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Title: Biomass: Teaching Strategy for the Laboratory at University Level

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Introduction

What is Biomass?

We can define biomass as any organic solid product formed naturally or by human action and includes all those natural components originating from land cultivation (crops and trees) as well as aquatic vegetation (algae and marine plants), which are the result of photosynthesis or animal digestion (Vassilev et al., 2010).

This biomass is produced by converting energy from sunlight through photosynthesis into chemical energy and is stored in the chemical bonds of carbohydrates such as cellulose, hemicellulose and lignin whose proportions vary depending on the type of plant (Yan et al., 2022; Odoh et al., 2023).

Biomass can be classified as follows: woody plants, herbaceous plants, aquatic plants, a mixture of biomass, biomass and animal waste (manure) contaminated, and industrial waste, the first three being the types of greatest interest in energy production, especially plants with C4 types of photosynthesis (McKendry, 2002).

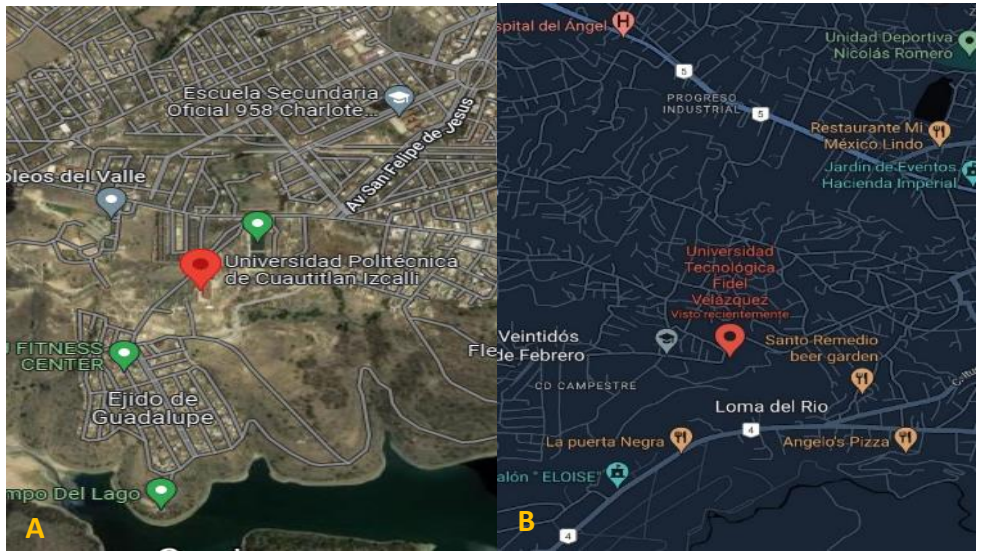
It is estimated that the average amount of Biomass on Earth is ≈550 Gt C of which ≈80% (≈450 Gt C) are produced by plants, mainly terrestrial ones (Barn-On et al., 2018).

Methodology

This practice has been conducted both at the Universidad Politécnica de Cuautitlán Izcalli (UPCI) located in the municipality of Cuautitlán Izcalli and at the Universidad Tecnológica Fidel Velázquez (UTFV) (UTFV) located in the municipality of Nicolás Romero both belonging to the Estado de México State (Figure 1).

This methodology has been assessed on young students between the ages of 18 and 22 belonging to IBT and IE careers in the case of UPCI, as well as IA and INT in the case of UFTV.

Figure 1: a) Location of the UPCI b) Location of the UTFV



(Taken from Google Maps, 2023)

Results

2.1.3 Obtaining potato starch

Materials

- Three large potatoes
- 200ml of water
- Blender
- Sieve
- Muffle
- Knife

Procedure

1. Peel the three potatoes and cut them into small cubes, to have the maximum amount of starch.
2. Blend with only 200ml of water for only three seconds (this is to avoid modifying its polymer chain).
3. Filter; use the sieve and a cloth.
4. Keep the liquid obtained at rest so that they separate.
5. Decant (remaining only with the lower part).
6. Dry for 24 hours.

2.1.4 Synthesis of the PLA

Materials and Reagents

- 500ml beakers
- Glass stirrer
- Granary scale
- Spatula
- Magnetic grill
- Magnetic stirrer
- Thermometer
- 250ml beakers
- Watch glass
- Molds
- Starch
- Acetic acid
- Vegetable dye
- Glycerin
- Lactobacilli (Yakult)

Procedure

1. Weigh 250g of starch on the granary scale.
2. Gradually add 250ml of water.
3. Mix and then add 30ml or 40ml of Lactobacilli.
4. Let ferment for 24 h.
5. Decant the water, leaving only the white mixture.
6. Shake on the grill, gradually adding 50ml of glycerin.
7. Leave stirring for 10 min.
8. Add 50ml of acetic acid little by little while stirring (add dye).
9. Heat the mixture until it boils, checking the viscosity with the glass stirrer.
10. Pour into the molds and put them on the stove until they have polymerized.

2.1.5. Survey Application

Once the practice was finished, the students were asked to answer an electronic form with a check box grid with options from 1 to 5 where number 1 corresponded to the option "I don't contribute anything" and number 5 corresponded to the option "I learned something new and reaffirm the knowledge that I already had”. The form consisted of five questions related to the acquisition and reaffirmation of knowledge related to biomass.

3. Results

3.1 Obtaining potato starch

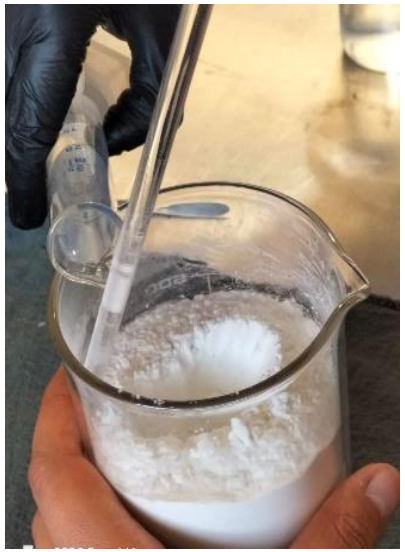
For this section, the students could easily follow the instructions for obtaining potato starch, the potatoes were blended, and the mixture obtained was sifted (figure 3).

Figure 3: Mixture obtained from potatoes.

(Own source)

The mixture was left to rest and was decanted, discarding the supernatant, and drying the precipitate for 24h, thus obtaining a fine, whitish powder (figure 4) that was used for the next section of the practice.

Figure 4: Obtaining potato starch.

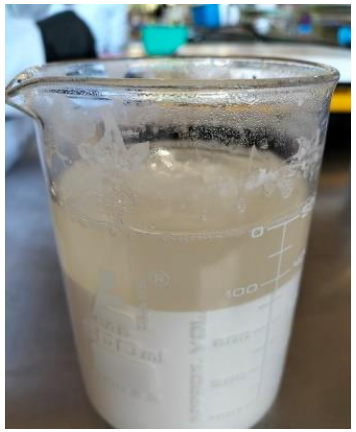


(Own source)

3.2 Synthesis of PLA

Once the starch was obtained, PLA was synthesized: Figure 5 shows the result of mixing hydrated starch with lactobacilli, leaving it to ferment for 24 h. Note the separation into two phases, the transparent supernatant, and the whitish precipitate.

Figure 5: Result of fermentation of potato starch by lactobacilli.



(Own source)

In figure 6 it can be seen how the PLA is added dye, at this stage the PLA has a high viscosity so that it allows the formation of small balls that do not stick to the hands when they are kneaded, once obtained this viscosity, the mixture was poured into the respective molds.

Figure 6: Obtaining PLA.

(Own source)

3.3 Verification survey

Once the practice was finished, the students were asked to answer a verification survey, the results obtained from this survey show that 80% of the students consider that "I learned something new and reaffirm the knowledge I already had", regarding their prior knowledge around biomass.

4. Conclusions

This paper presents a methodology that shows a laboratory practice where it is exposed that using simple and low-cost materials, basic knowledge about biomass can be taught in the laboratory.

The results obtained in the survey indicate that the application of this type of methodologies helps students, not only, to better understand or reaffirm the theoretical knowledge that is explained in the specialty subjects, but also to appropriate said knowledge and realize the technological applications that such knowledge implies.

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