

# A review on Cost Effective Sources of Bacterial Cellulose

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## Abstract

**Bacterial Cellulose produced from microorganisms has high attention due to its unique properties. The bacterial cellulose can be used as an alternative material in the fields of the food industry, Biomedical, Electronics, Paper Industry, Cosmetics, Textile /Fashion Industry, medicine, and leather. The main drawback in Bacterial Cellulose is that the production cost is higher when compared to that of plant cellulose. Researchers are trying out to find some alternative methods to produce cost-effective Bacterial Cellulose. This review mainly views on the potential possibilities of developing Bacterial Cellulose from fruit juice, fruit waste, fruit peels and Industrial waste for producing cost-effective bacterial cellulose.**

**Keywords—Bacterial Cellulose, Industrial wastes, Fruit juice&waste**

## I. INTRODUCTION

Cellulose is the most available polymer in the universe. Cellulose is present in various types of plants, animals, fruits, wastes, microbes, and some microorganisms. The cellulose that is obtained from various sources is subjected to various processes according to the application needs[1,2]. The cellulose from the plants, animals, and microbes is subjected to the purification process. The Cellulose produced from bacteria is one of the purest forms of cellulose and it possesses unique properties such as higher in crystallinity, water-absorbing capacity, tensile strength, and excellent mechanical properties[3-5]. The bacterial cellulose is been produced by the static and agitated culture method. The Hestrin-Schramm (HS) media culture method is used for the bacterial cellulose production. Cellulose produced from bacteria are produced in sheet form on the surface of the media in static methods, whereas in the agitated method pellicle forms are been formed by shaking the cultivation which is inoculated with the starter culture [5-7]. The HS media used for the production of cellulose consists of sucrose, yeast extract, ammonium sulphate, Monopotassium Phosphate, Magnesium sulphate are been used to develop Bacterial Cellulose. Apart from its unique properties, the Bacterial cellulose production is

costlier; hence it limits the use of plant Cellulose as an alternative. This review mainly focuses on the cost-effective alternatives for production of bacterial cellulose.

## II. BACTERIAL CELLULOSE

The Cellulose obtained by bacterial cellulose is one of the purest form of cellulose and has distinctive properties as crystallinity, high in tensile strength, and water absorption capacity. Bacterial Cellulose is produced from *A. Xylinum* and *gluconactobacter* which gives unique cellulose production. The Bacterial Cellulose production mainly depends on carbon and nitrogen sources. The HS media method is most widely used for the production of BC through static and agitated cultivation methods which is a costlier process. So to bring a cost-effective method the less expensive Carbon and Nitrogen sources from the wastes such as fruit waste, fruit peel, fruit juices, food waste, Sugarcane waste, agricultural and industrial wastes. The size and thickness of Bacterial Cellulose depend on the production methods, fermentation method, and raw material. The researchers are trying to find out a low cost production method to commercialize Bacterial Cellulose as a sustainable material.

### A. *Bacterial Cellulose from waste*

The Bacterial Cellulose is used in various applications, despite its potential towards the commercialization and industrialization on a large scale is very costlier, hence to overcome this problem, several substrates and the waste from the agricultural, breweries, bakeries, temples, textile industries, and industries are used to produce low-cost Bacterial Cellulose. This paper mainly focuses on fruit waste, fruit peel, fruit juices, agricultural and industrial wastes.

### B. *Bacterial Cellulose from Fruit Juices, Peels, and Extracts*

Fruit wastes are rich in carbon sources. The fruit waste and its extracts have polysaccharide content hence this would be very much helpful for the formation of Bacterial Cellulose. The wastes from Pineapple, Sugarcane molasses, Palm oil, Sugarcane, citrus peels, sweet potato, apple extract, grapes,

orange waste, watermelon, coconut are rich in nutrients and these wastes can be used for the production of low-cost BC.

**BC from Pineapple Waste**

A study investigates the various effect of pH, temperature, and pineapple waste concentration and the optimum conditions of pH 5.5, temperature 30 degree Celsius, and residual concentration of 80% will be best to use the pineapple waste in the production of Bacterial Cellulose.

The pineapple peels were used to prepare the media and it was compared with the HS media which results in high water holding capacity and the relationship between various pH conditions were studied and found out that a PH of 5 will be very suitable for Bacterial Cellulose production from pineapple waste.

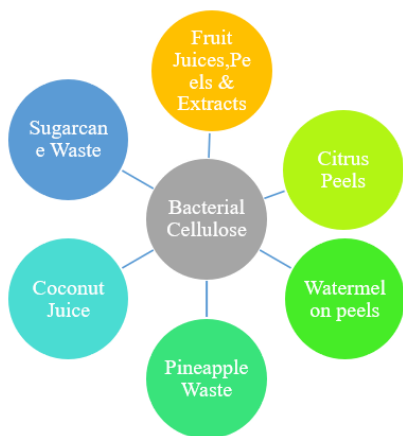


Fig. 1. Bacterial Cellulose Production from various Fruit Wastes

**BC from Citrus Peel Waste**

Citrus peels and pulps were hydrolyzed for the production of BC. The BC production was performed at 28-32 degrees Celsius for 21 days. The BC produced from citrus peels was characterized and found out that it has a thin fiber diameter, crystallinity high water-holding capacity and higher thermal stability. It is also been noticed that high presence of vitamin C and sugars the production of Bacterial Cellulose is higher in the culture medium as there is a decrease in the gluconic acid.

**BC from Sugarcane Waste**

Sugarcane molasses which has a high content of glucose, sucrose, and fructose increased the yield of Bacterial Cellulose and cellulose had moisture vapor, high mechanical strength in the wet strength, liquid permeability, it is mostly used in wound dressing and many other medical applications.

**BC from Coconut Juice**

Researchers have found out that Bacterial Cellulose production from coconut juices is high hence there is a decrease in the production cost. The BC produced from coconut juice has higher crystallinity, water absorption capacity, high mechanical strength and is best suitable to use in cosmetics and medicine.

**C. Bacterial Cellulose from Agricultural Waste**

Agricultural wastes from agro-based industries in the form of solids, liquids, fruit waste, and other forms of waste from farms, crops, and dairy products can be used effectively to produce Bacterial Cellulose. These types of agricultural waste are rich in essential oils, fatty acids, lignocellulosic contents, rich in proteins, nitrogen, and carbohydrates and they possess high mechanical properties.

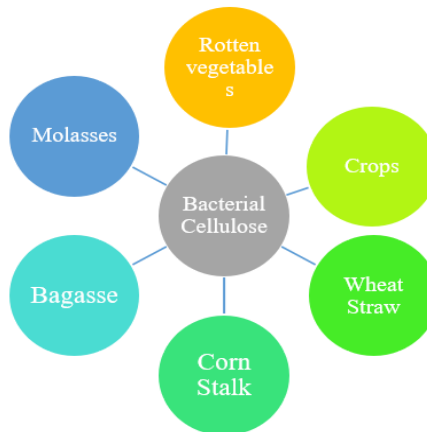


Fig. 2. Bacterial Cellulose Production from various Agricultural Wastes

**D. Bacterial Cellulose from Industrial Waste**

Industrial waste from breweries, beer waste, sludges, lipid fermentation waste, textile mills waste. These industrial wastes produce more amount of byproducts that are rich in nutrients hence it can be used to produce bacterial cellulose which is an effective waste management system. The waste from ABE factories, Beer waste, lipid fermentation waste, Beer waste, Dairy waste are rich in sugars, alcohols, and organic acids can be used as a medium for Bacterial production.

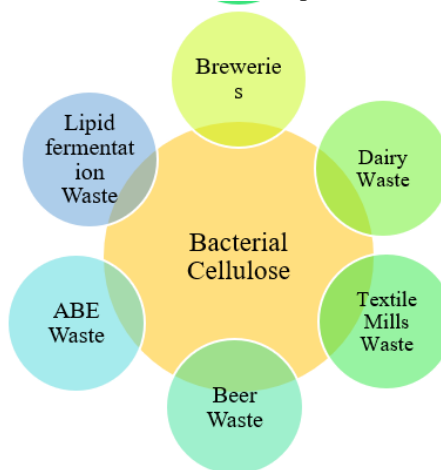


Fig. 3. Bacterial Cellulose Production from various Industrial Wastes

Type of Waste	Nutrients Added in the Medium	Reference
Citrus peel (Lemon, Mandarin, Grape fruit, Orange)	Nil	14
Pineapple Juice	Nil	12
Pineapple and Watermelon Peel	Nil	13
Wheat Straw	Wheat straw Hydrolysate with HS Medium	19
Molasses	Corn Steep liquor	19
Lipid Fermentation Waste	Nil	20
Dairy Waste	Nil	21
Beer Waste	Nil	22
ABE Wastes	Nil	23
Textile Mill Waste	Nil	24

Table 1. Various Wastes used in the production of Bacterial Cellulose

[4] Sun, R.C., "Detoxification of Biomass of Bioethanol" *Bioresources* 4(2), 452-455, 2008.

[5] Cannon, R.E, Anderson S.M "Biogenesis of Bacterial Cellulose" *Critical reviews in Microbiology*, vol.17(6), pp.435-447, 1991

[6] E.P. Coban, H.Biyik "Effect of various carbon and nitrogen sources on cellulose synthesis by *Acetobacter lovanesis* HBB5, *Biotechnology*, 10, pp 5349-5354, 2011

[7] J,Guo, J.M. Catchmark "Surface area and porosity of acid hydrolyzed cellulose nanowhiskers and cellulose produced by *Glucnactobacter xylinus*, *Carbohydr,polymer*, 87, pp.1026-1037, 2012

## Conclusion

Waste is produced in large quantities from various industrial sectors. The waste that comes from agricultural waste, Industrial waste, fruit waste are rich in nutrient source can be used for the production of Bacterial Cellulose. As these types of waste are in larger scale availability these waste can be used for the production of cost-effective Bacterial Cellulose. This Bacterial Cellulose can be used in many fields such as textile, fashion, Biomedical, Electronics, Paper industry as a sustainable material. From the environmental aspect this waste can be easily reused thus in turn reduces the problem of waste management and reduces the environmental hazards.

## REFERENCES

[1] Song, S., Ko., E "Sustainable fashion consumption and perception", *Global Marketing conference*, Singapore, 2014.

[2] Gross, R.A., Kalra B "Biodegradable polymers for the environment Science" ., 297, pp.803-807, 2002

[3] Chun kit Chan, Jooyoung Shin, Shou Xiang Kinor Jiang "Development of Tailor – Shaped Bacterial cellulose Textile cultivation Techniques for Zero waste design", *Clothing and textile research journal*, vol.36(1) pp.33-44, 2018