Bacterial cellulose production from grape pomace and other agricultural by-products

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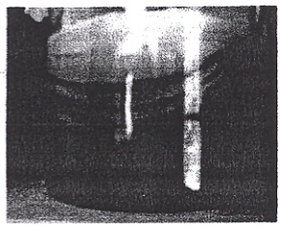
Introduction

Cellulose, mainly produced by photosynthesis is the most abundant, renewable biopolymer resource available today. Bacterial cellulose from *Acetobacter xylinum* is an alternative source which differ from those of plant cellulose as it is pure cellulose without lignin. Bacterial cellulose has therefore attracted attention as a new functional material for a variety of uses in food production, specialty filters and membranes, sound speakers (acoustic diaphragms), specialty paper and medical applications (artificial skin, medical pads). In this work we study the possibility of bacterial cellulose production from grape pomace and other agricultural by products like, dried raisins, carob pods, tea extract, coconut milk, molasses and cheese whey.

Materials & Methods

Grape Pomace caracteristics

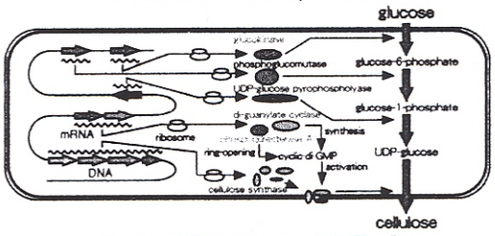
Humidity %	71,8 ± 0,5
pH	3,46 ± 0,05
Fermentable sugars gr/kg wet pomace	143,6 ± 3,2
Acetic acid gr/kg wet pomace	3,6 ± 0,1
Total acidity gr/ kg wet pomace (expressed in tartaric acid)	24 ± 0,8
α-amino nitrogen mg/kg wet pomace	109 ± 5
Ammonium nitrogen mg/kg υγρών στεμφύλων	56 ± 2,3

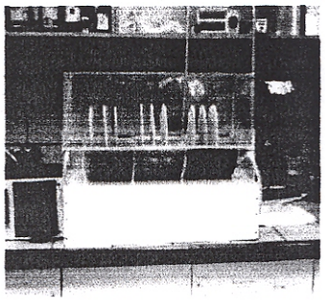


Bacterial cellulose production in static culture

This project was financed by the TEI of Athens "ATHINA 2004" research program

Acetobacter xylinum metabolism for bacterial cellulose production





Rotating disk bioreactor (Bungay & Sarafica, 1997)

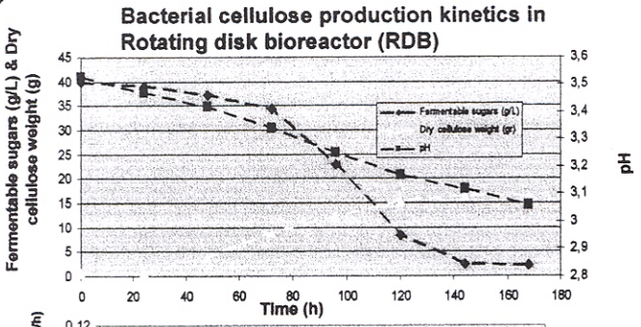
Grape pomace water extract Fermentation medium

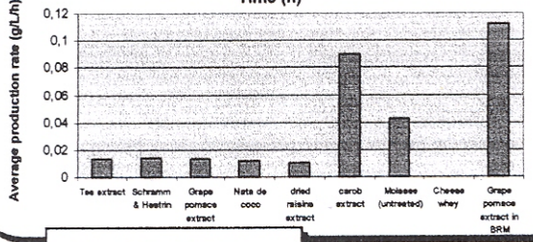
pH	3.55 ± 0,05
Fermentable sugars gr/L	40 ± 3,2
Acetic acid gr/L	1,2 ± 0,1
Total acidity (in tartaric acid) gr/L	5,6 ± 0,2
Alcoholic title	1,4 % vol
α-amino nitrogen mg/L	38 ± 3
Ammonium nitrogen mg/L	19 ± 2

Electron microscope photography of bacterial cellulose

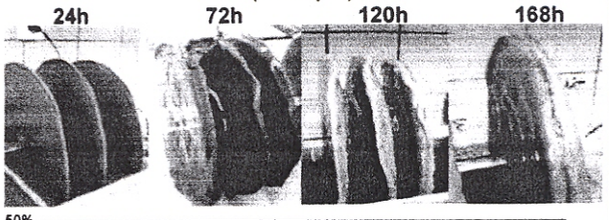
Results

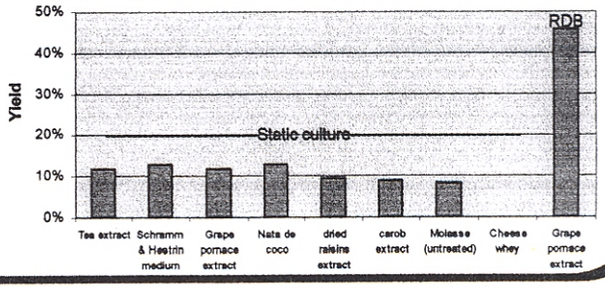
Bacterial cellulose production kinetics in Rotating disk bioreactor (RDB)





Bacterial cellulose production in Rotating disk bioreactor (at 16rpm)





Conclusions

Grape pomace extracted with water constitutes a fermentation substrate rich in sugars as well as all the necessary nutrients to support bacterial growth and cellulose production by *Acetobacter xylinum*. The use of a rotating disk bioreactor fitted with water retaining surface materials like felt can greatly improve yield and productivity. When compared with other liquid media having the same sugar content it performed better than those obtained from dried raisins, carob pods, molasses and cheese whey, falling short only to the optimized Schramm and Hestrin's medium. Cellulose production from cheese whey was minimal mainly due to the inability of *A. xylinum* to ferment galactose.

Bibliography

Bungay H.R, and Sarafica G.C. (1997) Production of Bacteria Cellulose Using a Rotating Disk Film Bioreactor. Patent No WO9705272

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Keywords: Bacterial cellulose, *Acetobacter xylinum*, grape pomace, rotating disk bioreactor.

Abstract

Cellulose, mainly produced by photosynthesis is the most abundant, renewable biopolymer resource available today. Bacterial cellulose from *Acetobacter xylinum* is an alternative source which differ from those of plant cellulose as it is pure cellulose without lignin. Bacterial cellulose has therefore attracted attention as a new functional material for a variety of uses in food production, specialty filters and membranes, sound speakers (acoustic diaphragms), specialty paper and medical applications (artificial skin, medical pads).

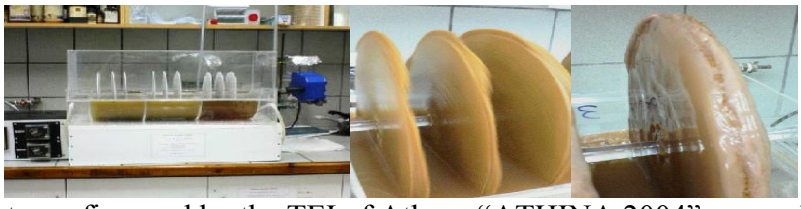
In this work we study the possibility of bacterial cellulose production from grape pomace and other agricultural by products like, dried raisins, carob pods, tea extract, coconut milk, molasses and cheese whey.

Grape pomace was recovered after pressing and sugars were extracted with 60°C water in a cascade four-stage system in order to obtain a fermentable medium and to minimize dilution of sugars and other nutrients.

The fermentation medium had the following composition: 50gr/L of fermentable sugars (glucose, fructose), pH 3,55, total acidity 5,6 gr/L(expressed in tartaric acid) ethanol 1,4 % vol, α-amino nitrogen content 38 mg/L, ammonium nitrogen 19 mg/L. Trials in jar fermentors proved that the substrate could support growth of *Acetobacter xylinum* and bacterial cellulose production without addition of nutrients. Fermentation duration was 3 weeks. The presence of ethanol in low concentration (1 to 2 %) and the addition of ammonium nitrogen improve bacterial growth. When compared with other liquid media having the same sugar content it performed better than those obtained from dried raisins, carob pods, molasses and cheese whey, falling short only to the optimized Schramm and Hestrin's medium.

Fermentation in rotating disk bioreactor minimized fermentation time to 6 days and improved yield by going up to 45,7% (weight of dry cellulose per carbon source consumed) and also improved average production rate by going up to 0,112 g/L/h of dry cellulose.

Grape pomace extracted with water constitutes a fermentation substrate rich in sugars as well as all the necessary nutrients to support bacterial growth and cellulose production by *Acetobacter xylinum*. The use of a rotating disk bioreactor fitted with water retaining surface materials like felt can greatly improve yield and productivity.



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