"Education for Knowledge, Science, and Culture"
- Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur
(Empowered Autonomous)

ANNUAL PROJECT PROGRESS REPORT

"Isolation & characterization of starch from banana pseudo-stem"

(01/11/2022 TO 31/10/2023)

SUBMITTED BY

VIVEKANAND COLLEGE KOLHAPUR ESTD JUNE 1964 (Autonomous)

DR. PRIYA DIGAMBAR PATIL

Department of Botany

Vivekanand College, Kolhapur

(Empowered Autonomous)

Annexure-C

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SEED MONEY SCHEME FOR RESEARCH

Annual Report of the work done on the Research Project

(Report to be submitted within 2 months after completion of each year)

1) Report report No. 1st/ 2nd / (Final): **1st**
2) University Reference No.: VCK/2022-23
3) Period of report: **From 1/11/2022 2022 to 31/10/2023**
4) Title of research project: **"Isolation and characterization of starch from banana pseudostem"**
5) a) Name of the Principal Investigator: **Dr. Priya Digambar Patil**
   b) Dept. and College where work has progressed: **Department of Botany, Vivekanand College, Kolhapur (Empowered Autonomous).**
6) Effective date of starting of the project: **1st November 2022**
7) Grant approved and expenditure incurred during the period of the report:
   a) Total amount approved: **Rs. 1,25,000/-**
   b) Total expenditure: **Rs. 18,000/-**
   c) Report of the work done: **(Annexure-I)**

1.	Brief objectives of the project	➢ Survey and collection of pseudo-stem of banana ➢ Isolation of starch from banana pseudo-stem ➢ Characterization of isolated starch
2.	Work done so far and results achieved and publication if any, resulting from the work (Give details of the papers and names of the journals in which it has been published or accepted for publication)	• **Survey and collection of banana pseudo-stem:** Field surveys were carried out for the collection of banana pseudo-stem. Collections were done by visiting different localities as when needed. • **Isolation of starch:** Starch was extracted from pseudo-stem of banana. Protocol for starch isolation is standardized. • **Characterization of starch:** Isolated starch was confirmed through biochemical tests. Characterization was done by using different techniques like SEM, DSC, FT-IR and XRD.

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3.	Has the progress been according to the original plan of work and towards achieving the objectives, if not, state reasons.	Yes. The progress is according to the original plan of work and towards achieving the objectives.
4.	Please indicate the difficulties, if any, experienced in implementing the project.	No
5.	If project has not been completed, please indicate the approximate time by which it is likely to be completed. A summary of the findings of the study. Two bound copies of the final report of the work done.	Project will be completed within time up to 31st October 2024.
6.	If the project has been completed. Please enclose a summary of the findings of the study. Two bound copies of the final report of work done may also be sent to the university.	No
7.	Any other information which would help in evaluation of work done on the project. At the completion of the project, the first report should indicate the output, such as a) Manpower trained b) Ph.D. awarded c) Publication of results d) Other impacts, if any	One research paper published in UGC care listed journal- International Journal Food and Nutritional Sciences (IF: 7.832) in December 2022. One Indian design patent is filed on 'Simple starch detector' on February 2024.

Signature of the Principal Investigator

Signature of the Principal

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Recommendation of the expert committee about continuation of the project after 1st year

Annexure-I

Report of the work done

India is the largest producer of banana next to mango. Banana is the most important fruit crop that grows all over the tropical regions of the world and has a major commercial importance in many of these countries. The annual production of banana in India is 26.2 million tons, contributing about 23% of world banana production. Pseudo-stem constitutes a major part of the plant biomass, which are usually left in the plantation or incinerated and wasted. In spite of various uses of banana plant, it is seen that huge portion of banana plants are just dumped as a waste causing environment hazards and making ecosystem imbalance. Currently, millions of tones of banana pseudo-stem are dumped in our country as waste and most of the farmers are facing huge troubles in disposing the accumulated bananas pseudo-stem. Therefore, an effective economic use of that is to reduce this environmental problem by utilization of banana pseudo-stem for extraction of starch.

The importance of bananas as a food crop in tropical areas cannot be underestimated. Starch being an energy reserve in most of the plants, it has a great economic importance. Starch is used in various forms as a food and for preparation of gels, pastes, adhesives, dried coating films and other purposes.

The banana (*Musa paradisiaca* L.) is one of the important tropical fruit crops. Banana belongs to the family Musaceae. India ranks second in banana production in the world, occupying about 3, 25858 ha. area under cultivation. The majority of the solid ingredients in grains and tubers are starch, which is found in nature as food that has been stored in the tissues of higher plants. Throughout the world, food grains, tubers and roots and sago are frequently utilized as raw materials for the production of starch. The interior soft core of banana is eaten as a cooked vegetable, and the stems are used to make fiber ropes and low-quality paper to some extent, but no significant industrial use for the stem has yet to be documented. The production of starch in this country has greatly decreased. Because there is a potential market for starch in the country, the novel starch - banana pseudo stem starch can be utilized advantageously to execute starch production.

When the plant reaches its maximum height, the lower portion of the midrib undergoes alteration, causing the tightly packed leaf sheaths that make up the pseudo-stem of a banana to thicken. It began at the onset of the reproductive organs formation. A delicate core that

resembles a tube is located in the center of the pseudostem (Figure 1) with a diameter of roughly 5–6 cm.

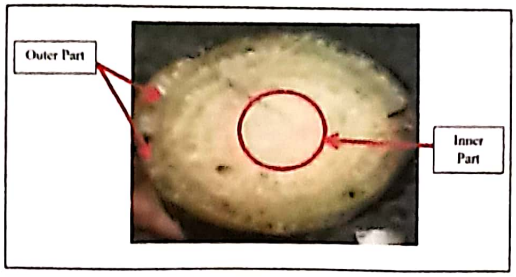


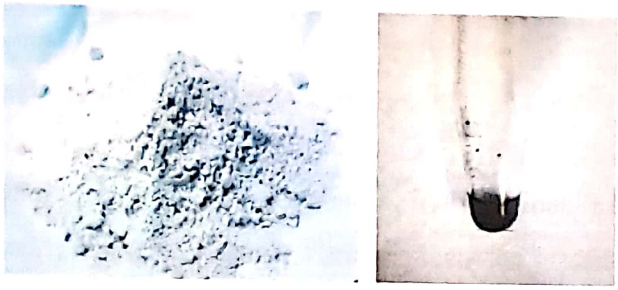
Figure 1: Cross section of Banana Pseudo-stem

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 pseudo-stem starch can be used with advantages for implementing the production of starch in this country for which there is potential demand.

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 poor quality of as obtained by the manufactures. As a result, in comparison to the real demand, the production has been extremely low. This has led to the enormous increase in the imports of starch from foreign source. Though several researches are available where isolation of starch from banana and their functional properties were investigated but there is very few reports are available on isolation of starch from banana pseudo-stem starch and

their potential use. Therefore, in the present investigation, isolation and characterization of starch from banana pseudo-stem of Konkan variety 'Velachi' was done.

The protocol for starch isolation from banana pseudo-stem was standardized under laboratory condition. The starch obtained from banana pseudo-stem was white, crystalline, non-hygroscopic powder and a yield of about 36.96%, which is considered to be appreciable. Isolated starch was further confirmed by I_2KI test and microphotography (Fig. 2). The intrinsic quality of botanical starch is its granule microstructure, which is frequently the fundamental element influencing its physicochemical and functional characteristics.



A B

Figure 2: A- Isolated banana pseudo stem starch, B- Starch-I_2KI

Fourier transform infrared (FT-IR) offers quantitative and qualitative analysis for organic and inorganic samples. FT-IR identifies chemical bonds in a molecule by producing an infrared absorption spectrum. The FT-IR spectrum for isolated starch was shown in figure 3. The infrared (IR) spectrum of starch samples was described by seven main modes, with maximum absorbance peaks near 3,500, 3000, 1,600, 1,400, 1,000, 800 and 500 cm^{-1}. FT-IR spectra showed similar pattern for the isolated starch, with seven main modes with maximum absorbance peaks near to 3,500, 3000, 1,600, 1,400, 1,000, 800 and 500 cm^{-1} (Fig. 3). The study was confirmed the observed spectra by FT-IR spectroscopy of starch sample. The characteristic angular O-H bending vibration was found in the range of 1639.70 cm^{-1}. The band at 1,080 cm^{-1} in isolated starch was associated with the amorphous structures of starch. The bands at 928~8 cm^{-1} were attributed to D-glucopyranosyl ring vibrational modes and 766 ± 10 cm^{-1} were attributed to D-glucopyranosyl ring stretching. The isolated starch was slightly less ordered in the external region of the granule.

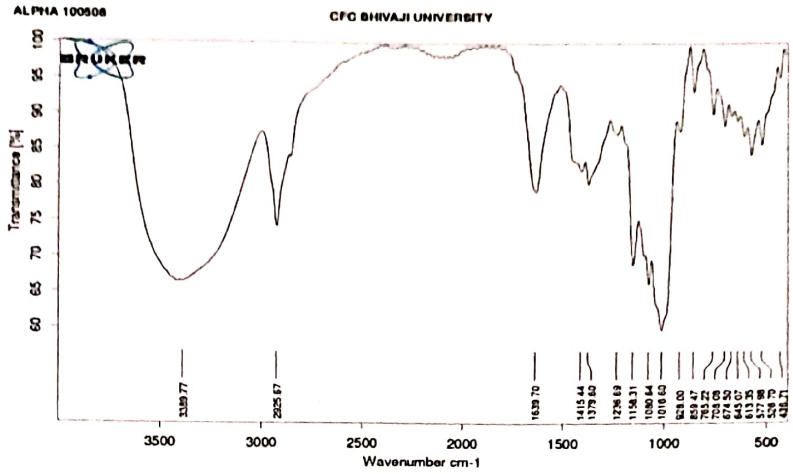
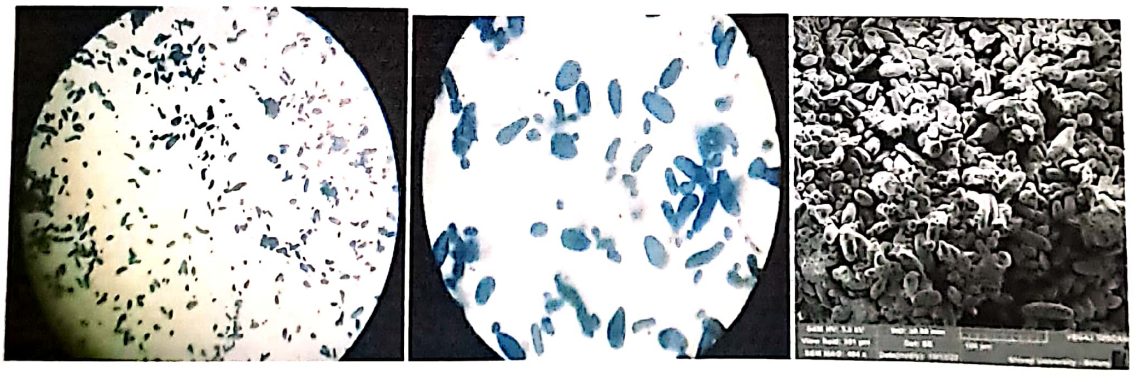


Figure 3: FT-IR Spectra of Banana Pseudo-stem Starch

Generally, banana starch granules from various banana varieties are irregular, elongated, and round/spheroidal in shape. Variety affects the granule shape of banana starch. For present study, granule size was expressed as average length for oval and elongated shape of starch granules. Based on the results of analysis using SEM, the size of starch granules from banana pseudo-stem starch average length of starch granules of was in between 15-65µm which showed small to medium granules. SEM analysis was performed to determine the granule shape and shown in Fig. 4 (C). The magnification was used 450X to 500X. Starch granules of banana pseudo-stem were found in regular elongated with smooth surface. The results showed that granules were larger in size and shape. Previous studies reported that starch granule size has been affecting the physico-chemical properties of starch. The granule size of banana starch is larger than other starch.



A **B** **C**

Figure 4: Granule morphology of banana pseudo-stem starch A) Starch granules at 10X B) Starch granules at 40X C) SEM image of starch granules

The chemical composition of starch extracted from banana pseudo stem is represented in Table 1. Starch extracted from banana pseudo-stem has 6.96% moisture content and 1.02% ash. It also contains 1.26% and 0.37% lipid and protein, respectively. The crude fiber content of banana pseudo-stem starch was found 2.47% .

Variety	Moisture (%)	Ash (%)	Lipid (%)	Protein (%)	Fiber (%)
Musa Var. Velachi Pseudo-stem starch	6.96	1.02	1.26	0.37	2.47

Table 1: Physico-chemical properties of isolated starch

Variety	Amylose (g/100g)	Amylopectin (g/100g)	Starch (%)
Musa Var. Velachi Pseudo-stem starch	11.94	25.02	36.96

Table 2: Amylose and amylopection analysis of isolated starch

Forming a gel will be more challenging the higher the amylose level. Due to the fact that, the amorphous structure that forms will raise the temperature during gelatinization, slowing down the process. Since, the amorphous structure that forms will raise the temperature during gelatinization, gelatinization process will run slowly.

The isolated starch of banana pseudo-stem had oval to elongated shaped and large sized granules showed prominent structure showed in light as well as scanning electron microscopy, indicating that the isolation procedure yielded intact granules. Isolated starch contained similar amount of short-range order which could influence on some other physico-chemical properties. The results obtained in structural characterization provide information about the possible behaviour of the starch when being used in certain applications. The physico-chemical properties of the starch indicate their potential applications as thickener, stabilizer, emulsifier, and de-foaming agent in the food (confectionery, sauces, edible films, etc.), pharmaceutical (excipient, tablet/capsule disintegrant, binder, etc.).

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(Dr. Priya D. Patil)
Principal Investigator

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