



Qualitative Test of Heavy Metals in *Chanos chanos* (Bangus) Found in the First District of Northern Samar

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The *Chanos chanos* is a warmwater teleost fish species that is commonly used as a food resource because of its good taste and great demand in the market. It is also known as the national fish of the Philippines. This study was conducted to determine the heavy metals found in *Chanos chanos* in terms of Arsenic (As), Cadmium (Cd), Chromium (Cr), and Lead (Pb). Samples were collected from San Jose, Northern Samar, Philippines. Physical properties of the sample in terms of its pH and solubility were also determined. Results showed that the *Chanos chanos* tested positive for the Lead heavy metal and found in the belly part of the fish. The pH level of *Chanos chanos* extract is acidic while it is soluble in water and methanol and insoluble to the toluene. It was noted that the presence of Lead indicates contamination of the marine resources, hence, a thorough policy on saving and mitigating these resources must be the first act of the concerned local agencies.

Keywords: *Chanos chanos*; detection; Arsenic; Cadmium; Chromium; Lead; fishpond.

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1. INTRODUCTION

Thousands of living creatures are found in the aquatic environment which can benefit humans. Milkfish is a source of food and is one of the major assets that human gets from these creatures. However, many of these living creatures are killed because of ocean pollutants. Milkfish, also called *Bangus* is an example of an aquatic animal. The *Chanos chanos* is a silvery marine food fish that is the only living member of the family Chanidae. In the Philippines, *Bangus* is mainly used for food because of its taste and has great demand in the market.

Chanos chanos is a very healthy source of protein and is also packed with nutrients. A few of the most abundant are vitamin D, Calcium, and Phosphorus. All three nutrients are very valuable to a healthy skeletal fracture. Vitamin D that comes from the fish is essential for maintaining healthy bones because it aids in calcium absorption [1].

Nowadays, due to the ocean pollution that come from a great amount of garbage and the developing industries, aquatic creatures are not safe to eat because of the heavy metals found in an organism. Although, heavy metals are naturally occurring elements that can be found in the earth's crust. Heavy metals are defined as metallic elements that have a relatively high density compared to water. With the assumption that heaviness and toxicity are interrelated, heavy metals also include metalloids, such as Arsenic which can induce toxicity at a low level of exposure. "Heavy metals are natural components of the Earth's crust. They cannot be degraded or destroyed to a small extent they enter our bodies via food, drinking water, and air. As trace elements, some heavy metals are essential to maintain the metabolism of the human body. However, at higher concentrations, they can lead to poisoning. Heavy metals could result for instance, from drinking water contamination, high ambient air concentration near emission sources, or intake via the food chain" [2].

"Arsenic is a natural metalloid element found all over Earth's crust. However, when combined with other elements like hydrogen and oxygen it becomes deadly poisonous. This chemical element is among the most toxic substances in the world and exposure may lead to various symptoms of poisoning, the development of cancer, and even death. Arsenic poisoning occurs primarily through ingestion but some of

the poison also seep in through touch and inhalation" [3].

"Cadmium accumulates in the kidney tissue of fishes in sub-lethal concentrations. It has been reported to possess nephrotoxic action in various animals. The kidney is also one of the principal target organs of Cadmium toxicity and exposure in almost all animal species is characterized by varying degrees of renal damage such as glomerulus, tubules, and Bowman's capsule" [4].

"Chromium is present in rocks, soil, animals, and plants. It can be solid, liquid, and in the form of gas. Chromium compounds are very much persistent in water sediments. They can occur in many different states such as divalent and multi-valent states. Cr VI and Cr III are the most stable forms and only their relation to human exposure are of high interest" [5-7]. "Chromium VI compounds, such as calcium chromate, zinc chromate, strontium chromate, and lead chromates, are highly toxic and carcinogenic. Cr III, on the other hand, is an essential nutritional supplement for animals and humans and has an important role in glucose metabolism. The uptake of hexavalent Chromium compounds through the airways and digestive tract is faster than that of trivalent chromium compounds. Occupational sources of Chromium include protective metal coatings, metal alloys, magnetic tapes, paint pigments, rubber, cement, paper, wood preservatives, leather tanning, and metal plating" [8].

"Lead poisoning was a classic disease and the signs that were seen in children and adults were mainly in the central nervous system and the gastrointestinal tract" [9]. "Lead has major effects on different parts of the body. Lead distribution in the body initially depends on the blood flow into various tissues and almost 95% of lead is deposited in the form of insoluble phosphate in skeletal bones" [10].

Even though heavy metals are naturally occurring in the earth's crust, a large number of toxic chemicals have been dumped on purpose from industrial sources or naturally flow off land and directly into our rivers and streams, which eventually end up in some fishponds [11]. Such heavy metals are not easily excreted out because they do not break down; rather, it increases within a certain body until it reaches a high level of toxicity. These bad effects on human health like chemicals such as oil, mercury, lead, pesticides, and other heavy

metals can all be found within the ponds and can contaminate water supplies and the food chain by ingesting these chemicals than the organisms. This study aimed to detect the presence of heavy metals in *Chanos chanos* (*Bangus*) and also focused to identify the heavy metals found in *Bangus* and how harmful it is to marine food fish, and humans.

2. METHODOLOGY

Samples of *Chanos chanos* were obtained in a fishpond in San Jose, Northern Samar, Philippines. The sample were collected on January to March 2020 and was halted due to the COVID-19 pandemic. The sample was prepared, cleaned, and blended. The meat part and the belly part of the *Bangus* was used in this study. After which, it was mixed with 75mL of water and 25grams of the sample to make a *Bangus* solution.

Physical Properties. The pH of the *Chanos chanos* meat extract was determined by using a digital pH meter. A 5mL of the meat extract was placed in a beaker and a digital pH meter was dipped into the meat extract solution. After a minute, the reading of the digital pH meter was recorded. The procedure was replicated thrice. The water pH of the fishpond of the sampling area was also measured. It was measured using a digital pH meter. The bottles were sterilized first. The procedure was replicated thrice.

Solubility. A 3mL of *Bangus* meat extract was placed in three (3) test tubes separately. The first test tube was added with a 4mL Hexane, the second test tube was added with 4mL water, and the third test tube with a 4mL of Ethanol. Each test tube was shaken vigorously. The observations were recorded as compatible or incompatible with the different solvents used. The procedure was replicated thrice [12].

2.1 Qualitative Detection of Heavy Metals

Qualitative detection of Arsenic. "In a prepared *Bangus* sample solution, a 3M HCl was added until it was barely acidic. It was centrifuged for three (3) minutes, and then the centrifugate was discarded. Then, on the residue, ten (10) drops of concentrated HCl were added, the solution was stirred and heated in a hot water bath for one minute and then the centrifugate was removed. The residue was washed with a mixture of eight drops of water and four (4) drops of concentrated HCl, and then, it was centrifuged

and added to the centrifugate of the concentrated HCl treatment. The residue and the centrifugate were separated. The residue was washed with hot water three times, then four (4) drops of concentrated HNO₃ were added, and heated for five (5) minutes in a water bath. After heating, 5 drops of 0.5M AgNO₃ were added and then stirred. To clear the centrifugation, fifteen (15) drops of 2.5m NaAc solution were added. The formation of a reddish-brown precipitate indicates the presence of Arsenic" [12].

Qualitative detection of Cadmium. "It forms a yellow precipitate with sulfide ion either from a natural solution containing free Cd²⁺ or from an ammoniacal solution of Cd(NH₃)₄²⁺. Since most sulfides are insoluble, and many of them are black, the presence of other metal ions may make it difficult to detect the yellow color of CdS. Therefore, separations must be as complete as possible before testing for Cd²⁺. In the prepared *Bangus* sample a 0.1 M Na₂S solution was added. The formation of yellow precipitate confirms the presence of cadmium ions" [13].

Qualitative detection of Chromium. Chromium can be taken through a series of colored tests which leaves no doubt as to its identity. Chromium (III) forms a steel green hydroxide which dissolves in excess strong base to give a deeply green-colored solution of the hydroxyl complex. Treating this complex with 3% hydrogen peroxide gives the yellow solution of the chromate ion, which upon acidification with dilute nitric acid gives the orange color of dichromate. Treatment of the cold solution of dichromate with 3% hydrogen peroxide gives the intense blue color of peroxide of chromium. This peroxide readily decomposes to the pale violet color of the original hydrated chromium (III) ion. In low concentrations of di-chromate, the blue color is fleeting, and attention must be focused on the test tube during the addition of the hydrogen peroxide to avoid missing the color change. The following color changes are all indicative of Cr³⁺. An excess of 6M NaOH was added to about one (1) mL of the *Bangus* sample solution. To this solution 10 drops of 3%, H₂O₂ were added. Then, the test tube was heated in the water bath until the excess H₂O₂ was destroyed as indicated by the cessation of bubbles. The yellow solution was acidified with 3M NHO₃. "The resulting orange solution was cooled in an ice bath. Finally, to the cooled solution, a drop or two of 3% H₂O₂ was added and immediate fleeting blue/steel green color was observed. This fleeting blue/steel green

color indicates the presence of chromium ions” [13].

Qualitative detection of Lead. Although “PbCl₂ is insoluble at room temperature, its solubility is increased dramatically at higher temperatures, it dissolves readily in boiling water. Pb²⁺ also forms an insoluble white sulphate, which dissolves in a solution containing acetate ion due to the formation of the weak electrolyte, Pb(CH₃COO)₂. The addition of chromate ion to this lead acetate solution yields a precipitate of yellow lead chromate. In the *Bangus* solution, a 3M HCl was added drop-wise. A large excess of HCl must be avoided because of the formation of the soluble chloro-complex, PbCl₄²⁻. Centrifuged and the supernatant liquid from the white precipitate was removed. Hot water was added to the precipitate and then stirred. If the precipitate dissolves, Pb²⁺ is present. To the hot solution, 3M H₂SO₄ was added. Centrifuged and supernatant liquid from the white precipitate (PbSO₄) is removed. To the precipitate, 3M NH₄ (CH₃COO) was added and then stirred. A few drops of 0.5M K₂CrO₄ were added to the solution. A yellow precipitate of PbCrO₄ indicates the presence of Pb²⁺ [12].

3. RESULTS

In this section, the data gathered in the experiment was presented. The results were based on the visible precipitate formed during the analysis. Each test was conducted thrice.

3.1 Physical Properties

The pH is one of the physical properties that can affect the presence of heavy metals in a sample. The release of heavy metals increases in the low pH condition than in higher pH [14]. The effect of pH on the speciation of heavy metals is of great significance to the migration and transformation of metals [15]. The mechanism of heavy metals uptake through water may explain the influence of pH and salinity on the lethal toxicity detected [16]. The change of pH conditions in the system

will have a certain impact on the migration and distribution of heavy metals [17]. The pH of the sample if it has heavy metals contributes to its surrounding pH. Table 1 shows the pH value of the belly part and meat part of the *Bangus* gathered in San Jose, Northern Samar, Philippines. In the pH scale, results above 7.0 is basic, below 7.0 is acidic, and 7.0 is neutral. As shown, the belly part of the *Bangus* concludes that it is barely acidic while the meat part is acidic. In overall, the *Bangus* sample is acidic in terms of the pH level. On the other hand, Table 2 shows the pH value of the water of the fishpond, the result shows that it has a neutral pH value.

Table 1. pH value of *Chanos chanos*

Sample Trial	Belly Part	Meat Part
1	Barely Acidic	Acidic
2	Barely Acidic	Acidic
3	Barely Acidic	Acidic

Table 2. pH value of the fishpond

Sample Trial	pH Value
1	7.7
2	7.2
3	7.0

The Table 3 shows the solubility of the belly part and the meat part of the *Bangus*. Based on the table, the belly part and meat part are soluble in the water and the methanol while both are insoluble to the toluene. It means that the belly and meat parts of *Bangus* are polar molecules.

3.2 Detection of Heavy Metals

Table 4 describes the qualitative test for Arsenic. A reddish-brown precipitate appears if there is a presence of Arsenic in the sample. In the sample, there was no formation of a reddish-brown precipitate. Hence, all samples yielded a negative result in the analysis. This shows that the *Bangus* from San Jose, Northern Samar were free of Arsenic contamination.

Table 3. Solubility of the *Chanos chanos*

Sample Trial	Water		Methanol		Toluene	
	Belly	Meat	Belly	Meat	Belly	Meat
1	Soluble	Soluble	Soluble	Soluble	Insoluble	Insoluble
2	Soluble	Soluble	Soluble	Soluble	Insoluble	Insoluble
3	Soluble	Soluble	Soluble	Soluble	Insoluble	Insoluble

Table 4. Detection of arsenic

Sample Trial	Belly Part	Meat Part
1	Negative	Negative
2	Negative	Negative
3	Negative	Negative

Table 5 describes the qualitative test for Cadmium. In detecting cadmium in the sample, a yellow precipitation formation must appear to confirm its presence. Based on Table 5, neither the belly part nor the meat part tested positive for the presence of cadmium. It simply means that the *Bangus* in San Jose, Northern Samar are cadmium contamination free.

Table 5. Detection of cadmium

Sample Trial	Belly Part	Meat Part
1	Negative	Negative
2	Negative	Negative
3	Negative	Negative

Table 6 describes the qualitative test for Chromium. A visible result for chromium will be indicated by a blue/steel green color in the *Bangus* sample solution. It showed that the belly part and meat part of the sample tested negative for the presence of chromium. This result shows that the *Bangus* samples and the location of the fishpond of San Jose, Northern Samar were chromium free.

Table 6. Detection of chromium

Sample Trial	Belly Part	Meat Part
1	Negative	Negative
2	Negative	Negative
3	Negative	Negative

Table 7. Detection of lead

Sample Trial	Belly Part	Meat Part
1	Negative	Positive
2	Negative	Positive
3	Negative	Positive

Table 7 describes the qualitative test for Lead. When yellow precipitation is formed in the sample, it indicates that there is a presence of Lead. As shown in the table, the belly part of the *Bangus* was tested negative for the presence of the lead. Meanwhile, the meat part of the *Bangus* tested positive for the presence of lead. Yellow precipitation formed and appeared. It means that

the *Bangus* in San Jose, Northern Samar have lead contamination. Lead contaminants may come from the waste thrown from the industrial factories and from the gasoline of boats that may cause contamination to the fish.

4. CONCLUSION

Based on the data gathered, the *Bangus* collected from San Jose, Northern Samar were free from Arsenic, Cadmium, and Chromium. However, the belly part of the *Bangus* fish tested positive for the Lead content. It can be noted that such presence of heavy metals in a marine resource like *Chanos chanos* is a warning since people living near the fishpond use these fishes as a source of their meal. A confirmatory test should be done to know the quantity of Lead contamination in the meat extract. In the meantime, the concerned local agencies must act swiftly on why there traces of Lead in *Bangus*. Mitigating the problem rather than solving it is better. The local government must collaborate with institutions in helping re-exam the area for a better view of the problem.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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