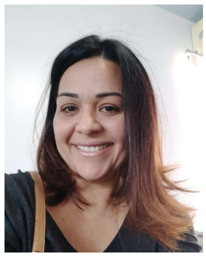
Orange peel waste using to obtain catalysts for caffeine degradation



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Introduction

In 2021, 16 214 982 Tons of oranges were produced in Brazil, with the South Region responsible for 6.25% of production (IBGE, 2021). Even with defined destinations (i.e. export and commercialization within the country), it is natural that a lot of waste is generated due to the amount of production. With this in mind, research is needed to better use solid orange waste, specifically orange peel. This waste can be used for water treatment, such as textile industry wastewater (BEDOYA BETANCUR et al., 2022), to remove toluidine blue (LAFI; REZMA; HAFIANE, 2015), methylene blue (GIRALDO et al., 2022; MECHATI et al., 2023), Cd2+ (GIRALDO et al., 2022), and dyes (GUIZA; FRANCK; BAGANÉ, 2018) from aqueous solutions.

Magnetic nanocatalysts can be produced using orange peel extract for water treatment, due to advantages such as easy recovery at the end of the process and the efficiency of the catalytic activity of the metals that compose them (OLIVEIRA et al., 2023; R.P. OLIVEIRA; G. LENZI, 2023). This application, in addition to being efficient for water treatment, promotes sustainability minimally by the application of the Principle of the Green Chemistry 3, 5, 7, and 9 ("Less hazardous chemical synthesis", "Safer solvents and auxiliaries", "Use of renewable feedstocks", and "Catalysis", respectively)(ANASTAS; WARNER, 1998) and the Sustainable Development Goals 6 and 12 ("Clean water and sanitation" and "Responsible consumption and production", respectively)(UNITED NATIONSDEVELOPMENT PROGRAMME, 2015).

Over 2.25 billion cups of coffee are consumed in the world daily (DRIVERESEARCH, 2024). Of course, coffee is not the only product that is caffeine-containing. But as a consequence of the high ingestion daily of this compound (by drinks, foods, drugs, among others), caffeine is one more emerging pollutant. Like other emerging pollutants, it involves research to know different ways to degrade it (DE ALMEIDA et al., 2021).

In this research, magnetic nanocatalysts synthesized with orange peel, cobalt ferrite and niobium pentoxide was applied to the degradation of Caffeine by CWPO (Catalytic Wet Peroxide Oxidation), Figure 1.

Aplication - CWPO reaction

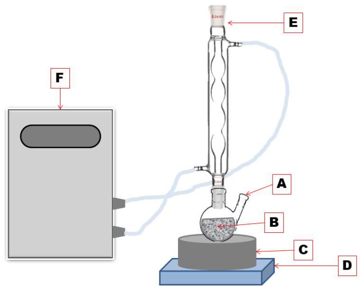


Figure 1. Scheme illustration of CWPO reaction. A) Reactor B) Solution with caffeine and catalysts C) Glycerin bath D) Stirring and temperature control plate E) Condenser F) Ultrathermostatic bath.

orange peel

Catalysts

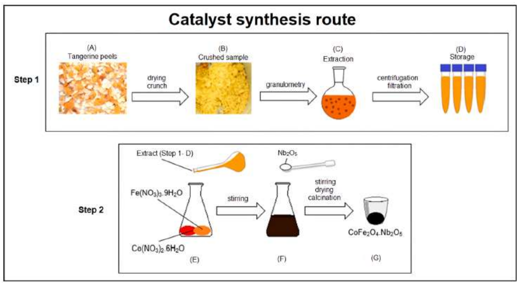
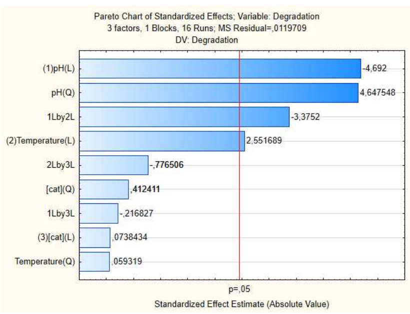
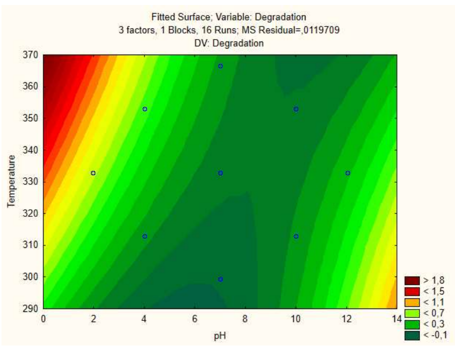


Table 1. Values of design of experiments to evaluate the caffeine degradation by CWPO.

Run	pH	Temperature (K)	catalyst concentration (mg.L^{-1})	catalyst weight (g)	Degradation (%)
A	7.00	333	302	0.045	3%
B	1.95	333	1000	0.150	71%
C	4.00	353	1415	0.212	61%
D	10.00	353	1415	0.212	3%
E	4.00	353	585	0.088	68%
F	12.05	333	1000	0.150	29%
G	4.00	313	1415	0.212	14%
H	4.00	313	585	0.088	8%
I	10.00	353	585	0.088	13%
J	10.00	313	585	0.088	7%
K	10.00	313	1415	0.212	8%
L	7.00	367	1000	0.150	2%
M	7.00	299	1000	0.150	4%
N	7.00	333	1698	0.255	10%
O	7.00	333	1000	0.150	4%
P	7.00	333	1000	0.150	4%

Results & Discussion





Conclusions

A design of experiments (DoE) was performed to evaluate the influence of temperature, pH and catalyst concentration in solution, Table1. Testing revealed that more than 70% of the caffeine was degraded. The study is being improved by degradation optimizations, as indicated by the results of DoE.

The authors would like to express appreciation for the support of the sponsors: the Capes, Fundação Araucaria, and CNPq agencies, analyzes performed at the laboratories LabMult C2MMa - UTFPR - Ponta Grossa and LabMult CA - UTFPR - Pato Branco.

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