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Valorization of Waste Dates in South Algeria: Biofuel Production

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***Abstract*—**In Algeria, the conditioning units of dates, generate significant quantities of waste arising from sorting deviations. This biomass, until then considered as a waste with high impact on the environment can be transformed into high value added product. It is possible to develop common dates of low commercial value, and put on the local and international market a new generation of products with high added values such as bio ethanol. Besides its use in chemical synthesis, bio ethanol can be blended with gasoline to produce a clean fuel while improving the octane.

***Keywords*—**Bioenergy, dates, bioethanol, valorisation.

I. Introduction

THE necessary reduction and progressive consumption of fossil fuels, whose scarcity is inevitable, involves mobilizing a set of alternatives. Renewable energy, including bio energy is an alternative to the depletion of fossil fuels and a way to fight against the harmful effects of pollution that undergoes the environment.

The valuation biomass by biotechnological processes is the solution of choice since it contributes to the production of bio energy and high-value substances. Among the latter may be drawn from this development, we can quote ethyl alcohol, Strategic Energy substance**.** However, the development of bio fuel production from wheat or corn or other raw materials for human food or animal involved in some way by specialists famine in some countries. On the other hand, bio ethanol can be produced from several other substrates rich in fermentable sugars, namely cellulosic biomass, energy crops and organic waste. Indeed, agricultural and agro-industrial produce large quantities of waste that are a nuisance to some environment. Numerous studies have shown that these wastes rich in organic matter were noble products and new materials for many industries. It should be noted that waste dates can be a recoverable raw material to be a source of energy and industrial interest molecules**.** Waste dates crystallize up to 65% of fermentable sugars and therefore represent a preferred substrate for the production of many substances.

Among other ethyl alcohol, the latter from a biotechnological process of anaerobic fermentation is an undeniable economic importance because it is used in various and vital sectors [1].

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According to statistics of the Ministry of Agriculture, Algerian national production reached 387,313 tons in 1998 which 30-50% is waste and dates of low value, or about 120,000 tons could be recovered and put on domestic market a new generation of highly prized and often imported [2].

II. Descreption of Manufacture Method

The production of ethanol from waste dates comprises the following steps:

- Washing dates,
- Absorption in hot water (85 ° C extraction),
- Pitting which separates the rings of the pulp which is ground and transformed into must that is sent in turn fermentation.
- Addition of dilution water, acid and yeast,
- Distillationof wine dates.

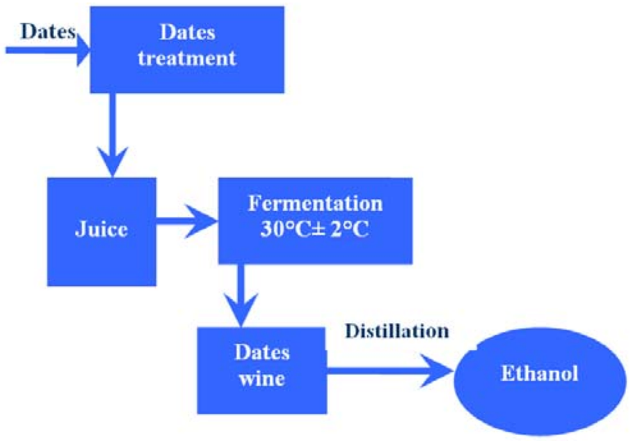

Fig. 1 Diagram of the various stages of manufacture ethanol

III. Materials and Methods

A. Biological Material

Saccharomyces cerevisiae is used for the production of alcohol. *Saccharomyces cerevisiae* is a species of yeast. It is perhaps the most useful yeast, having been instrumental to wine making, baking, and brewing since ancient times. It was originally isolated from the skin of grapes (one can see the yeast as a component of the thin white film on the skins of some dark-color fruits such as plums; it exists among the waxes of the cuticle). It is one of the most intensively studied eukaryotic model organisms in molecular and cell biology, much like *Escherichia coli* as the model bacterium. It is the microorganism behind the most common type of fermentation.

S. cerevisiae cells are round to ovoid, 5–10 micrometer in diameter. It reproduces by a division process known as budding [3].

B. Vegetable Material

The substrate used for the production of alcohol is formed of the waste of dates on certain varieties of common dates.

Fig. 1 Vegetable material

C. Methodology of Work

1. Preparation of must Dates

After washing, the imbibition of dates is carried out using a hot water (90 to 95°C) to facilitate coring. Water imbibitions with high sugar will be used as dilution water. Dates were then diluted with 200 g of pulp per 800 ml of water. The pH of the must is adjusted to between 4.3 and 4.7 with sulfuric acid (H2SO4, 1N). This acidic pH detrimental to bacterial growth is conducive to yeast overgrowth [4].

2. Alcoholic Fermentation

After inoculating the medium with baker's yeast *Saccharomyces cerevisiae* (1 g/l) [5], the bioreactor is immersed in a water bath where the temperature is maintained at 30 ± 2°C. The fermentation is carried out under anaerobic conditions for 72 hours [6]. However, the fermentation is promoted by agitation due to the movement of bubbles of CO_2 released.

During the fermentation, we followed:

- pH evolution ;
- Total sugars;
- The density.

3. Alcoholic Distillation

At the end of fermentation, the wine is distilled to extract ethanol. The distillation temperature is about 78°C [6].

D. Analytical Techniques

1. Determination of pH

PH determination is essential to the control of the must before and during fermentation. Its variation provides information on the metabolic activity of the yeast during the conversion of sugars into alcohol. PH determination is accomplished by a direct reading with a pH meter.

Fig. 2 Bioreactor of fermentation

2. Density Determination

The density was determined using a pycnometer of capacity 10 cm^3.

3. Determination of Total Sugars

The determination of total sugars is performed by the method introduced by Dubois.

4. Determination of Alcohol Degree

It was determined using a hydrometer (graduated from 0 to 100°) [7].

IV. Results and Discussions

In what follows, we analyze the results of physicochemical must respectively. Fig. 3 and Table I summarize all of these values. In the light of these results, we can see that after 72 hours of fermentation of musts, a significant degradation of total sugars is revealed, this transformation was especially active during the first 48 hours. This result is consistent with that reported by ELOKAIDI (1987), which referred to a fermentation time between (36 and 72 hours) [8]. However, total sugars were not completely consumed by the yeast; this may be due to the cessation of growth of *Saccharomyces Cerevisiae* and that by the accumulation of toxic substances [9].

Sasson reported that fatty acids, especially octanoic and decanoic acid formed by the yeast concentration in milligrams per liter, become toxic to yeast [10].

The evolution of Ph and density shown in Table I respectively for a time fermentation equal at 0h, 24h, 48h and 72 h showed a remarkable decrease, who is explained by the alcohol conversion of glucose and loss of mass as CO_2.

The alcohol produced in the laboratory has the following characteristics: volatile, flammable, clear, with a pungent odor.

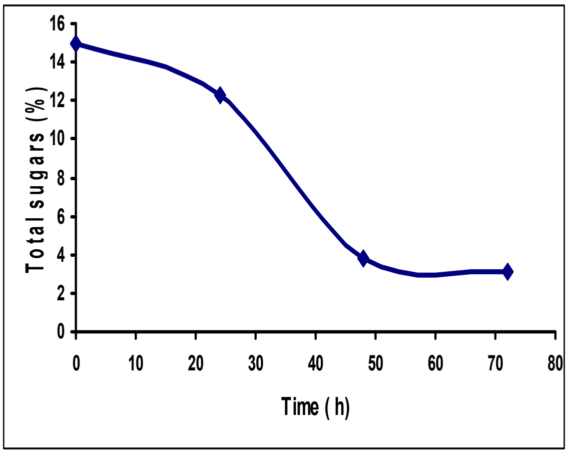

Fig. 3 Evolution of total sugars during the fermentation

TABLE I
EVOLUTION OF DENSITY AND PH DURING THE FERMENTATION

Time (Hour)	*Ph*	*Density (g/cm^3)*
00 h	6.3	1.054
24 h	4.109	1.018
48 h	4.042	0.995
72 h	4.019	0.987

g/cm^3 =Gram Per Cubic Centimeter, H= Hour

Fig. 4 Ethanol produced in the laboratory

The average values of physicochemical parameters of alcohol produced from the waste of dates are listed in Table II.

TABLE II
PHYSICOCHEMICAL PARAMETERS OF ALCOHOL

Symbol	Quantity	Mean Values of the Parameters
Ph	potential of hydrogen	5.639
D	Density	0.8752
R	Alcohol (Rectification)	88°

A. Infrared Spectrum of the Final Product

Vibrations of the following bands are noted:

- 2900cm-1: stretching vibration corresponding to the CH group;
- 3300cm-1: OH stretching vibration corresponding to a specific alcohol.

In what follows, we analyze the cost effectiveness of the process. Table III summarizes all of these values.

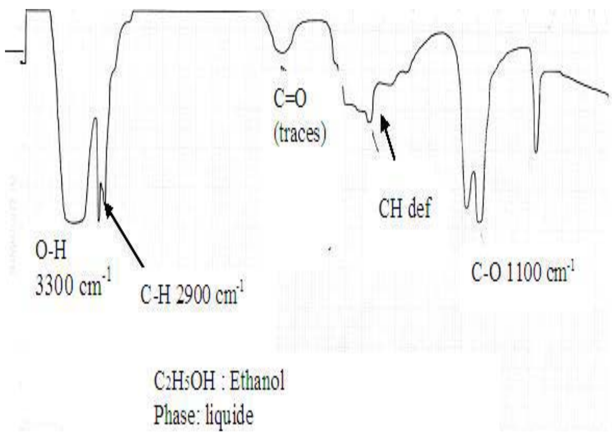

Fig. 5 Infrared spectrum of the final product

TABLE III
COSTS AND GAIN OF THE PROCESS

Product	**Price**
1Kg Of Dates	**20 DA**
1L Of Alcohol (78°)	**13100 DA** [11].
1 Kg Of Date (O,4 L)	5240 DA
Load	
Electricity	**1 DA kW. H**
Workforce	**20 DA /Kg**
Stuff	**20 DA**
Byproducts	
Nucleus Dates	**5 DA**
Distilled Water	**1 DA/L**
Gain =5225 DA/Kg	

DA=Algerian Dinar, kW=kilowatt

V. CONCLUSION

In the light of these results, we can see that Ethanol produced checked the conditions and global standards. It can be concluded that waste dates lost each year can be a potential source for the production of many products and can benefit from a good portion of its expenditure on imports.

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