American Journal of Life Science and Innovation (AJLSI)

ISSN: 2833-1397 (ONLINE)

VOLUME 4 ISSUE 2 (2025)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Life Science and Innovation (AJLSI)

Volume 4 Issue 2, Year 2025
ISSN: 2833-1397 (Online)
DOI: https://doi.org/10.54536/ajlsi.v4i2.5047
https://journals.e-palli.com/home/index.php/ajlsi

Heavy Metal Analysis in *Crassostrea iredalei* (Slipper Oyster) from Dumangas and Barotac Nuevo, Iloilo, Philippines

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Article Information

Received: April 20, 2025

Accepted: May 22, 2025

Published: October 11, 2025

Keywords

Crassostrea Iredalei, Heavy Metal Determination, Slipper Oyster, Spectrophotometry

ABSTRACT

It is relevant to analyze the concentrations of heavy metals in *C. iredalei*. This study was conducted to analyze the concentrations of the heavy metal contents, such as copper (Cu), lead (Pb), and zinc (Zn) in *C. iredalei* from Dumangas and Barotac Nuevo, Iloilo, Philippines. The samples of *C. iredalei* were analyzed using flame atomic spectrophotometry, and results were compared to regulatory limits set by the International Shellfish Safety and Sanitation Standards. In the town of Dumangas, Pb (mean = 0.01mg/L; sd = 0.11;) Cu (10.44 mg/L; sd = 2.95); and Zn (mean = 3.35 mg/L; sd = 0.13) were within the accepted values set by the regulatory limits of the International Shellfish Safety and Sanitation Standard. The samples of *C. iredalei* were taken from March 31st and April 7th, 2023. On the other hand, in the town of Barotac Nuevo, Pb (mean = -0.09, mg/L s = 0.02); Cu (mean = 10.14 mg/L, sd = 0.95; and Zn (mean = 3.21 mg/L; sd = 0.10) were within were within the accepted values set by the regulatory limits of the International Shellfish Safety and Sanitation Standard, too. This implies that the *C. iredalei* samples from farms in towns Dumangas and Barotac, Iloilo, Philippines, were safe for consumption and do not pose threats concerning heavy metal intoxication.

INTRODUCTION

A popular delicacy that is widely cultivated in the Philippines for human consumption is the slipper oyster, or Crassostrea iredalei (Monaya *et al.*, 2022). Therefore, encouraging a sustainable economy will raise the fishing industry's and its related sectors' economic value (Rustia *et al.*, 2023). It is a popular item throughout Asia due to its inexpensive cost, especially among the poor (Pakingking *et al.*, 2022). One essential food source that may be found all across the coastal region is *C. iredalei.* The nation produced 40,736.89 metric tons (MT) of C in 2021. Western Visayas contributed 10,886.16 MT, the second-highest amount among the other regions (Department of Agriculture's Bureau of Fisheries and Aquatic Resources, 2022).

Meat production for domestic use is the primary objective of oyster farming. By 2020, it is anticipated that oyster production alone will be worth Php 1.552 billion. Nutrition, food security, and the battle against poverty depend on them because they are the primary source of food and money for poor fishermen (Lebata-Romos *et al.*, 2023). Situated in the center of the Philippines, the Western Visayas region is one of the main suppliers of oysters. More farms are being established in the Western Visayas region as a result of the need for extra sources of income brought on by small-scale fishermen's diminishing catch.

However, contamination in aquatic biological systems has become much more common in recent years due to mining and agricultural activities (Noman *et al.*, 2022). Heavy metals in coastal and estuarine ecosystems, along with other environmental pollutants, have raised concerns in environmental conservation (Wang *et al.*, 2022). Oysters are filter feeders that can collect pathogens from surrounding waters, potentially causing foodborne diseases in consumers (Pakingking *et al.*, 2022).

Persistently polluted organisms absorb heavy metals, which can cause severe illnesses such food poisoning, liver damage, cardiovascular abnormalities, and even death (Anandkumar *et al.*, 2018). Food contamination by toxic heavy metals is a worldwide environmental risk that impacts hundreds of millions of people. Their toxicity results in a broad range of harmful biological effects (Balali-Mood *et al.*, 2021). Oysters are valued as delicacy, but their fitness for human consumption should be monitored, especially as they are believed to be hyper-accumulators of a number of dangerous metals, such as cadmium, copper, and zinc (Wang & Weng, 2018). Cellular processes such as growth, proliferation, differentiation, damage repair, and apoptosis are all hampered by heavy metals. Through the production of Reactive Oxygen Species (ROS), oxidative stress, enzyme inactivation, and weakened antioxidant defense, these metals cause toxicity. High levels of exposure to heavy metals, especially lead and mercury, can cause serious side effects such as kidney failure, bloody diarrhea, and colic in the abdomen (Tsai *et al.*, 2017).

Due to equipment problems, the Bureau of Fisheries and Aquatic Resources (BFAR) has not performed heavy metal analyses in the past four years, saving them for cases of oyster exportation outside of the country (R. Chua, personal communication, January 10, 2024). Therefore, it

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seems sense to investigate the levels of heavy metals in *C. iredalei* in Dumangas and Barotac Nuevo, Iloilo.

The purpose of this study was to examine the levels of heavy metals in *C. iredalei* from Barotac Nuevo and Dumangas, Iloilo. In particular, this study was able to characterize the many types of heavy metals that are present in *C, including* lead (Pb), copper (Cu), and zinc (Zn). *C iredalei*, from the oyster farms at Barotac Nuevo and Dumangas, Iloilo, during the last week of March and first week of April 2024. Additionally, the study measured the amounts of Cu, Pb, and Zn in *C. iredalei* at the time of collection and determined the heavy metal concentration in *C. iredalei* with regard to the International Safety and Sanitation Standard for Shellfish.

According to the study's findings, it was safe to eat *C. iredalei* from the municipalities of Dumangas and Barotac Nuevo. In the last week of March and the first week of April 2024. The Pb, Cu, and Zn levels were within the permissible range established by the International Shellfish Safety and Sanitation Standards.

MATERIALS AND METHODS

Research Design

The occurrence of heavy metals like lead (Pb), copper (Cu), and zinc (Zn) in oysters from Dumangas and Barotac Nuevo, Iloilo, was investigated using a descriptive quantitative design. Additionally, it determined that the concentrations of certain heavy metals were within permissible bounds.

Research Setting

Oyster farms in Dumangas and Barotac Nuevo provided the data for this investigation. The laboratory of a private institution in Iloilo City was used to examine the heavy metals.

Ethical Considerations

This study was approved by the ethics committee of a private university in Iloilo City.

Data Collection Procedures

Collection of *C. iredalei*: For two weeks, *C. iredalei* samples were taken every week from two locations: Dumangas and Barotac Nuevo.

Preparation of Samples: In accordance with the techniques of Azevedo *et al.* (2019), Pakingking *et al.* (2022), and Villafuerte *et al.* (2022), the *C. iredalei* were taken out of their shells using a knife. During transportation, the meat and intravenous fluid were gathered in a zippered storage bag and kept on ice. A mortar and pestle were then used to defrost and homogenize the samples. After being moved to their individual crucibles, the homogenates were weighed at 25 grams apiece.

After being dried at 105 °C in a Memmert Drying Oven, the oyster samples were moved to a muffle furnace and heated for at least 24 hours at an increasing temperature of 450 °C to 500 °C. A desiccator was then used to chill the samples. Two milliliters of nitric acid were added to each oyster sample, which was then heated on a hot plate until it dried. To get carbon-free ash, this process was carried out at least twice.

The samples were cooked on a hot plate with ten milliliters of 1N hydrochloric acid until all of the ashes had been dissolved. Following a 2.5 millimeter pore size Whatman Grade 5 filter, the materials were moved to a 25 milliliter volumetric flask.

Detection of Heavy Metals: A flame atomic absorption spectrophotometer (Agilent AA55 MY1546001) was used to measure the levels of Cu, Pb, and Zn in the filtered digests. The stock standard solution was diluted to a concentration of 1000 micrograms per milliliter (μg/mL) or parts per million (ppm) in order to create all of the heavy metal standard solutions. The stock solution was then further diluted into concentrations of 0.300, 0.500, 0.700, 1.000, and 1.500 μg/mL to create the working standard solutions. Every result was expressed in parts per million or milligrams per liter. Analytical grade substances were used in this investigation. A certified chemist examined and verified the study. Five (5) replicates of each of the two (2) sets of samples were examined.

Interpretation of Results: The mean and standard deviation were used to determine whether the results fell within the range of the International Shellfish Safety and Sanitation Standards, which are regulatory limits established by the Food and Drug Administration and the European Union.

RESULTS AND DISCUSSIONS

The results showed that the Zn (*mean* = 3.35 mg/L; *sd* = 0.13), Cu (*mean*=10.44 mg/L; sd = 2.95), and Pb (*mean* = 0.01 mg/L; *sd* = 0.11;) in the municipality of Dumangas were all within the acceptable levels established by the International Shellfish Safety and Sanitation Standard (Table 1). The *C. iredalei* samples were taken from March 31 and April 7, 2023. On the other hand, Pb (*mean* = -0.09 mg/L, s=0.02), Cu (mean = 10.14 mg/L, sd = 0.95), and Zn (mean = 3.21 mg/L, sd = 0.10) were all within the permitted limits established by the International Shellfish Safety and Sanitation Standard in the town of Barotac Nuevo.

Table 1: Concentrations of Heavy Metals in *C. iredalei* Collected from Dumangas, Iloilo, Philippines

Heavy Metal	Accepted Value	Concentration (mg/L) Mean	SD	Interpretation
Pb	1.5	0.01	0.12	Within accepted values
Cu	100	10.44	3.23	Within accepted values
Zn	150	3.35	0.14	Within accepted values

Table 2: Concentrations of Heavy Metals in *C. iredalei* Collected from Barotac Nuevo, Iloilo, Philippines

Heavy Metal	Accepted Value	Concentration (mg/L) Mean	SD	Interpretation
Pb	1.5	-0.09	0.02	Within accepted values
Cu	100	10.14	1.04	Within accepted values
Zn	150	3.31	0.11	Within accepted values

Discussion

Zinc, copper, and lead in *C. iredalei* that were gathered from the municipalities of Dumangas and Barotac Nuevo, Iloilo met the The International Shellfish Safety and Sanitation Standard's permissible limits. These heavy metals' comparatively low levels in *C. iredalei* can be ascribed to the sampling locations' seclusion from mining operations and industrial industries. The farms where the *C. iredalei* were gathered and isolated from other rivers in the area. According to Noman *et al.* (2022), contemporary mining and farming methods have the potential to contaminate aquatic biological systems, which in turn may affect the levels of heavy metals in aquatic invertebrates like *C. iredalei*.

Zinc and copper were the most prevalent metals found because of Cu and Zn-based agricultural products that are widely used in nearby shrimp and fish-rearing ponds. The levels of these heavy metals were found to be consistent with the findings of Pakingking *et al.* (2022) in their examination of slipper oyster farming areas of the Cogon and Palina Rivers and Cabugao Bay (in Roxas City and the Municipality of Ivisan, respectively, Capiz Province, Western Visayas, Philippines). Concentrations of lead, cadmium, mercury, and chromium, meanwhile, were below the legal thresholds established by the US and the EU. The Food and Drug Administration. Additionally, research by Ochoa *et al.* (2013) found that the concentrations of heavy metals in oysters cultivated in Catalonia, Spain's Ebro Delta were largely similar to those found in earlier studies conducted in various unpolluted areas. This suggests that the higher exchange rate with marine water in bays where oysters are grown results in a decrease in metal levels.

Since zinc and copper are regarded as necessary nutrients for the typical growth and development of *C. iredalei*, the comparatively greater quantities of these elements are to be expected (Ochoa *et al.*, 2013). According to Pan and Wang (2009), aquatic invertebrates contain copper, and the bioaccumulation of this element might rise in direct proportion to the size of the animal. Natural cofactors in enzymatic processes within cells are Zn and Cu, which occur as ions (Zn^{2+} and Cu^{2+}), and high levels of these metals are obtained by *C. iredalei* through their diet. Because Pb has been frequently linked to human poisonings, periodic monitoring of harmful metals in oysters should continue even though the concentration was below permissible levels (Balali-Mood *et al.*, 2021).

According to this study, *C. iredalei* can be safely consumed because heavy metals like lead, copper, and zinc were within permissible bounds. However, ongoing observation is necessary.

Only the quantity and interpretation of lead, copper, and zinc from C.iredalei samples collected between March 31 and April 7, 2024, from the municipalities of Dumangas and Barotac Viejo, Iloilo, are covered by the findings.

CONCLUSION

As of the last week of March and the first week of April 2024, the levels of lead, copper, and zinc in *C. iredalei* from Dumangas and Barotac Nuevo were within the permissible range established by the International Shellfish Safety and Sanitation Standard. In terms of heavy metal intoxication during those months, the *C. iredalei* samples were safe to eat. It is advised that heavy metals, such as Cu, Pb, and Zn, be continuously monitored in *C. iredalei*, not just in Dumangas and Barotac Nuevo, Iloilo, but across the region. Measuring the concentrations of chromium, iron, and cadmium might also help future studies build on the current findings.

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