

FROM FRUIT WASTE TO FUEL: BIOETHANOL PRODUCTION IN SCHOOLS



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CONTEXT

In Bogotá, Colombia about 6,500 tons of waste are generated daily, and most of it is sent to landfills, where organic waste produces methane, a highly polluting greenhouse gas.

In our school, fruit consumption generates organic waste that is usually discarded, contributing to this problem. At the same time, there is a need for more sustainable alternatives to fossil fuels.

Organic waste contains sugars that can be transformed through fermentation, where yeast produces ethanol and carbon dioxide.

This makes bioethanol a renewable fuel and a potential solution to reduce waste and generate cleaner energy.



OBJECTIVE

To evaluate if fruit waste from our school can be used to produce bioethanol through fermentation.

QUESTION

Can fruit waste be transformed into bioethanol through fermentation?

HYPOTHESIS

If fruit waste with higher sugar content is used, then fermentation will be more effective, producing more CO₂ and ethanol.

VARIABLES

Independent variable:

Type of fruit waste (orange vs banana)

Dependent variable:

CO₂ production (balloon size)

MATERIALS

Orange peels, banana peels, water, yeast, sugar, plastic bottles (1L), balloons.

PROCESS



Cut fruit into small pieces



Heat for 10 minutes and blend with water



Place in bottles



Add yeast and sugar into the bottle



Filter and distill



Add a balloon and let ferment for 7 days

We did 3 trials with orange peel and 6 with banana peel

EXPERIMENTAL SETUP

- To fill each 1L bottle, we used:
 - 250g of fruit peel
 - 200ml of water
 - 20g of sugar
 - 10g of yeast.
- Bottles were filled up to 700 ml to prevent overflow during fermentation.
- We conducted:
 - 3 trials with orange peel
 - 3 trials with banana peel
- After observing better results with banana peel, we performed 3 additional trials using 500 g of banana peel (higher amount of material). In these trials, yeast and sugar were added first, followed by the mixture

RESULTS

ORANGE

Fermentation was not successful.

During distillation, essential oils were obtained instead of ethanol.

This suggests inhibition of yeast activity.

BANANA (FIRST TRIAL)



Balloon diameter: 10cm

Moderate fermentation

BANANA (IMPROVED)



Balloon diameter
52cm 56cm 22cm

Stronger fermentation

CONCLUSIONS

- Fruit waste can be used to produce bioethanol, but not all materials behave the same.
- Banana peels showed higher fermentation because they contain fermentable sugars that yeast can convert into ethanol (alcoholic fermentation).
- In contrast, citrus peels may inhibit fermentation due to compounds such as essential oils, which can reduce yeast activity (Wilkins et al., 2007).
- Additionally, increasing the amount of organic material led to greater CO₂ production, which is consistent with fermentation processes described in bioethanol production studies (Balat et al., 2008).
- These results suggest that both the type of material and preparation method influence bioethanol production efficiency.

FUTURE WORK

- Improve the distillation process by controlling temperature more precisely to better separate ethanol from water, since incomplete distillation may have reduced ethanol recovery.
- Increase ethanol production by optimizing the amount of organic material and sugar, as higher banana content showed greater fermentation in our results.
- Future trials could also improve mixing conditions to ensure better contact between yeast and sugars, enhancing fermentation efficiency (Balat et al., 2008).
- Finally, test the bioethanol in small energy applications, such as simple motors, to evaluate its practical use as a renewable fuel.



REFERENCES

- Wilkins, M. R., Widmer, W. W., & Grohmann, K. (2007). Simultaneous saccharification and fermentation of citrus peel waste.
- Balat, M., Balat, H., & Öz, C. (2008). Progress in bioethanol processing.