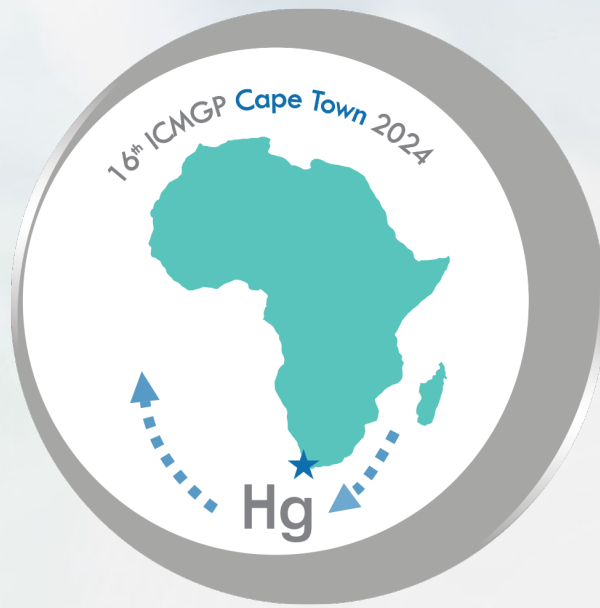




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Use of bitter cassava as an alternative to gold amalgamation

Emiliano M. Silva, Pariya Torkaman, Maria do Carmo S. Barreto,
Jorge Valença Mariz, Marcello M. Veiga, Giorgio de Tomi



The authors



University of São Paulo
Department of Mining Engineering
Brazil

Emiliano M. Silva, Ph.D. cand.
Prof. Giorgio de Tomi, Ph.D.



University of British Columbia
Department of Mining Engineering
Canada

Pariya Torkaman, Ph.D.
Prof. Marcello M. Veiga, Ph.D.



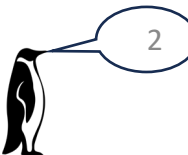
Maná Foods
Cibus Starch
Brazil

Maria do Carmo S. Barreto, Ph.D.
Jorge Valença Mariz, Ph.D.



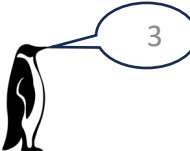
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Introduction

- In this study we explored "*manipueira*," a by-product from the cassava root starch industry, as an alternative to the traditional amalgamation process for gold extraction.
- Gold ore samples from Antioquia, Colombia (49 ppm Au), and Pernambuco, Brazil (16 ppm), were used in leaching tests with *manipueira* from a cassava starch production company.
- The objectives of the study were:
 - To compare gold extraction by *manipueira* leaching tests with conventional amalgamation;
 - Take advantage of the proximity between a large cassava starch industry and an AGM operation in Pernambuco, Brazil.

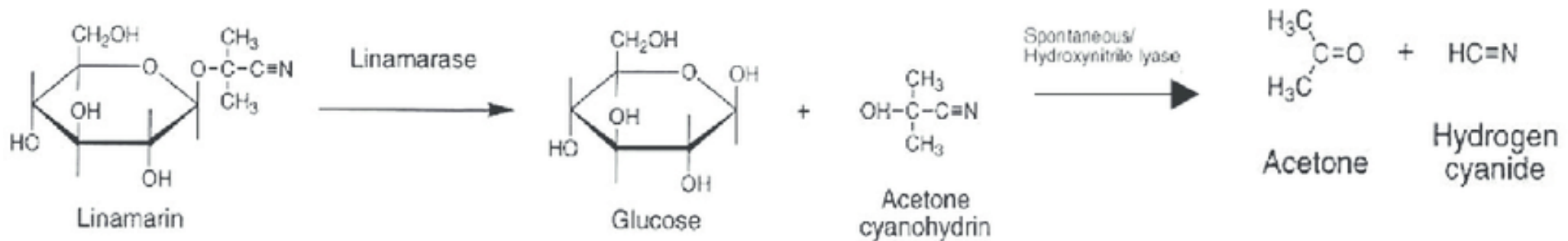


Cyanogenic plants

- More than 2000 plants contain glycosides that can be converted to cyanide by hydrolysis
- Some bitter cassava can have 2.4 g of cyanide/kg of plant
- More than 800 million people in the world have cassava as staple food



<https://abam.com.br/a-mandioca-a-guerra-e-a-seguranca-alimentar-do-brasil-e-do-mundo/>



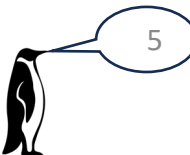
Cassava production (2022)

Country	millions of tonnes
 Nigeria	60.8
 Democratic Republic of the Congo	48.8
 Thailand	34.1
 Ghana	25.6
 Cambodia	17.7
 Brazil	17.6
World	330

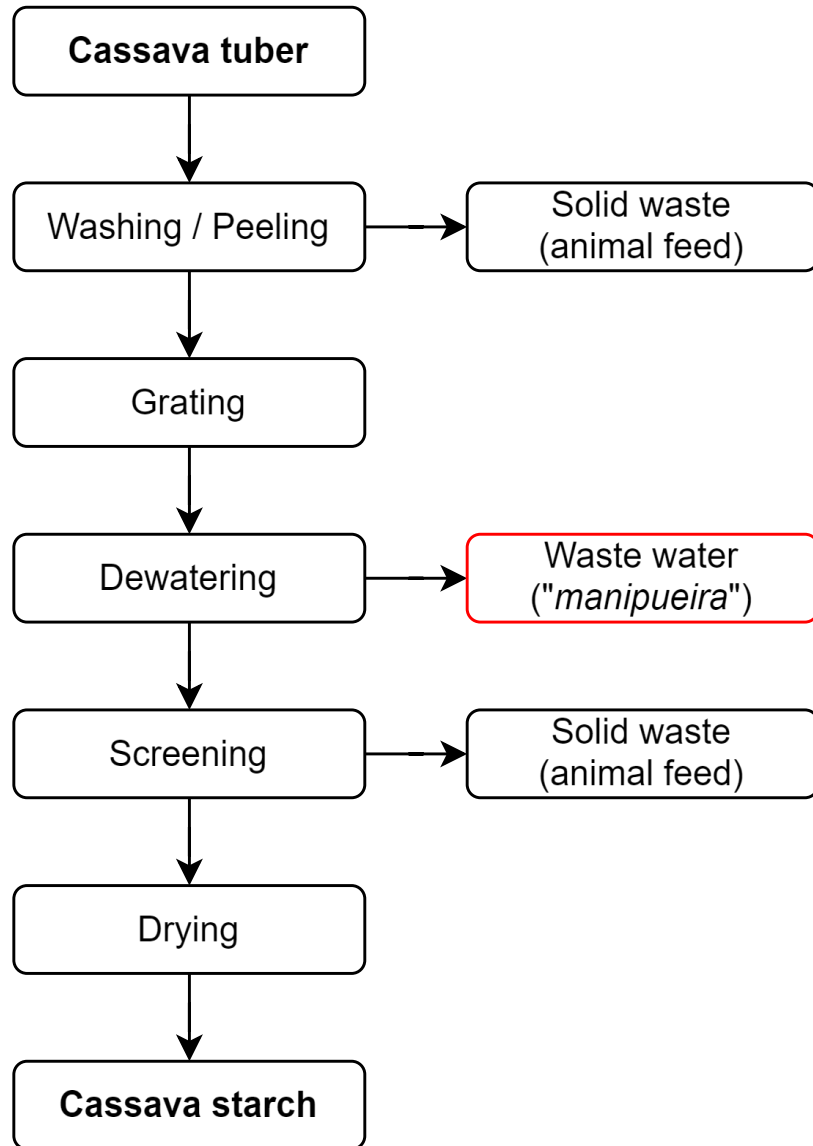
Food and Agriculture Organization Corporate Statistical Database, 2023



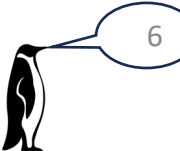
- Nigeria produced 18% of the total world cassava production in 2022



Obtaining “Manipueira”



~30% w/w



Study area



Maná, Pernambuco, Brazil

- Large automated cassava starch production plant
- Processing up to 400 t/day of cassava to extract starch



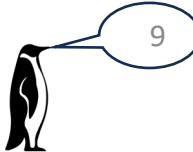
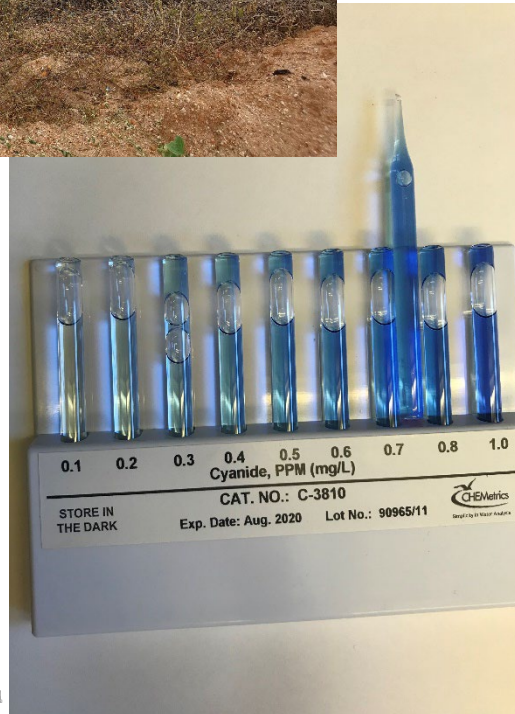
Centrifuges to extract starch



Maná/Cibus, Pernambuco, Brazil



- Producing up to 120,000 L/day of “manipueira” (varying concentrations between 100 and 600 ppm of free CN)
- Free CN in manipueira can be analyzed by colorimetric method



AGM in Salgueiro, Pernambuco, Brazil



- Amalgamation of the whole ore with Copper-Hg plates
- Tailings with Hg are leached with cyanide



Methodology

Samples

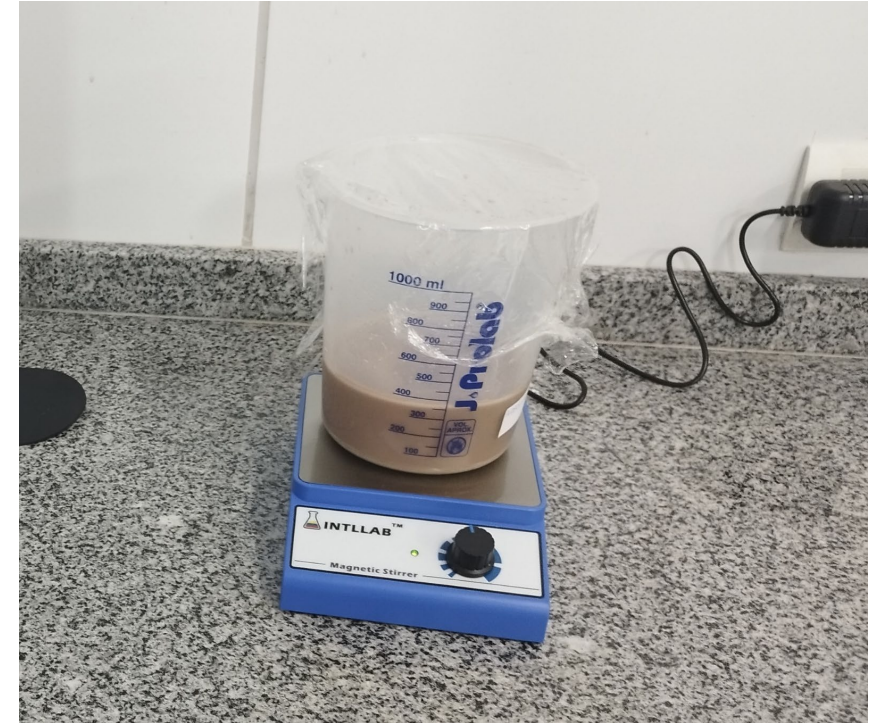


49 ppm Au



16 ppm Au

- Ground to < 100 mesh (149 μm)
- Amalgamation in the lab of Colombian ore
- Lab agitated leaching tests
- Various leaching times
- Solid : Liquid ratios ranging from 10 to 20 %
- Controlled pH ~ 10.5
- $[\text{CN}^-]$ in manipueira ranging from 250 to 600 ppm
- Au analysis by fire assay (head and tailings)

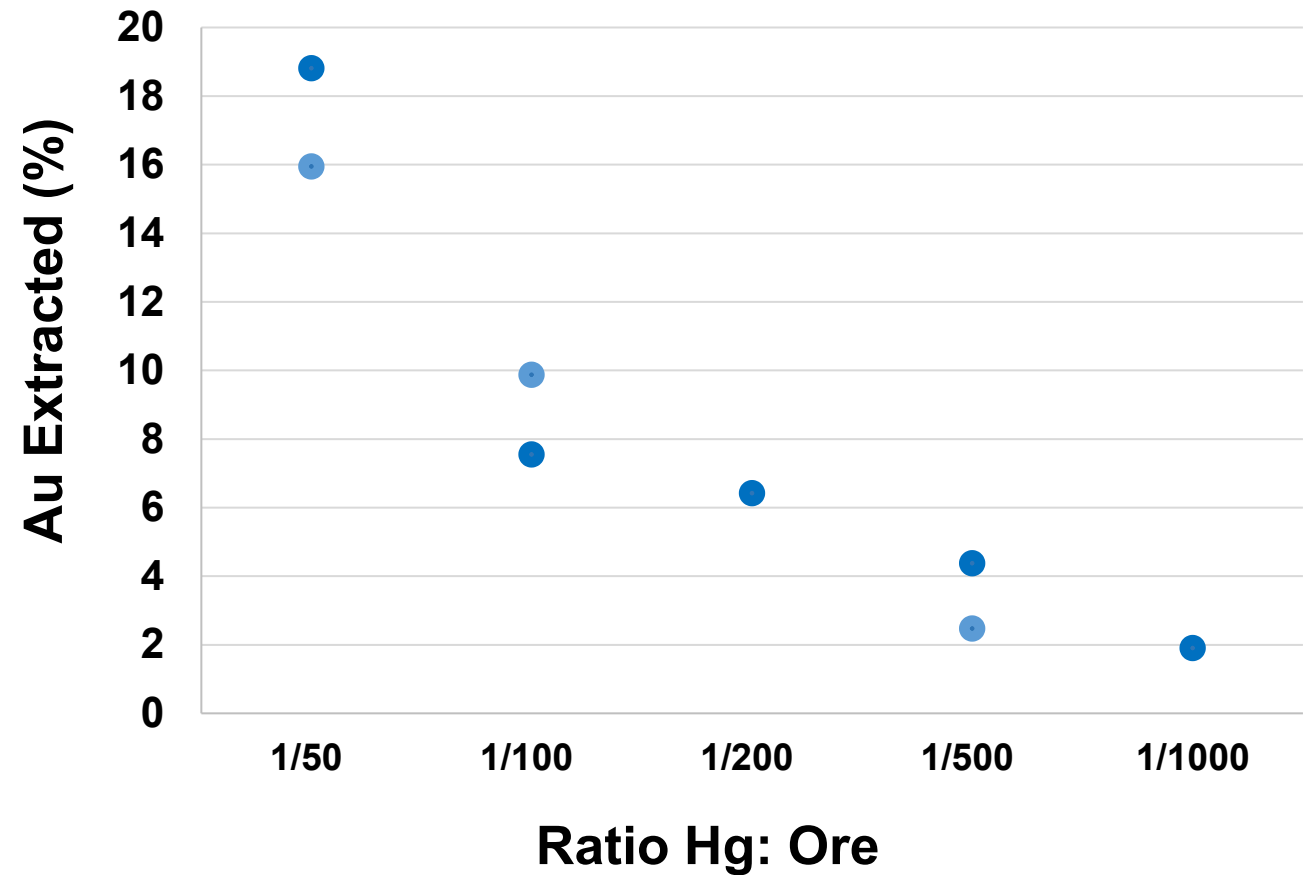


Results



Amalgamation in the lab of the Colombian sample

- Sample with 49 g/t Au
- 2 hours of amalgamation with different concentrations of Hg
- **Max extraction 19% Au** with 28 times more Hg than used by artisanal miners



+

More Mercury

-



12

Results



Leaching gold with manipueira – Colombian sample

Solution	Mineral (g)	S:L	Time (h)	Au Extracted (%)
Manipueira (265 ppm Free CN)	10	20%	24	50
Manipueira (600 ppm Free CN)	10	20%	24	82

Against the max extraction of 19% Au by amalgamation



Results

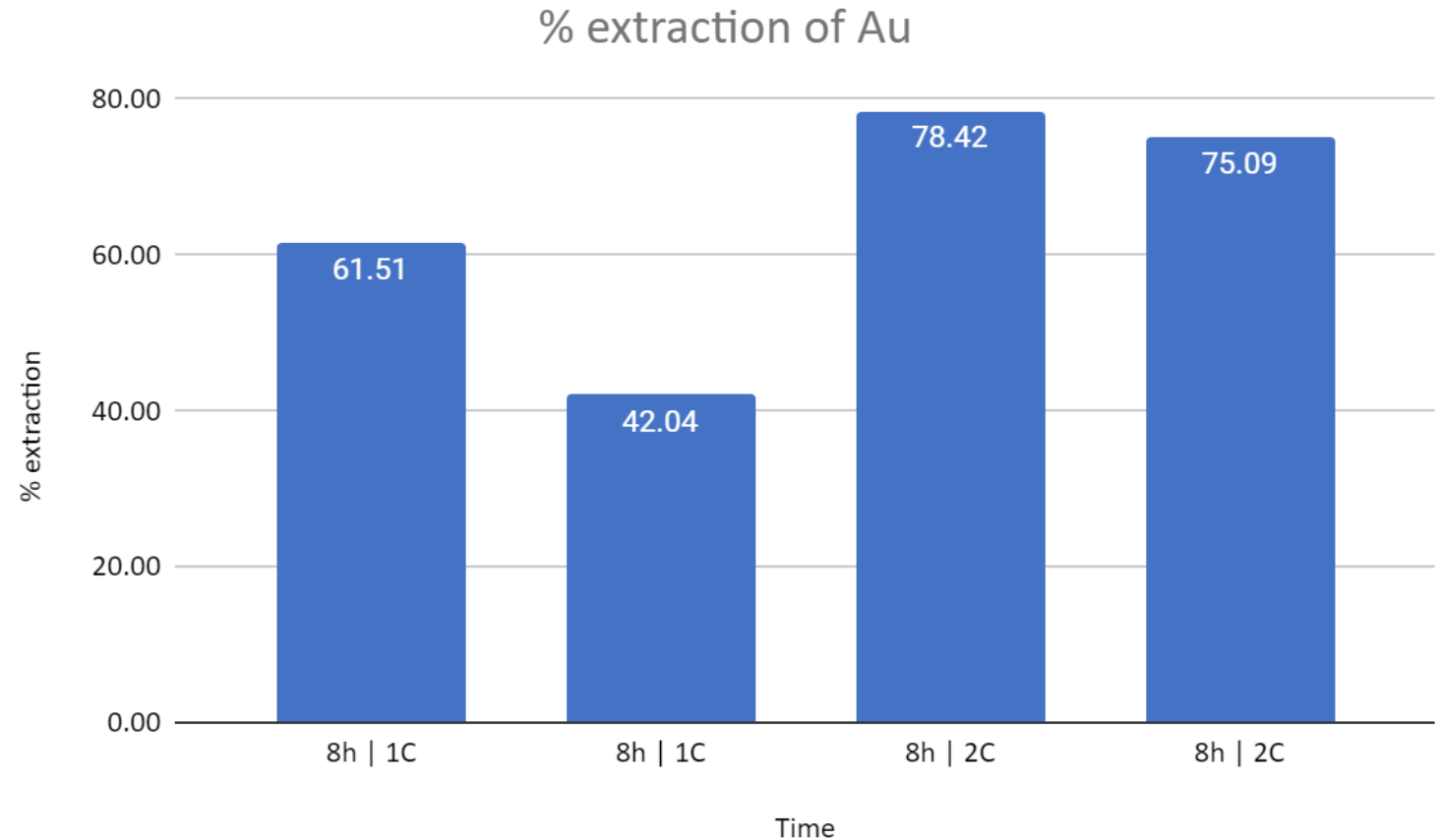


Leaching gold with manipueira – Brazilian sample

- S:L = 1 : 7 (50g)
- $[\text{CN}^-]$ = 250 ppm in “manipueira”;
- 8 h leaching

- 61.5% of Au extracted

- 2 cycles
- 78.4% of Au extracted



Final considerations

- Although this is not a single solution to the whole Hg problem, cassava waste water (*manipueira*) can be a green alternative to amalgamation in AGM in areas where bitter cassava is cultivated.
- Cyanide concentrations in cassava varies according to several environmental variables.
- Transporting several cubic meters of manipueira to different locations can be a limiting factor.
- *Manipueira* must be used with stabilization of the pH.
- **The proximity between a cassava starch industry and an AGM operation in Pernambuco (BR) is an advantage.**



Selected references

- Torkaman, P., Veiga, M., Lavkulich, L., & Klein, B. (2023). **Investigation of techniques to replace amalgamation in artisanal gold mining operations.** *International Journal of Sustainable Energy and Environmental Research*, 12(2), 17–30. <https://doi.org/10.18488/13.v12i2.3422>
- Torkaman, P., et al. (2021). **Leaching gold with cassava: An option to eliminate mercury use in artisanal gold mining.** *Journal of Cleaner Production*, 311(May), 127531. <https://doi.org/10.1016/j.jclepro.2021.127531>
- Torkaman, P., & Veiga, M. M. (2023). **Comparing cyanidation with amalgamation of a Colombian artisanal gold mining sample: Suggestion of a simplified zinc precipitation process.** *Extractive Industries and Society*, 13(December 2022), 101208. <https://doi.org/10.1016/j.exis.2022.101208>



Thank you

emilianosilva@usp.br

emilianomsilva@gmail.com

