Fish oil is an essential nutrient rich in both saturated and unsaturated fatty acids, particularly omega-3, which plays a key role in neuronal development and memory function. The Pangasius fish (*Pangasius hypophthalmus*) is known to contain relatively high levels of omega-3 compared to other freshwater species. This study aimed to examine the effect of Pangasius fish oil on the memory performance of mice (*Mus musculus*). A completely randomised design was employed, involving 24 mice divided into six treatment groups: P0 (control), P1 (0.0016 ml/g body weight/day), P2 (0.0033 ml/g), P3 (0.005 ml/g), P4 (0.0066 ml/g), and P5 (0.0083 ml/g), with four replications each. Treatments were administered over a period of seven days, and memory was assessed using the Y-maze test by recording the number of mice that correctly explored all three arms. The findings indicated a tendency for Pangasius fish oil to enhance memory in mice, likely attributed to its omega-3 content.

Key word: Fish oil, Memory, Mus musculus, *Pangasius hypophthalmus*, Y Maze

I. INTRODUCTION

Fish is a widely consumed food product valued for its rich nutrient content, including fats, vitamins, minerals, and water (Dangal et al., 2024; Maulu et al., 2021; Sharma et al., 2020). Among the various fish species consumed, *Pangasius hypopthalmus*, commonly known as Patin fish, is particularly popular. This species is widely found and cultivated in Indonesia, especially in South Sumatra, where its production has increased by 68% over the past five years, making it a significant focus of Indonesian aquaculture (Amir et al., 2024; Perwita Sari et al., 2024; Surya et al., 2023).

Pangasius hypopthalmus is prized for its large meat content, which is rich in essential nutrients, particularly fish oil. This fish oil comprises 75% unsaturated fatty acids (omega-3) and 25% saturated fatty acids, with the omega-3 content being approximately 40% higher than that of other freshwater fish (Sugata et al., 2019; Syahrul et al., 2023). Omega-3 fatty acids are critical for the growth and development of brain neurons, thereby impacting memory function (Dighriri et al., 2022;

Dinicolantonio & Keefe, 2020; Komar-Fletcher et al., 2023; Lange, 2020; Loong, Spencer, Barnes, Samuel, Gatto Nicole, 2021; Majou & Dermenghem, 2023; Zhou et al., 2022). Memory refers to the process of encoding, storing, and retrieving information, and it is broadly categorized into short-term and long-term memory (Jamaludin, 2022; Oyigeya, 2021; Seitz et al., 2023). Previous research has extensively explored the role of omega-3 in enhancing cognitive abilities and its potential as an antioxidant (Arsecularatne et al., 2024; Castellanos-Perilla et al., 2024; Mora et al., 2022; Suh et al., 2024).

Notably, previous studies have shown that extracts from fish such as snakehead (*Channa striata*), which are rich in unsaturated fatty acids like omega-3 and linoleic acid, can significantly support neuronal development and enhance memory performance in mice (Atmajaya et al., 2019; Lee et al., 2022; Petermann et al., 2022). Omega-9, another unsaturated fatty acid commonly found in freshwater fish, has also been associated with cognitive improvements (Carr et al., 2023; Das et al., 2024; Lehner et al., 2020; Santos et al., 2023; Scharnweber et al., 2021; Zeleke Tilinti et al., 2023). These findings highlight the broader role of unsaturated fatty acids in supporting brain function and memory. However, despite the widespread consumption of *Pangasius hypophthalmus*, particularly in Indonesia, and its relatively high omega-3 content—approximately 40% higher than other freshwater fish—there is still a limited body of research exploring its direct impact on memory. Given this gap, the present study aims to examine the potential effect of *Pangasius hypophthalmus* fish oil on the spatial memory of mice (*Mus musculus*), thereby contributing new insights into its cognitive benefits.

II. RESEARCH METHOD

This research was conducted at the Integrated Laboratory of Raden Fatah State Islamic University, Palembang. The experimental design consisted of six treatment groups, each with four repetitions. The Y-maze test was employed to assess the spatial memory of the mice by recording the percentage of correct arm entries, such as ACB, ABC, BCA, BAC, CAB, and CBA, compared to incorrect entries such as AAC, AAB, BBC, BBA, CCB, CCA, ABB, ACC, BAA, CAA, ACA, ABA, BCB, BAB, CBC, CAC, AAA, BBB, and CCC (Callahan et al., 2021; Kim et al., 2023; Mohandasan et al., 2022; Oktiansyah et al., 2018; Shang et al., 2023; Thongrong et al., 2024; Vorhees & Williams, 2024; Wijnen et al., 2024).

The selected Patin fish were cleaned and drained before being weighed for extraction preparation. The fish oil was extracted following a standard protocol (Panagan et al., 2011). The testing procedure involved housing four mice per treatment group in cages measuring 30 cm × 37 cm × 9 cm, lined with rice husks and covered with wire mesh, and each provided with food and water. The mice were acclimatized for seven days prior to the administration of fish oil, which was given orally once daily for seven consecutive days at the designated doses: P0 (control, 0 ml/g body weight/day), P1 (0.0016 ml/g body weight/day), P2 (0.0033 ml/g), P3 (0.005

ml/g), P4 (0.0066 ml/g), and P5 (0.0083 ml/g body weight/day).

On the eighth day, the spatial memory of each mouse was assessed using the Y-maze test, conducted in a dark room illuminated with red light to minimize external visual stimuli. The movements of the mice were recorded using a camera mounted on a tripod, and both the number and percentage of correct arm entries in the Y-maze were observed as indicators of memory performance. The collected data were then subjected to analysis of variance (ANOVA), and post-hoc tests were performed if the F-value exceeded the critical threshold at the 5% and 1% significance levels.

III. RESULT AND DISCUSSION

The observations revealed that some mice were able to complete the Y-maze within five minutes. The results, as shown in Table 1, indicate differences in the average memory scores of the mice after being treated with varying doses of Pangasius fish oil.

Table 1. Average Memory Scores of Mice after Treatment with Pangasius Fish Oil

Treatment	Repetition (%)				Average (%)
	1	2	3	4	
Control	63.15	62.50	84.21	50.00	64.96 ± 14.19
0.0016 ml/g body weight/day	68.00	68.75	66.67	68.18	67.90 ± 0.88
0.0033 ml/g body weight/day	50.00	63.63	73.91	80.00	66.88 ± 13.13
0.005 ml/g body weight/day	57.89	68.18	89.28	72.72	72.02 ± 13.07
0.0066 ml/g body weight/day	58.33	80.00	64.51	76.19	69.76 ± 10.07
0.0083 ml/g body weight/day	89.47	57.14	89.47	75.00	77.77 ± 15.35

Table 1 shows fluctuations in the average memory scores of the mice, indicating that Pangasius fish oil has an effect on memory in mice (*Mus musculus*). Statistical analysis suggests that Pangasius fish oil does not significantly enhance memory ($p < 0.05$), although the average changes in memory scores observed in the Y-maze test suggest a tendency for Pangasius fish oil to influence memory in mice. This is evident in the treatment group with the highest average memory score of 77.77% at a dose of 0.0083 ml/g body weight/day.

Based on this study, Pangasius fish oil (*Pangasius hypopthalmus*) influences memory in mice (*Mus musculus*), with the highest dose resulting in improved average memory scores. The average memory improvement fluctuated across treatments compared to the control group, with the highest average improvement being 77.77% and the lowest 64.96%. The fluctuation in average memory scores suggests that Pangasius fish oil can enhance memory in mice. This finding aligns with research which explained that the potential of snakehead fish extract (*Channa striata*) as a cognitive enhancer in white mice (*Mus musculus* L), where the Y-maze test indicated no significant differences between the control group and the group given snakehead fish extract, although there was a tendency for memory enhancement, albeit not statistically significant (Mustafa, 2023; Yuliana et al., 2022).

The memory improvement observed is likely due to the nutritional content of Pangasius fish oil, which consists of 25%

saturated fatty acids and 75% unsaturated fatty acids (omega-3). Omega-3 fatty acids are crucial for brain neuron growth, which in turn affects memory. Higher doses of fish oil result in greater absorption of omega-3 fatty acids (Dighriri et al., 2022; Loong, Spencer, Barnes, Samuel, Gatto Nicole, 2021; Wood et al., 2022). Omega-3 fatty acids, particularly Eicosapentaenoic Acid EPA and Docosahexaenoic Acid (DHA), play a key role in the formation of sphingomyelin, a structural component of nerve cells (myelin). EPA is important for cell membrane formation, and the sphingomyelin formed by EPA and DHA is used to build brain cell membranes and myelin in nerve cells. Adequate levels of EPA and DHA in the brain facilitate the transmission of signals from the brain to axons, with myelin accelerating the signal transmission, thereby enhancing motor function and development. Conversely, insufficient EPA and DHA levels result in cell membrane degradation, leading to impaired signal transmission to axons, which in turn hampers neurotransmitter function and slows motor development (Madinah et al., 2021; Namiecinska et al., 2024; Pilecky et al., 2021; Sinclair, 2019; Yang & Chen, 2022).

DHA has a significant impact on hippocampal nerve development and synaptic function. Long-chain polyunsaturated fatty acids, particularly DHA, are neuro-biological agents that influence neuronal membrane structure, synaptogenesis, and myelination (Cao et al., 2010). DHA functions as a nerve sheath, facilitating nerve signal transmission to the brain. Omega-3 fatty acids are essential nutrients for brain development and nerve function (Kim et al., 2011).

Regular DHA intake can enhance prefrontal cortex activity, which is responsible for cognitive functions (Cao et al., 2010). DHA also contributes to maintaining brain cell membranes, supporting neurogenesis, neurotransmission, and modulating gene expression in mammals, which can result in neuron growth and memory enhancement (Oster & Pillot, 2010). Regular consumption of fish rich in omega-3, such as salmon, herring, and sardines, helps meet the brain's omega-3 needs. For the Indonesian population, Pangasius fish is more accessible and provides a viable source of omega-3 (Lauritzen et al., 2016).

The enhancement of memory observed in mice following administration of *Pangasius hypophthalmus* fish oil can be mechanistically explained through the action of omega-3 fatty acids particularly EPA and DHA on neuronal plasticity and synaptic signalling. DHA, a major structural component of neuronal membranes, contributes to increased membrane fluidity, which facilitates efficient synaptic vesicle fusion and neurotransmitter release. It also modulates the expression of Brain-Derived Neurotrophic Factor (BDNF), a key molecule involved in the survival and growth of neurons, particularly in the hippocampus a brain region central to memory formation (Calderon & Kim, 2004). Moreover, omega-3 fatty acids influence the regulation of inflammatory processes within the brain; DHA and EPA are known to inhibit the production of proinflammatory cytokines such as IL-6 and TNF-α, which, when elevated, are associated with cognitive decline (Oster & Pillot, 2010).

At the molecular level, these fatty acids can activate Peroxisome Proliferator-Activated Receptors (PPARs), which are nuclear receptors that regulate gene expression involved in neuronal differentiation, mitochondrial biogenesis, and oxidative stress response. By improving mitochondrial function and reducing oxidative damage, omega-3 supplementation supports the energy metabolism required for effective synaptic plasticity. This results in enhanced signal transmission and neural efficiency, contributing to improved learning and memory function (Weiser et al., 2016). These interconnected mechanisms help explain why higher doses of Pangasius fish oil rich in omega 3 fatty acids lead to greater cognitive performance in mice, as observed in this study.

IV. CONCLUSION

The findings of this study indicate that fish oil derived from *Pangasius hypophthalmus* has the potential to improve memory function in mice (*Mus musculus*), as demonstrated by an increase in correct Y-maze exploration percentages across all treatment groups compared to the control. The highest dose (0.0083 ml/g body weight/day) resulted in the greatest memory performance, with an average correct exploration rate of 77.77% ± 15.35, compared to 64.96% ± 14.19 in the control group. This suggests a dose-dependent relationship between Pangasius fish oil administration and memory enhancement.

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