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Starch extraction from banana pseudostem

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SUMMARY : The banana (*Musa paradisiaca* L.) belongs to the family Musaceae. Banana is one of the important tropical fruit crops. India ranks second in banana production in the world, occupying about 3, 25858 ha. area under cultivation (Anonymous, 1992). The starch occurs in nature as stored food in the tissues of higher plant and forms the bulk of the solids of grain and tubers. Raw material commonly used for the manufacture of starch in different parts of worlds is: food grain (maize, wheat, jowar) tubers and roots (potato, sweet potato, tapioca) and sago. In countries suffering from shortage of food, the availability of these materials for starch manufacture is limited. The starch is present in the form of granules and can be demonstrated by pouring iodine solution over the cut stem. Banana stem is used to some extent in the preparation of fibre ropes and cheap quality paper, and the inner soft core is consumed as a cooked vegetable, but no important industrial use of the stem has so far been reported. The production of starch in this country has greatly decreased. Thus, the new starch, *viz.*: *Banana stem starch* can be used with advantages for implementing the production of starch in this country for which there is potential demand.

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Banana is the cheapest, most plentiful almost nourishing of all fruits. It contains all the essential nutrients including minerals and vitamin and has several medical properties. Banana is a rich source of energy, about 24 bananas each weighing 100g, would provide the energy requirements (2400 cal/day) of a man *(Kotecha and Desai, 1995)*. Ripe banana contains moisture 70 per cent, crude fibre 0.5 per cent, proteins 1.2 per cent, carbohydrates 27 per cent, lipids 0.3 per cent, minerals 0.9 per cent, phosphorus 29 mg/100 g, calcium 8 mg/100g, iron 0.6 mg/100 g, b- carotene 0.5 mg/100 g, niacin 0.7 mg/100 g, ascorbic acid 12 mg/100 g, riboflavin 0.05 mg/ 100 g and energy 104 cal/100 g (*Anonymous 1977)*. Banana has been grown in Jalgaon region varieties are Shrimanti, Dwarf Cavendish, Basrai, Robustra, Lal velchi, safed velchi Rajeli nendran and Red banana. The Shrimanti variety is most popular variety in Jalgaon Region.

The starch occurs in nature as stored food in the tissues of higher plant and forms the bulk of the solids of grain and tubers. Raw material commonly used for the manufacture of starch in different parts of worlds is: food grain (maize, wheat, jowar) tubers and roots (potato, sweet potato, tapioca) and sago. In countries suffering from shortage of food, the availability of these materials for starch manufacture is limited. The starch is present in the form of granules and can be demonstrated by pouring iodine solution over the cut stem.

After harvesting the fruit, the felled plant is generally allowed to rot in the field. The stem is used to some extent in the preparation of fibre ropes and cheap quality paper, and the inner soft core is consumed as a cooked vegetable, but no important industrial use of the stem has so far been reported. The estimated output capacity of all the starch factories located in the country is about 73,000 tons per annum, but it is reported that these factories could hardly produce 1350 tons in 1947 and 3599 tons in 1998. This was because of the irregular supplies of maize, which occurred due to food shortage in the country and also its

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poor quality as obtained by the manufactures. Thus, the production has been very meagre when compared with actual demand. This has led to the enormous increase in the imports of starch from foreign source from 1946- 47 onwards. According to figures available in seaborne trade for the year 1948-49, total quantity import of all starches amounted to about 8,76,000 cwts. (*i.e.* about 43,800 tons).

CFTRI (1982) observed that starch was formed in nature as stored food in the tissue of higher plants and forms the bulk of the solid of the grains and tubers. They observed that starch was extracted from banana pseudostem when crushed in the sugar cane crusher in presence of water. They mentioned three methods of starch extraction from banana pseudostem.

Method I:

Material cut into small pieces was easily crushed in the presence of water. Practically all starch was released in about three crushing, the liquid being separated off each time by passing it through sieves of 60-70 mesh.

Method II:

A high-speed emery wheel with a rough abrasive surface and a rubber-rasping machine studded with sharp steel spikes on a high speed-revolving wheel, also proved efficient. With both these devices the stem was gradually crushed into fine pulp, which was throughly stirred with water releasing practically all the starch.

Method III:

Power driven cane crusher for preliminary crusher, followed by working of the crushed material in a paper pulp beater, was explored on a pilot plant scale. The stems were cut longitudinally before feeding to the crusher. The fibrous material was crushed to small pieces and a pressed juice, which contained about 40 per cent of the starch, and the fibrous material were transferred to the pulping tank and worked up with the paper pulp beater in the presence of water for about an hour. The liquid containing the starch in suspension was strained through a set of sieves of decreasing mesh size to eliminate the fiber, the starch allowed to sediment in cylindrical vessels. The thick starch slurry was suitably diluted before tabling. The starch tends to settle quickly in the inclined tables while the light pulpy portion flows out with effluent. Plain water was run into the tables for final washing f the product, which was then scraped off, dried and powdered. *Luis Arturo Bello-Perez and Silvia Maribel Contreras-Ramos (2000)* observed that the banana native starch was acetylated and some of its functional properties were evaluated and compared to cornstarch. Acetylated banana starch presented higher values in ash, protein and fat than corn acetylated starch. The acetylating considerably increased the solubility of starch and similar behavior was found for swelling power. *Murphy (2000)* observed that no other single food ingredient compares with starch in terms of shear versatility of application in the food industry, second only to cellulose in natural abundance. This polymeric carbohydrate was designed by nature as a plant energy reserves. Man however has extended the use of starch for beyond this original design. *Dayane Rosalygn, Zidora, Bogdan Demezak Junior (2006)* observed that starch obtained from green banana and commercial corn starch in order to compare the granule morphology and the rheological behavior of these gel-starches. The banana starch granules presented an oval and ellipsoidal shape with irregular diameters. The granules of cornstarch showed a podiatric shape, with different sizes. The rheological behavior of gel starch solutions showed a non-Newtonian character with pseudo plastic behaviour.

Due to the non-availability of maize (which is being mainly used for food purpose). The production of starch in this county has greatly decreased. Thus, the new starch, *viz., Banana stem starch* can be used with advantages for implementing the production of starch in this country for which there is potential demand. Considering the above fact the present research work was undertaken with specipic objectives: To test the presence of starch in the banana pseudostem, to find out the most cultivated variety at Jalgaon having a starch and to extract starch from that variety.

EXPERIMENTAL METHODS

Procurement of banana stem:

Banana pseudostems of "Shrimanti" variety were procured after harvesting of banana. Fresh and healthy banana pseudostems were procured. The banana pseudostem was washed under tap water to remove dust and foreign matter.

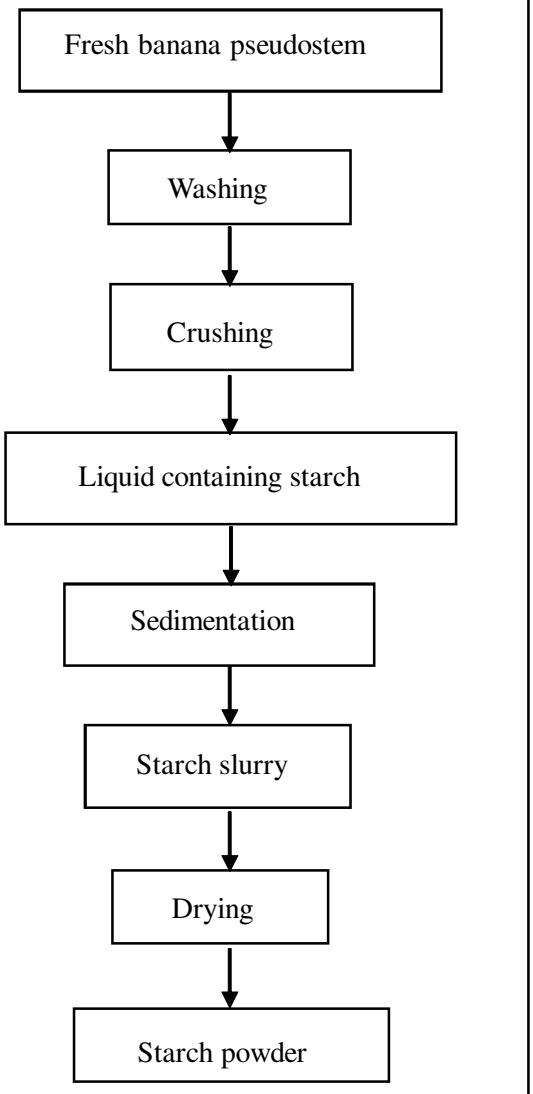
Preparation of a sample:

Choose banana pseudostem of 'Shrimanti' verities with higher initial moisture content were choosed pseudostem was cut. The whole pseudostem was cut into longitudinal pieces, which is suitable for crushing.

Procedure:

Fresh banana pseudostems with high initial moisture content were selected. They were cut into longitudinal small pieces. The pieces were crush into sugarcane crusher in presence of water. After crushing, liquid

containing starch was obtained. It was kept for sedimentation for 12 hrs. Starch was allowed to settle at the bottom then upper liquid was removed and starch was separated. The starch sample was kept for evaporation and drying to form starch powder.



Flow chart of starch extraction from banana pseudostem

Experimental procedures:

Moisture content:

The moisture content of sample was determined by using hot air oven method. The sample was kept in oven at 110^{0}C for 24 hrs. The moisture content in per cent was calculated using equation 3.1 and 3.2 *(Chakraverty, 1981)*.

$$M_w = \frac{W_1 - W_2}{W_1} x100$$

$$M_d = \frac{W_1 - W_2}{W_2} x100$$

where,

M_w - Moisture content per cent wet basis
M_d - Moisture content per cent dry basis
W_1 - Initial weight of sample, g
W_2 - Final weight of sample, g

Weight reduction:

Weight reduction in bananas during osmotic dehydration was determined by using equation 3.3 (Shashikakabai, *et al.* 2004).

$$\text{Weight reduction (WR) \%} = \frac{W_2 - W_1}{W_1}$$

Water loss:

Water loss was determined by using equation 3.5 (Shashikalabai, *et al.* 2004).

$$\text{Water loss (WL) \%} = WR + SG$$

where,

W_1 = initial weight of sample, g
W_2 = final weight of sample after osmosis, g
W_3 = Oven dried weight of sample after osmosis, g
m_1 = Initial moisture content of sample before osmosis on w.b, per cent.

EXPERIMENTAL FINDINGS AND ANALYSIS

The experiment of the starch extraction of banana pseudostem was carried out with different temperature, evaporation rate and volume changes n the raw juice for different time interval with temperature. The following results were obtained, after the research.

Table 1: Various parameters while crushing pseudostem in sugarcane crusher

Sr.No.	Paramrters	Reading
1.	Initial wt. of banana pseudostem used	9700 g
2.	Initial volume of raw juice before sieving	1600 ml
3.	Volume of juice after sieving	1500 ml
4.	Wt. of fiber after crushing	8000 g
5.	Crusher speed for crushing	25 rpm
6.	Time required for crushing	20 min.

Table 2 : The temperatures for different working condition for starch extraction

Sr. No.	Working condition	Temp (°C)
1.	Initial temperature of fresh banana stem	35
2.	Initial temperature of crusher	38
3.	Temperature of crusher in working condition	36
4.	Temperature of juice after sieving	30
5.	Temperature of fiber	35
6.	Final temperature of crusher	36
7.	Room temperature	42

Initial moisture content of banana pseudostem:

The overall initial moisture content of the banana pseudostem was 94 per cent. This was determined by keeping the samples of banana pseudostem in an oven at 110°c for 24 hrs.

The Fig.1 shows that there was sudden weight reduction in solar dryer initially and then it was constant. The weight reduction in first sample was from 46.87 g to 8.08 g and in second sample was from 47.28 g to 8.12 g.

Fig. 1 : Weight reduction of juice of banana pseudostem in solar dryer

The Fig. 2 shows that there was continuous weight reduction in oven dryer. The weight reduction in first sample was from 45.48 g to 8.35 g and in second sample was from 45.51 g to 8.03 g.

Fig. 2 : Weight reduction of juice of banana pseudostem in oven dryer

The Fig. 3 shows that there was continuous weight reduction in sun drying. The weight reduction in first sample was from 53.25 g to 8.12 g and in second sample was from 55.29 g to 8.50 g.

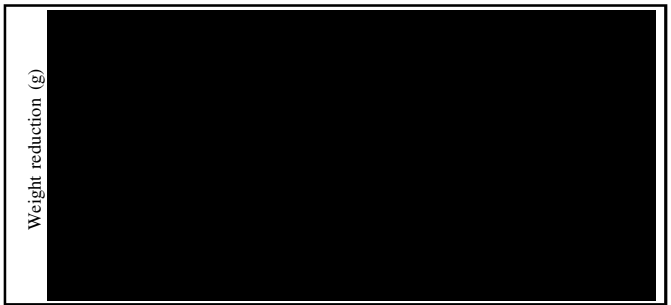


Fig. 3 : Weight reduction of juice of banana pseudostem when sun dried

Table 3 shows the maximum amount of starch was obtained from solar dryer in first sample (*i.e.* 3.9%) and in second sampl (*i.e.* 3.5%).The minimum amount of starch was obtained from oven drying in first sample (*i.e.* 3.2 %) and in second sample (*i.e.* 3.2 %). The colour observed was white amorphous in oven dryer, in sun drying it was blackish and in solar dryer it was in between white amorphous and blackish.

Table 3: Starch obtained from different types of drying

Sample	Type of drying	Percentage of starch
I	Solar dryer	3.9
	Oven	3.2
	sun	3.4
II	Solar dryer	3.5
	Oven	3.2
	sun	3.3

Conclusion:

The study on "Starch extraction from banana pseudostem" was carried out at Department of Agricultural Process Engineering, Dr. Ulhas Patil College of Agricultural Engineering and Technology Jalgaon during the year 2007-2008.

Fresh banana pseudostem with suitable MC of "Shrimanti" variety was selected for experiment. Banana stems were cut into small pieces and they were crushed in the sugarcane crusher in presence of water. Crushed juice was kept for sedimentation. Sedimented product was found to be liquid starch. Liquid starch was dried using various drying methods such as sun drying, solar drying and oven drying for different temperatures and time. The dried product was white amorphous powder of starch.

Based on the results following conclusions were drawn:

– The maximum amount of starch was found to be 3.9 per cent by solar drying at 65 ^{0}C for 7 hrs.
– The minimum amount of starch was found to be 3.2 per cent by oven drying at 50 ^{0}C for 24 hrs.
– The average amount of starch was found to be 3.4 per cent by sun drying of starch at 42 ^{0}C for 6 hrs.
– The pH of starch was observed to be 6.4.

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