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BIOTECHNOLOGICAL POTENTIAL OF *Ochroma pyramidale* AS A MERCURY SUBSTITUTE IN GOLD MINING

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ABSTRACT

The damage that mercury causes to human health and the environment has stimulated the search for natural substances that are really efficient. Reports on the use of *Ochroma pyramidale* leaves in the gold separation process led us to evaluate this evidence in the laboratory. This study demonstrated the effectiveness of the aqueous extract of *Ochroma pyramidale* in the process of separating gold from other sediments, after its gravimetric pre-concentration.

Keywords: Balsa wood. Mercury. Gold. Rio Madeira. Amazon.

1 INTRODUCTION

Gold extraction uses gravimetric techniques to concentrate the precious metal, but it also uses substances such as mercury and cyanide to concentrate/separate alluvial gold from the other residues that make up the gold concentrate. However, the toxic effects that these substances have on human health and the environment [1] have stimulated the search for natural alternative substances that are truly efficient and eliminate impacts on environmental health and human exposure.

Ochroma pyramidale, also known as balsa wood, is a tropical tree species from the Malvaceae family, known for its extremely light and resistant wood. *O. pyramidale* leaves have been used in the gold separation process in Chocó, Colombia [2 3]. There are also empirical records of the use of its leaf extract in small-scale artisanal gold mining (ASM) in the Amazon, which makes it a potential substitute for metallic mercury (Hg^0).

However, to date no study has demonstrated the efficiency of this process in the separation of fine gold (alluvial and/or colluvial) in the Madeira River Basin (Brazilian Amazon). Therefore, in this work, we sought to evaluate the performance of the extract from the leaves of *Ochroma pyramidale* in the gold separation process in the laboratory and to understand the properties of the extract's action on the mineral particles.

2 MATERIAL & METHODS

The study was carried out at the Environmental Biogeochemistry Laboratory of the Federal University of Rondônia (UNIR). The aqueous extract of the leaves of *Ochroma pyramidale* was prepared using fresh leaves of young specimens planted on the UNIR campus and submerged in distilled water for 01 hour (100g/L) [4]. The extracts obtained were called crude aqueous extract. The crude extract (100%) was diluted with distilled water in the following proportions 1:1/2, 1:1 e 1:2 (v/v).

A viscosity test was carried out to determine the kinematic viscosity of the *O. pyramidale* extracts using a Ford cup-type viscometer for Newtonian liquids n° 02 (orifice diameter = 2,53mm), brand Nalgon, at a temperature of 25°C, according to NBR 5849/2015 [5]. All experiments were carried out in tenfold.

Portions of 100g of the auriferous concentrate (donated by the Cooperativa dos Garimpeiros do Rio Madeira - COOGARIMA) were placed in a beater and the less dense particles were removed through levigation by dragging the force of the water. A neodymium magnet was passed over the remaining waste to remove metals with ferromagnetic properties and only after these procedures was the aqueous extract of *O. pyramidale* applied to the auriferous concentrate. The auriferous concentrate was fractionated into 100g (dry weight) aliquots and subjected to the gold separation test with the aqueous extract of *O. pyramidale*. The golden determinations were carried out on 1g (dry weight) of the auriferous concentrate before the extract of *O. pyramidale* was applied and at the end with on all the gold recovered. The chemical extraction was carried out with aqua regia at a concentration of 3:1 of HCl/HNO_3 v/v (Merck®) and the gold content was determined by ICP-OES (Optima 8300 Perkin Elmer®).

3 RESULTS & DISCUSSION

After hydrating the fresh leaves of *Ochroma pyramidale*, it was possible to extract a viscous yellow/reddish liquid (figure 1) with an average kinematic viscosity of 68,30 ± 21,49 mm^2/s for the crude extract and 47,90 ± 14,70 mm^2/s for the extract diluted in a 1:1 (v/v) ratio, at a temperature of 25°C and pH 6.5.

Figure 1 A specimen of the plant and an extract of its leaves of *Ochroma pyramidale*.

The gold concentration test was more effective using the aqueous extract diluted in a ratio of 1:1 (v/v, crude extract and water) than the crude extracts. Applying the crude extract to the auriferous concentrate removed all particulate material from the pan, including the gold particles. When the diluted extract was used, it only interacted with the less dense solid particles, dragging them along and leaving the denser particles, such as gold, trapped at the bottom of the beater (figure 2).

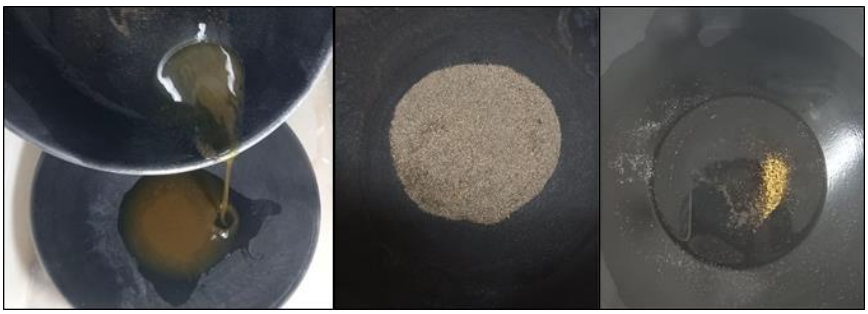

Figure 2 Procedure for separating gold from other sediments using *O. pyramidale* extract.

Notably, the concentration of gold was due to the viscous fluid released by the leaves of *O. pyramidale* [3]. This viscous liquid is attributed to the mucilage produced by the leaves of *O. pyramidale* and is a water-soluble polysaccharide polymer complex. Our results showed that the mucilage from the aqueous extract of *O. pyramidale* has biosorbent properties with the ores of the auriferous concentrate. There are reports in the literature that mucilage from other plants is able to bind to metal ions efficiently. Table 1 shows the results of the gold concentrations in the tests carried out before extraction with *O. pyramidale* and in the final product.

Table 1 Gold concentration results obtained at the beginning and end of the process.

Gold concentrate	Results $\bar{x}$ ($g.kg^{-1}$)	Percentage (%)	Concentration
[C] Au_0	3,58 ± 1,04	0,35 ± 0,10	1x
[C] Au_f	11,10 ± 11,40	1,11 ± 1,20	3x

We observed that the solid-liquid interaction between the extract and the gold concentrate particles is proportional to the viscosity of the *O. pyramidale* extract. The higher the viscosity, the greater its adsorption power with dense particles, which makes it impossible to separate the gold. However, by reducing the kinematic viscosity to 45-50 mm^2/s, the binding forces with the denser particles were reduced, favoring the removal of uninteresting particles and concentrating the gold ore.

4 CONCLUSION

This study demonstrated the effectiveness of the aqueous extract of *Ochroma pyramidale* in the gold separation process in the laboratory, promoting a final product that is three times more concentrated, making it a promising substitute for mercury in small-scale artisanal mining. Alternative procedures to the use of mercury in alluvial gold extraction in the Amazon must be carried out in a simple and economical way, so that artisanal miners can make practical use of the extract in their operations. This study contributes directly to the guidelines of the Minamata Convention.

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