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Potential for Economic Utilization of Cassava Starch Factory Wastes

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Abstract

The technological advancement in the agro-based industries utilizes the waste materials which are generated during the processing of the raw materials into the finished products. The waste materials are utilized in many ways with proper biotechnological approaches. The cassava bagasse is the one such material which has immense potential for utilized in the preparation of value added products from it. Since the waste materials obtained from the cassava tuber processing have both carbohydrate rich and poor protein materials. These waste materials can be recycled in the production of ecofriendly natural products which will replace the conventional synthetic materials.

Introduction

Cassava (*Manihot esculenta* Cranz) is considered as a significant wellspring of food and dietary calories for a huge populace in tropical nations in Asia, Africa and Latin America. In India, cassava is cultivated in an area of 28,00,000 ha with the production of 96,23,000 MT (GOI - Horti. Stat., 2008). Tamil Nadu stands first in area (1,51,500 ha) and production (61,14,400 t) followed by Kerala (90,300 ha and 24,92,110 t). By 2010-2011, there will be a great demand of 4.30 lakh tonnes of cassava starch for adhesive, paper, textile, food, laundry and in pharmaceutical industries. It is grown in Tamil Nadu mainly for processing and value addition.

Cassava Bagasse

Cassava bagasse, which is a fibrous material, is the by-product of the cassava-processing industry (Figure 1). It contains about 30 to 50% starch on dry weight basis. Due to its rich organic nature and low ash content, it can serve as an ideal substrate for production of several value-added products such as single cell protein (SCP), mushrooms, enzymes, organic acids, amino acids, biologically active secondary metabolites, packing materials etc. The physico-chemical composition of cassava bagasse (Table 1) may differ due to the use of different crop varieties. Cassava bagasse does not show any cyanide content. However, its poor protein content makes it unattractive as an animal feed. In comparison to other agricultural residues, cassava bagasse can be considered as a rich solar energy reservoir due to its (cassava's) easy regeneration capacity.

Microbial Strains Cultivated on Cassava Bagasse

Because of its high starch (80.6%) and low ash content (1.8%), cassava bagasse could offer numerous advantages in comparison to other crop residues

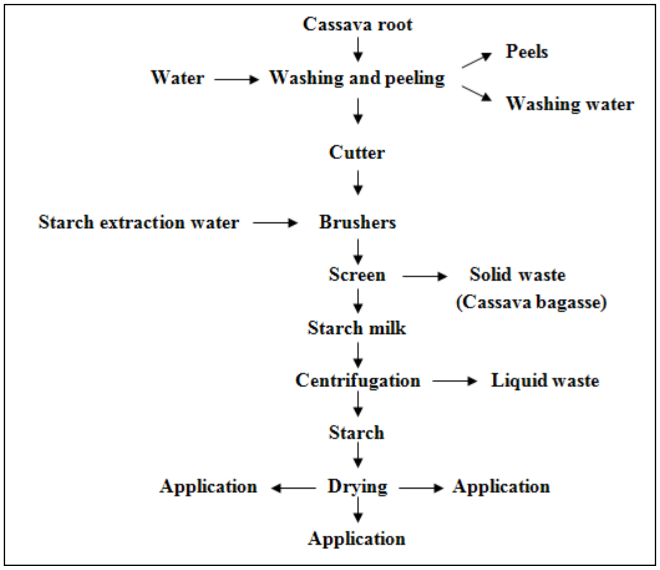

Figure 1: Industrial processing of cassava

Table 1: Nutritional potential of cassava bagasse

S. No.	Constituents	(%)
1.	Water	11-12
2.	Protein	0.85
3.	Fats	0.30
4.	Carbohydrates	56.20
5.	Fibre	10.60
6.	Sugar	1.20

such as rice straw and wheat straw, which have 17.5% and 11.0%, respectively, ash contents, for usage in bioconversion processes using microbial cultures. When compared with sugarcane bagasse, it offers advantages, as it does not require any pretreatment and can be easily attacked by micro-organisms. *Aspergillus niger*, *Candida* sp., *Rhizopus* sp. and *Pleurotus* sp. are the yeasts and fungi used for cultivation on cassava bagasse.

Cultivation Systems

The processes involving cultivation of microbes on cassava bagasse can broadly be classified into two groups: processes based on liquid fermentation, and processes based on solid-state fermentation (SSF). Most of the work has been carried out in SSF systems. High water retention capacity (85 ± 90 %) also makes it an ideal substrate for SSF processes.

Production of Organic Acids

Among the various products produced through microbial cultivation on cassava bagasse, organic acids are important ones. Among these, citric acid production has been well studied. Citric acid is used in several industrial processes, such as food and pharmaceutical industries. It is also used in cosmetics and plastic industries. Cassava bagasse was found to be a good substrate, giving 13.64 g citric acid per 100 g dry substrate. This corresponded to 41.78% yield. Under improved fermentation conditions, the citric acid production increased to 27 g/ 100 g dry substrate, which corresponded to 70% yield (based on sugars consumed). On comparing the citric acid production from various agro-industrial residues, such as cassava bagasse, wheat bran, rice bran, sugarcane pressmud, etc., using an indigenous strain of *Aspergillus niger*. Cassava bagasse gave the highest yield of citric acid based on the total starch or sugars present initially in the medium.

Production of Aroma Compounds

One of the important areas of cassava bagasse utilization in bioprocesses has been on the production of flavour and aroma compounds. Cassava bagasse was used in combination with soya bean or apple pomace. All the media supported fungal growth. Media containing cassava bagasse with apple pomace or soya bean produced a strong fruity aroma.

Production of Mushrooms

Cassava bagasse has also been used for mushroom cultivation in SSF. Beux *et al.* (1995) compared the cultivation of *Lentinus edodes* on cassava bagasse and sugarcane bagasse, individually or in their mixture. Both the substrates were found suitable for mushroom production, but the best results were obtained when a mixture of cassava bagasse (80%) and sugarcane bagasse (20%) was used. Data on kinetics of starch consumption (present in cassava bagasse) showed that about 77% of the starch was used during the biotransformation process. The protein content of the substrate was improved three times. The results were claimed to be useful in providing a novel alternative technology for shiitake production. Barbosa *et al.* (1995) also compared cassava bagasse and sugarcane bagasse for mushroom production. They used a different fungal culture, *Pleurotus sajor-caju*. Cassava bagasse showed good potential for mushroom cultivation, but the best results were obtained when cassava bagasse was used in a mixture with sugarcane bagasse (8:2, dry weight basis). The results were claimed to be useful for upgrading the cassava bagasse for animal feed.

Production of Broiler Feed

The fibrous residue discharged from cassava starch factories contains calcium and 50-55 % of unextracted starch. The feed is produced by mixing the residue with cassava flour in 1:1 ratio, steaming to solubilize the lignocelluloses, drying and incorporating other ingredients. The economic broiler farming is possible by feeding the birds with cassava residue based feeds. This feed could be inoculated with microbial inoculants to enrich the feed with single cell proteins.

Hydrolysate of Cassava Bagasse in Bioprocesses

Cassava bagasse was hydrolyzed using HCl and the hydrolysate was used for the production of xanthan using a bacterial culture of *Xanthomonas campestris*. Xanthan is a bacterial heteropolysaccharide of high viscosity even at low concentration. It is widely used in salad dressings, sauces, puddings, desserts, beverages, soups etc. Pullulan is another fungal polysaccharide produced by *Aureobasidium pullulans* during its growth on cassava starch wastes. It has good film forming property and hence has wide use for edible coating of food products.

Biotransformation of Cassava Bagasse

The high starch contents of cassava bagasse, an approach was applied to biotransform this into food and feed using edible fungal cultures. Researchers explored the possibilities of cultivating *Rhizopus* strains capable of attacking raw cassava starch present in cassava bagasse. They used 19 *Rhizopus* strains in SSF, but only three of them were capable of attacking significantly raw starch present in bagasse. The cassava bagasse can be used until 15% inclusion level in the total diet of dairy cows without physiological or nutritional damage.

Production of Packing Materials

Bagasse obtained from the industrial production of cassava starch was used to obtain a composite that is similar to cardboard, through a technique used in small scale artisan production of recycled paper. A mixture of 90% cassava bagasse and 10% of Kraft paper was used for the production of these composites. The cassava bagasse-Kraft paper composites obtained had a slight resistance to direct contact with water. The bagasse also used to prepare composites for disposable trays.

Conclusion

It can be concluded that biotechnological interventions in cassava bagasse utilization is enormous as it can lead to the production of a whole range of products that can find use in the food, textile, pharmaceutical, beverage and confectionery industries. Nevertheless, tapping the potential by identifying the most appropriate microbial strains, standardizing and optimizing the culture conditions, economizing the production etc. are vital for maximizing their use in the years to come.

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