



Journal of Renewable Energies

Revue des Energies Renouvelables

journal home page : <https://revue.cder.dz/index.php/rer>

Ethanol Production by *Balanites aegyptiaca* Fruits Valorization in the Adrar Region of Algeria

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Abstract

Climate change is one of the biggest challenges facing the planet today. It is important to ensure access to energy to promote quality of life and economic development. It is therefore essential to address this problem in sustainable development. Advances in the development of new technologies have given hope that the goals will be attainable in the field of energy.

Currently, biotechnological processes make it possible to promote this fruit of the desert date tree and make available to citizens a new generation of products with high added value such as bioethanol. In this context, various alcoholic fermentation tests at the laboratory level are carried out to determine the dilution rate, in order to optimize the process. We compared the degree of crude alcohol of four dilutions, i.e. the dilution by (six, nine, ten and eleven times) of the mass (110) g of the *Balanites* fruits pulp. We obtained after the distillation step, the following optimization results for the fermentation of the four substrates at different dilution than the 10-fold dilution of the substrate gave the best yield.

Keywords: Biomass, *Balanites aegyptiaca*, Bioethanol, Fermentation.

1. Introduction

The increase in greenhouse gas emissions caused by global industrial development is leading to the search for alternative energy sources to fossil fuels; this is being deployed by the growing concern caused by the reduction in non-renewable energy resources. [1] In addition, the production of energy by biomass is an efficient technique for converting sustainable resources into energy, which respects the climate.

The demand and excessive consumption of fossil fuels from year to year cause, in addition to global warming, a significant decrease in fossil resources [2].

Researchers at the international level have launched huge programs to replace conventional fuels by that of biomass or biofuels [3], such as bioethanol, biodiesel, biogas ... To reduce the consumption of original fuels oil, political leaders have opted for this choice of biofuels production [4].

In addition, the *Balanites* (heglig) or Desert Date tree referred to in this work is the African species known under the botanical name of *Balanites aegyptiaca*, known under the name of *Balanites roxburghii* Planch in India. On the other hand, it is known in southern Algeria by the name Tougua. It is a very common tree on the African continent.

Currently, biotechnological processes make it possible to promote this fruit of the desert date free and make available to citizens a new generation of products.

It should be noted that this fruit is not exploited in Algeria despite its adaptation to the climate of the region on the one hand and on the other hand its valuation allows us to produce products with high added value such as bioethanol and on the other product that will be used in the medicine and the cosmetics domain.

2. Material and methods

2.1 Plant material



Fig1. *Balanite aegyptiaca* tree

For the realization of this study we used the pulp of the fruits of *Balanites aegyptiaca* from the region of Timiaouine fig 2



Fig 2. *Balanite aegyptiaca* fruits

2.2. Biological material

The biological material used in this study to promote fermentation for the production of bioethanol is the yeast *Saccharomyces cerevisiae*. [5, 6, 7] fig 3



Fig 3. Yeast reactivation *Saccharomyces cerevisiae*

2.3. Methodology

Preparations of dilutions

The quantity used is 4*500g of fruit soaked in 3 liters of hot water each, for 24 hours to facilitate pitting which separates the pits from the pulp. fig 4



Fig 4. Fruits soaked in 3 liters of hot water

The juice obtained will be put in four fermentation reactors then the dilution is carried out to obtain 4 reactors with different dilution Dilution I (1: 6), Dilution II (1: 9), Dilution III (1: 10) Dilution IV (1: 11).fig 5



Fig 5. The four fermentation reactors

The next step is to add the yeast prepared in the reactor and adjust the pH between 4,3 and 4,7 [8,9].

The bioreactors inoculated with baker's yeast (1 g/L) [7] are placed in a water bath at a temperature of $29\pm 2^{\circ}\text{C}$ for 72 hours under self-agitation caused by the movement of the CO_2 bubbles released [10,11].

Alcoholic fermentation

Alcoholic fermentation consists of transforming fermentable sugars in anaerobiosis by yeasts into alcohol and carbon dioxide with the release of calories according to the following reaction:
 $\text{Sugars} + \text{Yeasts} \Rightarrow \text{Ethanol} + \text{CO}_2 + \text{Energy}$

During this reaction, the release of carbon dioxide can be observed; an accentuation of the color and an increase in volume, due to the increase in temperature and the carbon dioxide released.

Distillation

After 72 hours the fermentation is stopped, and the substrate is filtered and distilled to extract the bioethanol under a distillation temperature of around 78°C [9,12]. Fig 6.



Fig 6. Distillation system carried out at our unit

The analyses carried out:

Density: (OIV-MA-AS2-01A: R 2012)

Degree of alcohol: (Boulal et al 2016)

3. Results and discussion

The density, volume and bioethanol degree from each distillation are presented in the following tables:

Table 1. Bioalcohol Density and volume

Dilution	Density	Volume ml	Temperature
7	0,91	23	19,4
9	0,94	32	19,4
10	0,98	66,5	19,6
11	0,98	66	19,4

Table 2. Bioalcohol degree and Density

Dilution	Density at 20°C	Volume ml	Alcohol degree
7	0,909	23	49
9	0,939	32	53
10	0,979	66,5	64
11	0,978	66	61

Tables 1 and 2 present the different parameters which characterize the bioethanol resulting from the different distillations, namely the density, the volume, the temperature and the degree of alcohol. From these results we can notice that the dilution 10 times is the dilution which gives us the greatest degree of bioalcohol.

The alcoholic degree obtained after rectification is of the order of 94 °. The weight yield is 125g of fruit in the form of 30mL of alcohol with a concentration of 94 °.

4. Conclusion

The present work has shown that the valorization of *Balanite* fruits with a view to their transformation into ethanol after fermentation is possible, instead of losing them in nature.

Finally, the results of this work, although preliminary, open up promising avenues that could help provide a means of producing bioethanol from a local product. The by-products of this tree can be used in several fields such as energy, medicinal, food and cosmetic fields. Content.

Thanks to its chemical composition and its high sugar content, the *Balanite aegyptiaca* or desert date fruit must makes it possible to obtain a significant production of bioalcohol. The volume of this bioalcohol obtained after 72 h of fermentation of the 10-fold dilution in comparison with the results of the other dilutions obtained is considered to be the best yield.

6. References

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