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Removal of heavy metals using cactus mucilage and potato starch from the Smelter Lagoon in Cerro de Pasco, Peru

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Abstract— *The present investigation had the objective of evaluating the efficiency of cactus mucilage with potato starch in the removal of Aluminum (Al), Copper (Cu), Iron (Fe), Lead (Pb) and Zinc (Zn). Data were collected from the point with coordinates 361194.863 east and 8809776.548 north of Laguna Smelter, Cerro de Pasco. Initial results were 1.966 mg/L Al; 0.3635 mg/L Cu; 8.844 mg/L Fe; 0.554 mg/L Pb; 1.8563 mg/L Zn. In P1 and with treatment of 50g of cactus mucilage and 10g of potato starch, it was possible to reduce the aforementioned metals, the data obtained are as follows: 1.72 mg/L of Al; 0.28 mg/L of Cu; 6.788 mg/L of Fe; 0.515 mg/L of Pb; 1.5385 mg/L of Zn and also a neutral pH of 7.06 was obtained, therefore an alternative and economic treatment for mining industry water is being proposed.*

Index Terms—*Heavy metals, mucilage, cactus, cactus removal*

I. INTRODUCTION

Heavy metals are harmful inorganic pollutants and the contamination of water bodies by heavy metals is a critical health and environmental problem [1]. High concentrations of heavy metals in waters pose a threat to health and the environment. [2].

Water is a fundamental resource for human beings, but due to population growth, water pollution has increased. [3].

The Smelter lagoon located in the Smelter population center adjacent to the Colquijirca population center district of Tinyahuarco, province of Pasco, is open to untreated wastewater, runoff and wastewater from mining tailings. Water bodies with the presence of heavy metals cause serious contamination and treatment methods are very expensive. [4]. Studies evaluate heavy metals in food, specifically in meat and milk, finding different metals such as cadmium, mercury, lead, and arsenic are elements that due to their high impact on health and concentration should be thoroughly evaluated and monitored. [5].

This is the reason why the research of technologies for the reduction and/or elimination of heavy metals has been promoted, which must be economical, reliable and safe; materials of plant origin are the most recommendable because they are renewable, biodegradable and economical. [6].

Mining is one of the most important economic activities worldwide, several river basins in southern Peru are rich in deposits and deposits that over time the areas where the processes are carried out face changes, becoming affected areas. [7]. Industrial practices, such as chrome plating, leather tanning, wood treatment and mining, are the main causes of the accumulation in the environment of chromium, an element considered a toxic heavy metal.[8]. The mining industry is the main responsible for the degradation of the water body, due to the discharge of tailings that have different characteristics, carrying with them high concentrations of dissolved and suspended materials. [9].

Currently, many mining companies prioritize the welfare of the surrounding communities, however, there are environmental liabilities that have been abandoned as in the case of the Smelter Lagoon. [9]. Accessible technologies are needed to eliminate and/or reduce heavy metals. [2]

Opuntia cladode mucilage has been used in several industries and in traditional applications, however, it is important to know alternatives for the absorption of heavy metals present in water. [10] However, it is important to know alternatives for the absorption of heavy metals present in water, such as the application of cactus mucilage (Opuntia Ficus) and potato starch that seeks high efficiency to achieve an improvement and a lower social and environmental impact

II. MATERIALS AND METHODS

A. Sample location and collection

Samples were collected from the Smelter lagoon located in the town of Smelter in the district of Tinyahuarco, province of Pasco (Fig. 1.). The strategic and representative point was identified where the samples were taken (see Fig. 2), 3 liters of water were extracted. The georeferencing and identification of the monitoring point was recorded as shown in Table I. The sample was labeled and sent to the laboratory Analytical Laboratory E.I.R.L. (ALAB) accredited by the accreditation agency INACAL - DA with registration No. LE - 096.

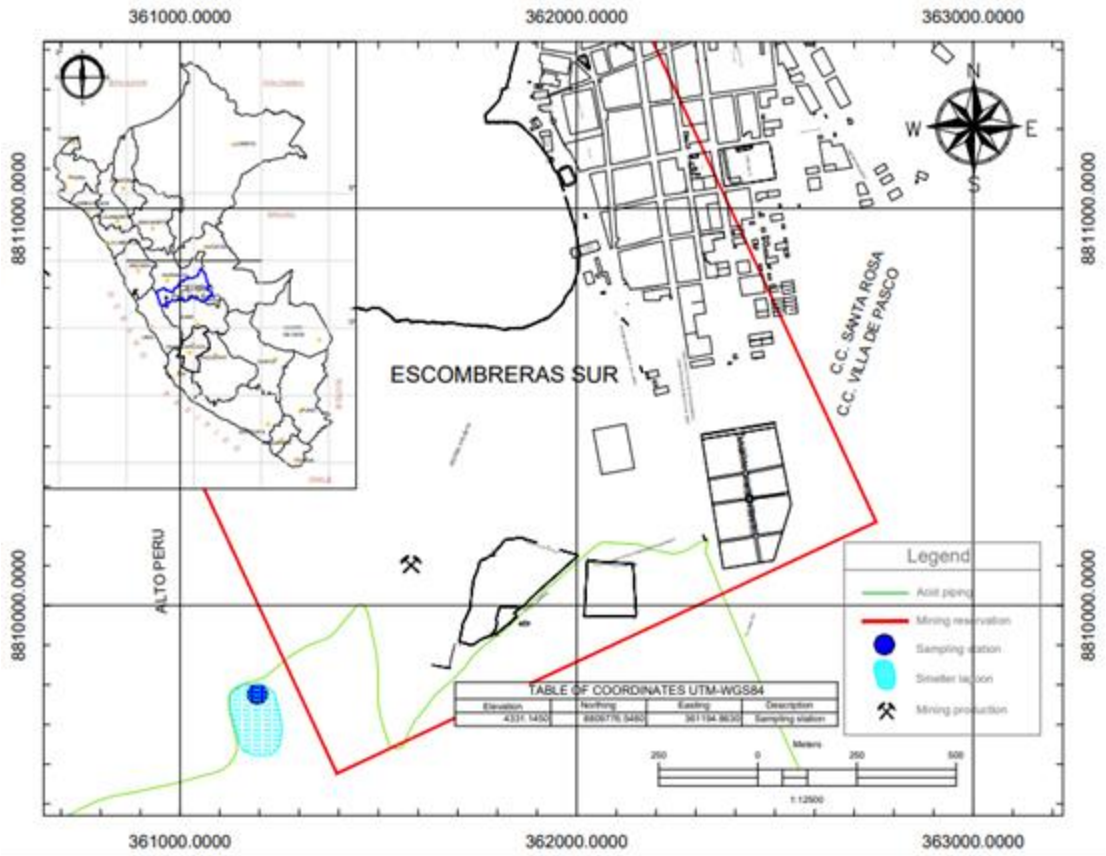

Fig. 1. Map of the Laguna study area.

Table I: Coordinates of the Monitoring Station

Point	This	North	Elevation
(P1)	361194.863	8809776.548	4331.145

B. Characterization of the sample

Parameters such as pH and heavy metals were taken into account. Table II shows the metals evaluated; Analytical Laboratory E.I.R.L. was required to obtain the corresponding results, whose analysis was carried out through atomic emission spectrometry.

Table II: Metals evaluated

Metals	P1 (mg/L)
Aluminum	1, 966
(Al)	0.3635
Copper (Cu)	8.844
Iron (Fe)	0.554
Lead (Pb)	1,8563
Zinc (Zn)	

Dissolution	Description
P1 + 50gMN+10gAP	500ml of P1 water + 50g of nopal mucilage + 10g of potato starch.

Fig. 2. Punto representativo del muestreo.

C. Nopal cactus mucilage concentration to reduce heavy metals

Nopal is an abundant, cost-effective and biodegradable natural product that acts as a coagulant, flocculant and biosorbent for wastewater treatment. [11].

The Nopal plant was found in the district of San Jeronimo de Tunan, Huancayo with an approximate length of 23 cm.

In a 500 ml volume of water sample from Smelter Lagoon, 50 g of Nopal mucilage and 10 g of potato starch were added as shown in Table III, to determine the reduction of heavy metals present in the water.

Table III: Concentration of Opuntia ficus solution.

III. RESULTS

A. Hydrogen Potential Results

The results obtained from the pH result show that the effect of cactus mucilage plus potato starch works effectively achieving a pH, in Fig. 3 that the initial pH is 8.25 and obtaining a final pH of 7.06.

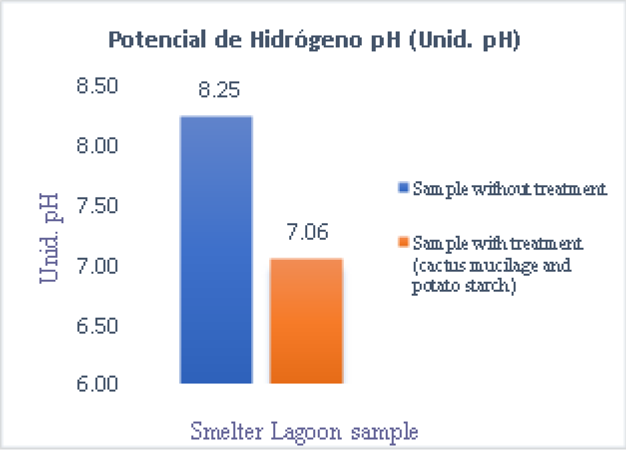

Fig. 3. pH variation with the application of Mucilage and potato starch.

B. Metal removal results

The results of the initial metal concentrations are detailed in Table IV

Tabla IV: Concentración inicial de los metales pesados

Dissolution	Unid.	Results
Aluminum	mg/L	1.966
Copper	mg/L	0.3635
Iron	mg/L	8.844
Lead	mg/L	0.554
Zinc	mg/L	1.8563

a. Aluminum

As shown in Fig. 4, aluminum was successfully removed from 1.966 mg/L to 1.72 mg/L. The nopal mucilage together with the potato starch acts neutralizing the pH causing the adsorption of this mineral.

Fig. 4. Aluminium removal.

b. Copper

In this metal, the results show that it was possible to remove from 0.364mg//L to 0.28mg/L (Fig. 5). The nopal mucilage together with the potato starch acts by neutralizing the pH, causing the adsorption of copper.

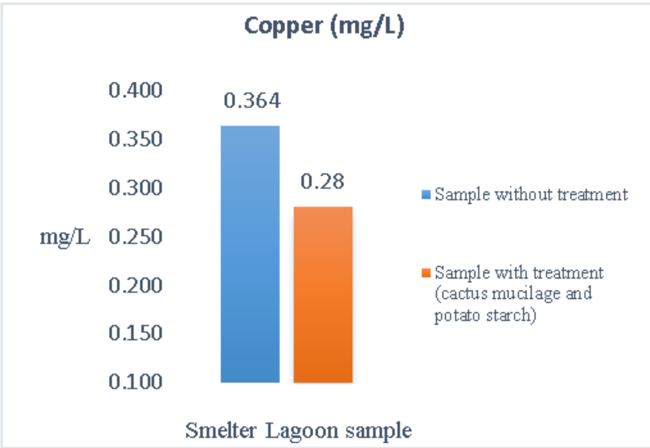

Fig. 5. Copper removal.

c. Iron

The tests experimented for iron start from an initial figure of 8.844 mg/L (Fig. 6) and apply cactus mucilage together with potato starch. The elimination of this metal is based on the precipitation of hydroxides produced by pH neutralization.

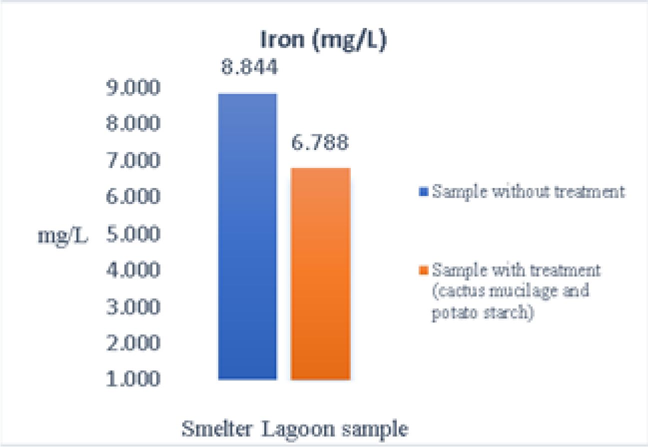

Fig. 6. Iron removal.

d. Lead

Fig. 7 shows the results of the Pb concentration, according to the results of the ALAB laboratory, the following results were obtained: 0.554mg/L initial and 0.515mg/L final.

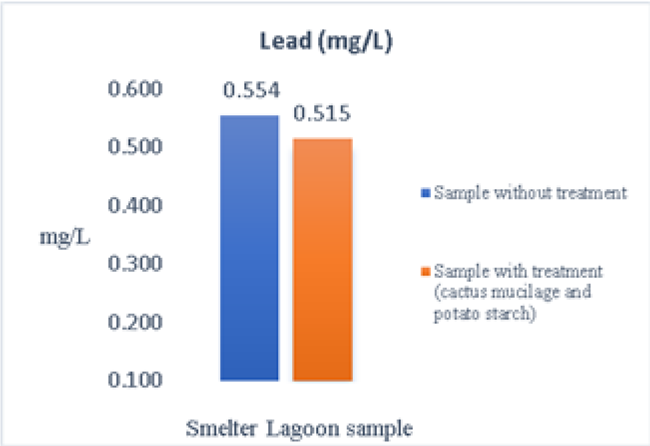

Fig. 7. Lead removal.

e. Zinc

As shown in Fig. 8, Zinc was successfully removed from 1.856mg/L to 1.5385mg/L. The nopal mucilage together with the potato starch acts neutralizing the pH causing the adsorption of this mineral.

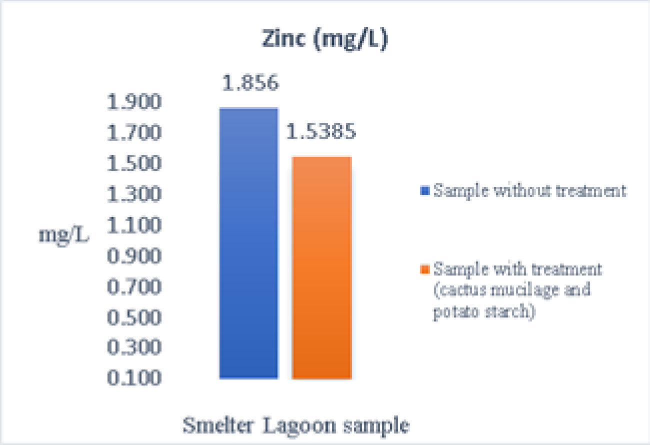

Fig. 8. Zinc removal.

CONCLUSION

It is concluded that the use of cactus mucilage together with potato starch reduces the concentration of metals, thus being considered as an efficient alternative.

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