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INSPIRING PRACTICES | HONORABLE MENTION 2024 | COLOMBIA

#ENVIROMENT

Young people harness local cactus to produce biofuel for their community

Using knowledge in Science and Technology, the students became aware of difficulties in accessing fuel and found the answer in the very plants of their region.

TEACHER
Stefany Rodriguez

STUDENTS
Stephanie Montero
José José Oñate
Amalfi Sara

COMMUNITY/CITY
San Juan del Cesar, La Guajira

SCHOOL
Institución Educativa Rural Hugues Manuel Lacouture

PROJECT NAME
Biocombustible Juntero

STEM AREAS
Science, Technology, and Mathematics

OTHERS AREAS OF KNOWLEDGE
Environmental Education

Junta, a rural area of San Juan del Cesar, Colombia, is far from major commercial centers. So, even when local farmers have good harvests, they often can't reap the expected benefits, as many are unable to afford the fuel costs needed to travel and sell their products. Observing this reality, three young people realized the solution was right before their eyes: in the cactus plants.

This desert plant has a high content of compounds and is rich in sugar, which makes it suitable for conversion into alcohol. Thus, it can be transformed into biofuel to power vehicles. The creation, named "Biocombustible Juntero," received an honorable mention at Solve for Tomorrow Colombia in 2024.

The students carried out a process similar to that of ethanol, a common fuel in Latin America as an alternative to gasoline. The cactus was chosen because it is very abundant in La Junta and could be collected for free. "In fact, it's a plant considered invasive since there's no control over its spread. Now, we're giving it a purpose with a great benefit," explains the mediator teacher, Stefany Rodriguez, who is a Mining Engineer and Math teacher.

Two 11th-grade students and one from 10th grade participated—the final years of compulsory education. Each was responsible for a task: José José Oñate handled prototyping, Stephanie

Montero led the research and problem structuring, while Amalfi Sara focused on validation, analysis with experts, and interviews with transporters.

The idea was to offer an affordable and sustainable solution, especially for the community's transporters and farmers. "We saw the difficulty within our own families. This is a community that is constantly limited in its development due to high transportation costs and difficulty accessing fuel," says Rodriguez.

According to her, some student's relatives would lose part of their agricultural production because they couldn't afford transportation to distant markets. "We thought: how can we change this? Not only to relieve the burden on the community but also to show that even from a rural area like ours, we can make a difference," the teacher recalls.

The young trio had the opportunity to get hands-on with every stage of the process, from collecting the cactus to mixing and testing in the lab.

Learning begins with the teacher

The educator is also from San Juan del Cesar, but from the urban area. Working in the rural area of La Junta has been a challenge for her, especially due to lack of internet connectivity. "We tried to take advantage of that limitation and explore other strategies with our students," she shares. One of the ways was to implement Project-Based Learning. So, when she came across a Solve for Tomorrow announcement, she decided to apply with her students. She guided around 30 projects, resulting in three finalist projects.

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Previously, the teacher had no experience with Design Thinking but learned throughout the program through training and mentorships. One of the practices she adopted was actively listening to the target audience—from Empathy to Testing. “We went out into the field, conducted interviews, and with every progress, we shared it with the transporters,” she recalls. Around ten farmers were interviewed, and most said they were willing to use the biofuel.
With the research in hand, the team designed a mobile biorefinery lab capable of processing the biomass of desert plants into a renewable energy source. After processing the cactus biomass, the group fermented it using local microorganisms adapted to the desert conditions of the rural area. This biofuel was then distilled.

The school lab was essential for conducting chemical experiments.

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Eureka Moment!

The tests were conducted in the lab with a car engine. Initially, they ground the cactus manually, but the process was too time-consuming. “The kids were exhausted, it was tedious. So I asked: how can we make this more efficient?” recalls Rodriguez. That’s when they had the idea to use a blender the teacher brought from home. They also noticed that the container was too small and didn’t allow for proper agitation for the chemical reaction they needed. “We swapped it for a larger container and made simple adjustments that made a big difference,” she concludes.

“The future of our rural communities lies in seeking local, sustainable, and affordable alternatives,”

she believes..

Producing renewable energy

The team also used a bioreactor, a device that facilitates microorganism growth, which in this case were responsible for fermentation. Besides the teacher’s blender, all materials were reused from what they already had at home, like plastic and glass containers. However, to measure results, they had to obtain a pH meter, an electroanalytical instrument used to measure the pH of a solution.

Now, the team plans to continue scaling the project by conducting tests on a motorcycle, the community’s primary means of transportation. “I believe it was a very meaningful learning experience for the students, showing how to contribute to sustainable development,” says the teacher. Rodriguez shares that the group reflected on the United Nations’ Sustainable Development Goals (SDGs) when designing the project. They initially focused on affordable and clean energy and later realized they also promote responsible production and consumption by repurposing organic waste. This reduces waste generation and fosters a circular economy model, which involves sharing, renting, reusing, repairing, refurbishing, and recycling materials and products as much as possible to create added value. “With creativity, we bring solutions to many issues,” she explains.

She also notes that the experience encouraged students to express themselves more, as they were shy at first. “To teachers wanting to start a similar project, I would say it’s important to

fully experience every stage—empathy, ideation, prototyping—and to remember that every idea counts," she advises.

Explaining!

According to the Inter-American Institute for Cooperation on Agriculture (IICA), between 2013 and 2023, global biofuel production grew by 50%, using mainly raw materials like vegetable oils, corn, sugarcane, palm, and soy. One of the biggest current challenges for expanding biofuels is competition with food production, which could raise food prices and cause scarcity, threatening food security. That's why thinking outside the box and investing in other sources like the cactus used in "Biocombustible Juntero" brings a new perspective to the issue, by utilizing a plant that doesn't interfere with food production and is already abundantly available in the community.

Focus on practice!

Take a look at the teacher's guide on how to develop a project with students to turn local plants into biofuels

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1 Empathy

In the rural community of La Junta, in San Juan del Cesar (Colombia), three students identified a persistent problem: local farmers couldn't get fair returns from their harvests due to a lack of resources to transport their goods to sales centers. Through everyday observations and conversations with family members, farmers, and transporters, they recognized that high fuel costs were severely limiting the economic development of their community. Teacher Stefany Rodriguez, also from the municipality, facilitated a field research process, in which they interviewed producers and transporters to gain deeper insight into the situation.

2 Definition

Based on the collected information, the team set the goal of developing a fuel alternative that was accessible, sustainable, and suited to local conditions. They noticed that the cactus, abundant in the region and considered invasive, could be used as raw material due to their high sugar content, which is useful for producing alcohol-based fuel. The students organized themselves with specific roles: José José Oñate focused on prototyping, Stephanie Montero on structuring the problem and documentation, and Amalfi Sara on technical analysis and validation with experts. With this approach, they defined the concept of a local cactus-derived biofuel: "Biocombustible Juntero."

3 Ideation

Inspired by the ethanol production process, common in many parts of Latin America, the team developed a system to transform cactus biomass into usable fuel. Unlike traditional biofuel crops, cactus didn't require investment to obtain, which made the project economically viable. From the interviews, they identified potential user acceptance. They built a mobile biorefinery using recycled materials, tailored to rural conditions. They also considered sustainability principles, including waste reuse and promoting a circular economy.

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4 Prototype

They used the mobile lab to process the cactus biomass, fermenting it with local microorganisms adapted to the desert environment. Initially, they did the grinding manually, but seeing that it was inefficient, they switched to a household blender, which significantly improved productivity. They also made changes to the container type to improve chemical mixing. They incorporated a bioreactor and a pH meter to monitor the fermentation and get more precise data. The prototype was tested with a car engine and successfully validated.

5 Testing

During the testing phase, the team shared progress with the interviewed transporters, receiving direct feedback and refining the production process. Initial tests confirmed the fuel's viability on a small scale, and they now plan to test it on a motorcycle, the most common local vehicle. Beyond technical achievements, the project helped students develop communication and reflection skills, integrating the Sustainable Development Goals into their approach. The proposal received an honorable mention at Solve for Tomorrow Colombia 2024 and remains in development, with plans for expansion.