



INSPIRATIONAL CASES |  FINALIST 2022 |  BRASIL

#ENVIRONMENT

Students filter pesticides from water using vegetable charcoal

With their knowledge on Science and Mathematics, three teenagers developed a filter using macaúba seeds. The prototype retains chemicals used in coffee plantations.

TEACHERS

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COMMUNITY/CITY

Franca, São Paulo

STEM AREAS

Science and Technology

STUDENTS

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SCHOOL

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OTHER AREAS OF KNOWLEDGE

Environmental Education

PROJECT NAME

Macafiltro: uso da macaúba para remoção de agrotóxicos de água contaminada

The coffee economy is so present in the municipality of Franca, in southeastern Brazil, that it motivated the creation of a discipline dedicated to deepening knowledge about this production chain. Called “Would you like some coffee?”, the subject was the starting point for three students to have the idea of a solution to remove pesticides from coffee plantations using another fruit: the macaúba.

The project, “Macafiltro: uso da macaúba para remoção de agrotóxicos de água contaminada” (In English, Macafiltro: using macaúba to remove pesticides from contaminated water) was a finalist in Solve for Tomorrow Brazil in 2022. Initially, the team researched the possible negative impacts of coffee plantations and, together with [mediator teachers](#) Henrique Pereira and Camila Nunes, discovered that pesticides can contaminate water.

The main chemical identified by the team was glyphosate, used to kill weeds that grow alongside coffee. This can cause health problems such as cognitive impairment and cancer. “This pesticide is sprayed on crops and from there, it can infiltrate the soil and fall into the water table or run off the surface and end up in rivers. Since this water is piped by the residents themselves to supply their homes, the idea came up of making a filter that could be attached to the pipes before the

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chemical reaches the water tank,” explains Pereira, who is a Biology teacher and coordinator of Natural Sciences and Mathematics at the school.

To build this filter, the team decided to produce vegetable charcoal. As a raw material, they used the fruit of a palm tree called macaúba, also known as coco-baboso, coco-de-espinho, or macaúba. The species is so abundant in the rural area of Franca that the seeds often spoil on the ground. In this way, the project would solve two problems in a single prototype: water contamination and macaúba waste.

The team did not set out to produce activated carbon, normally used for filtering, because it would require chemical and industrial processes beyond the student’s possibilities. Therefore, the goal was to produce charcoal from the endocarp of the macaúba tree - that is, the rigid part that protects the fruit’s seed.

The first stage of the prototype was to develop a method to extract the part of the fruit to burn it and to turn it into charcoal. “First, we broke the macaúba coconut with a hammer to remove the endocarp. After much effort, we discovered that, on the ground in the pastures, the pulp of this fruit degraded quickly and only the endocarp was left,” recalls the teacher.



The use of pesticides on coffee plantations serves to control pests but can have harmful effects on humans if water is contaminated.



Eureka moment!

With the endocarp extracted, they burned it in a regular barbecue grill, to take the form of charcoal. However, at the end of the process, the burnt macaúba ended up mixing with the regular charcoal from the grill. “When these problems arose, I encouraged the girls to think. It didn’t take long for them to produce the idea of putting the endocarps inside an aluminum can, like the ones used for soda, to separate them while they burned on the barbecue. They surprised me with how quickly they could solve the problems,” he highlights.

Experience with trial and error

The newly produced macaúba charcoal was crushed in a homemade pestle to make it easier to fit into the filter. The idea then was to place this material inside the PVC pipe attached to the water tanks of the houses in the region, to serve as a filter and to remove pesticides.

Now, how can the charcoal itself not end up in the water after being inserted into the pipe? The students thought of using pieces of tulle, a light mesh-like fabric, to act as a sieve: preventing the charcoal but allowing the water to pass through. However, in the first tests, the layers of tulle proved to be very fragile and broke easily under the force of the water. Next, they tested nylon screens, which are used in fish farms, which also didn’t work. The team then discovered a unique way to use the tulle: they found a more resistant model and folded the fabric three times to trap the charcoal inside the filter. It finally worked!



“The target audience for our project is people who live in rural areas and who are often not the owners of the plantation but rather the workers. Therefore, the filter solution needed to be low-cost”,

emphasizes the teacher.

Testing the capacity to remove pesticides

The materials cost around R\$25 (something like 4 dollars), not including the labor to harvest and break the macaúba. But the work didn’t end there. “After building the prototype, we needed to test whether it was efficient in retaining glyphosate. We bought the substance, but the school did not have the resources for laboratory testing. There was only one in the city for this kind of test,

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costing between R\$400 to R\$500 (about 70 to 85 dollars), and the results took a long time to be ready,” he recalls.

The teacher paid for the test himself and went ahead. However, these analyses were inconclusive, as the machines are calibrated for the concentration permitted by law, 500 micrograms per liter. “That is less than a grain of sand in a liter of water, and our sample had one spoonful of glyphosate per liter. This was the point when we needed to ask for help to reach a concentration that could be tested in the laboratories,” he adds.



The filter is made with simple materials found in everyday rural areas: a PVC pipe with tulle as a filter. Inside, charcoal made from macaúba palm is inserted.

Teacher Henrique Pereira, who had just started a master’s degree at that time, asked a chemistry teacher for help in calculating the parameters of the products. This allowed the students to produce samples with the most appropriate concentration of glyphosate and nitrate to send to another laboratory outside the city.

The results of this new test varied according to the samples. The numbers closest to reality showed a reduction of 18% in nitrate and 6% in glyphosate after filtering with macaúba charcoal.

A transforming lives science

The educator reports that working on scientific projects for high school students is more challenging, but worth it. In the case of “Macafiltro”, contact with scientific methodology increased the team’s academic performance and interest in studying. Currently, the three girls who developed the project are studying in college in the field they dreamed of. One of them developed a taste for science and enrolled in the Chemical Engineering course, determined to change her family history through knowledge. “This student came from an exceedingly difficult family background. With Solve for Tomorrow, for the first time in her life, she saw that dedication to school could lead to new things, reports the teacher.



Learn more!

While they were waiting for the laboratory analysis on glyphosate, the Solve for Tomorrow mentor recommended researching other substances that could be filtered by the “Macafiltro”. That’s how they discovered that nitrogen fertilizers used in coffee plantations when mixed with water, turn into nitrate - a substance that can be toxic for human consumption. This hypothesis helped the project advance to the final of the program.




Focus on practice!

Take a look at the teacher’s recommendations on how to use charcoal to remove pesticides in water.




Empathy

 To maintain high productivity, coffee plantations require the use of pesticides and fertilizers. However, these products can be dangerous if they infiltrate the water consumed by people.




Definition

 Students at a school in Franca, in the state of São Paulo, studied coffee production and thought about how to prevent chemicals used on crops from reaching the water tanks of rural residents.




Ideation

 With the support of Biology and Mathematics teachers, the team studied how to produce charcoal filters obtained from the fruit of the macaúba, a palm tree that is found in abundance in the region's pastures.




Prototype

 After a series of tests, the “Macafiltro” was developed, made with PVC pipe, valves, pieces of tulle, and charcoal obtained from the endocarp of macaúba palms. This filter can be attached to the pipes of homes before the water reaches the supply tanks.



Test

 After laboratory tests, the “Macafiltro” proved promising. Even without reaching the activated carbon stage, the material was able to reduce the concentration of nitrate by 18% and glyphosate by 6%. Learn more about the project [here](#) (in Portuguese).