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PRODUCTION OF STARCH FROM MANGO (MANGIFERA INDICA.L) SEED KERNEL AND ITS CHARACTERIZATION

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Abstract— Mango (Mangifera Indica.L) is the national fruit of India. Peels and seeds are the by-products obtained during processing of mango. The Mango seed possess disposal problem if not handled properly therefore conversion of mango seed kernel to starch is the solution of this problem. Starch is used in food and pharmaceutical industry. These industries depend on crops that are the primary source of food for the human thus raising the food prices. Unlike the conventional method of producing starch, this method totally uses raw waste. The report showed the maximum yield of starch was 59.06 percent, the amylose content 16.3 percent and ash content between 0.12 to 0.15 percent. The purity of the starch obtained was 97.18 percent when compared to market starch which was 92.59 percent. Thus, it can be concluded that the starch obtained from mango seed kernel can be used in food industry.

Index Terms—Mangifera indica, Seed, Kernel, Starch, Adhesive.

I. INTRODUCTION

Starch is a carbohydrate consisting of large number of glucose units which are linked by glycosidic bond. It is a food reserve substance in plant and is widely used in pharmaceutical industry. It is also used as a food additive usually as thickeners and stabilizers. It can also be used to produce gel and ethanol. Extensive research is done on the isolation of starch from variety of food sources like potato, maize, corn and rice and their application in food and non- food industry[1]. The physicochemical properties of starch differ from source to source of raw material. Very few literatures are available on isolation of starch from non-conventional sources like the seeds of fruits.

One such source for the production of starch is mango (Mangifera indica) seed kernel. Mango belongs to the genus Mangifera of the family Anacardiaceae. Mango is a tropical fruit. As per the investigation of Kusuma D.K et. al, [2] India is the largest producer of mango with 44.14% of the world total production. Mango flesh are usually consumed or processed in an industry thus disposing a large amount of seed as solid waste. Approximately 40–60% waste is generated during processing of mango, out of which peel and kernel constitute 12–15% and 15–20%, respectively[3]. Mango kernel, on a dry basis, contains 65% starch, 2.9% reducing sugars, 5.7% proteins, 0.8% pectin, 9.3% fat and 1.1% tannins and rest is moisture[4]. The kernel obtained after decortication of mango seed is used as a supplement to wheat flour or for the extraction of edible oil.[3]. The mango seed kernel flour can also be used for edible purpose besides being used as an animal feed. Very little information is present about the isolation of starch from mango seed kernel. The mango seed kernel is a promising seed because of its high level of carbohydrate and oil [5]. The present study focuses on the isolation of starch from the raw mango seed kernel and the study of physicochemical properties of different varieties of mango.

II. MATERIALS AND METHODS

A. Materials/Instruments Used

The materials/instruments used for this work were, Proportional-Integral-Derivative Controller (PID), hot air oven, thermometer (0 to 100˚C), centrifuge, pH meter, crucible and muffle furnace.

B. Sample Collection

Sindhoori, Totapuri and Bagenpalli mangoes are collected from the local market of Bengaluru, Karnataka of the 2015 harvest. A sample of Sindhoori mango is shown in Fig 1.

Fig 1: Sindhoori Mango

C. Process of Starch Isolation

The mango seed is collected and sun dried for two days. Then the mango seed kernel is manually separated from the hull and cut into small pieces of 5-10mm size. A sample of mango seed kernel and hull is shown in Fig 2.

Fig 2: Mango Seed along with the Kernel

10g of raw kernel sample is weighed and taken in a starch isolation unit. To this, 80ml of 0.16% of Sodium Hydrogen Sulphite solution is added. The temperature of the process is maintained at 50˚C for 24hrs using a PID controller. Also the content is agitated at an interval of 1hr with the help of glass rod. This is called steeping process. The experimental setup of starch isolation unit with PID controller is shown in Fig 3.

Fig 3: Experimental Setup for Starch Isolation with PID Controller

After the steeping process the solution is decanted to obtain the steeped kernel. Then, the steeped kernel is grounded in a mixer grinder by adding 50ml of distilled water to obtain brownish white color slurry. Then this slurry is filtered using a muslin cloth and filtrate is obtained. Thereafter, the filter cake is washed with distilled water until unless clear wash water is obtained. The filter cake is disposed and the obtained filtrate is further centrifuged at 2800 rpm for 5 mins. The upper non-white layer is disposed and the white layer was re-suspended in distilled water and again centrifuged. This is done for 4 times and finally the starch is collected and dried in an oven for 6 hrs at 50˚ C. A sample of isolated starch is shown in Fig 4.

Fig 4: Isolated Starch

This procedure of starch isolation is continued for three varieties of mango seed kernel for different solid solvent ratio.

D. Physicochemical Properties Analysis of Starch Ash Content (%)

Ash content was determined using AOAC method [6]. In a pre-weighed empty crucible (W_1) 5g of starch is taken and is again weighed (W_2). The crucible is then kept in a muffle furnace for 5hours at 900˚C. The crucible is then allowed to cool and weighed (W_3). The ash content was determined using the following equation

Ash content (%) = $\{(W_3-W_1) / (W_2-W_1)\}$ X 100 …..(1)

pH

Priya.D.Patil et.al method is used for the pH determination [6]. 5g of starch is taken in 20ml of distilled water and is mixed thoroughly for 5 minutes. The starch is allowed to settle and pH of the water phase is taken using a calibrated pH meter. Average of three trials is taken.

Amylose Content (%)

The method reported by Priya.D.Patil et.al [6] is used for amylose determination. 20mg of starch is taken and 20ml of 0.5N KOH is added to it. The suspension is mixed and then transferred to a 100ml volumetric flask to make the final volume to the mark with distilled water. 10ml of the test starch is pipetted out and is transferred to a 50ml volumetric flask and 5ml of 0.1N HCl is added followed by 0.5ml of iodine reagent. The final volume is made to the mark by distilled water and the absorbance is measured at 625nm. The amylose content is determined using the following equation

Amylose content (%) = (85.24 x A) - 13.19 ……(2)
Amylopectin content (%) = 100 - %amylose ……(3)
Where,
A = Absorbance

E. Production of Adhesive

10grams of starch is added to 500ml of distilled water in 1000 ml beaker and is heated at 50˚C. 50 ml of 0.01M hydrochloric acid is then added and the temperature of the solution is brought up to 75˚C. The solution is heated and stirred until the starch becomes gelatinized. The solution is then cooled to room temperature. 6 grams of Borax (viscosity enhancer) is added in the increments of 0.5 grams at a temperature of 80˚C. Continuous heating and stirring is carried on until the desired viscosity is obtained [9]. A sample of glue produced from starch is shown in Fig 5.

Fig 5: Glue Produced from Starch

III. RESULTS AND DISCUSSION

A. Confirmation Test of Starch

Starch is a polysaccharide consisting of two fractions- amylose (10-20%) and amylopectin (80-90%). Amylose forms a colloidal suspension in water whereas amylopectin is completely insoluble.

Iodine - Potassium Iodide (KI) Reagent preparation: It is also known as Lugol's solution. Iodine is not very soluble in water therefore to dissolve iodine with water potassium iodide is added. As a result a linear triiodide ion complex is formed. The obtained Lugol's solution appears to be orange or yellow colour.

Starch test: The lugol solution is added to the extracted sample. The linear triiodide ion complex slips into the coil of starch giving an intense blue-black colour indicating the presence of starch. If no starch is present, the colour of the solution remains the same. The confirmation test of isolated starch is shown in Fig 6.

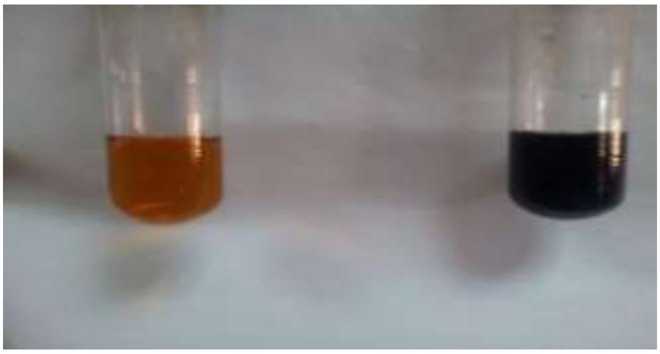

Fig 6: Starch Test Negative (Orange Yellow Color) for Water and Positive (Blue Black color) for Starch

B. Determination of Optimum Solid-Solvent Ratio

10 grams of Sindhoori mango kernel is taken at different solid-solvent ratio to determine the optimum yield of starch.

Table 1: Effect of Solid-Solvent Ratio on Yield of Starch

	Yield of starch/10g of kernel			
Solid to solvent ratio	Trial 1 (g)	Trial 2 (g)	Trial 3 (g)	Average (g)
1:8	5.068	5.138	5.113	5.106
1:10	5.151	5.21	5.087	5.149
1:12	5.726	5.803	5.842	5.790
1:14	5.874	5.907	5.939	5.906
1:15	5.912	5.923	5.899	5.911

It is observed from table 1 that as the solid to solvent ratio increases the yield of starch increases. The maximum yield is obtained at 1:14 solid to solvent ratio after which there is no much effect. This may be due to the reason that at low solid to solvent ratio the solvent is not enough to steep the kernel properly and the starch is not isolated effectively whereas at higher solid solvent ratio the kernel is steeped properly so the isolation of starch is obtained effectively.

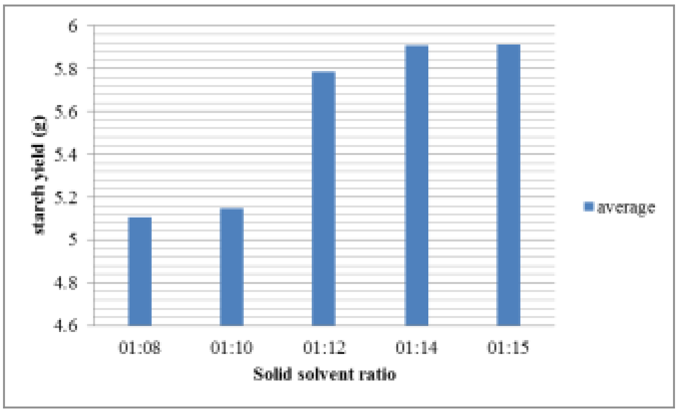

Fig 7: Effect of Solid Solvent Ratio on Starch Yield

A bar chart comparing the yield of starch/10g of kernel with different solid solvent ratio is shown in Fig 7.

C. Percentage Yield of Different Variety of Mango

Different variety of mango i.e Sindhoori, Totapuri and Bagenpalli are taken and the percentage yield of each variety is calculated. Table 2 compares the percentage yield of starch produced from different variety of mango. Sindhoori mango shows the highest yield of starch followed by Bagenpalli and Totapuri.

Table 2: Percentage Yield of Starch

Mango varieties	Amount of raw mango seed kernel used (g)	Solid to solvent ratio	Amount of starch obtained (g)	Percentage yield of starch (%)
Sindhoori	10	1:14	5.906	59.06
Totapuri	10	1:14	4.745	47.45
Bagenpalli	10	1:14	4.842	48.42

D. Material Balance

The result produced is verified for 1:10 solid to solvent ratio using material balance shown in the Fig.8.

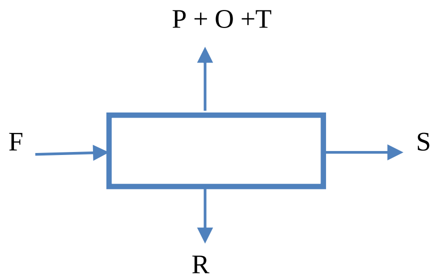

Fig 8: Material Balance

Where,
Feed, F = 10g
Starch, S = 5.21g
Residue, R = 4.477g
Protein(P) = 0.015g
Oil(O) = 0.029g
Tannin(T) = 0.049g

Material In = Material Out

F = S + R + P + O + T
10 = 5.21 + 4.477 + 0.015 + 0.029 + 0.049
10 = 9.78
Loss = 0.22g

From the material balance it is observed that during isolation of starch process 0.22g of loss occurs which is within the permissible limit.

E. Physicochemical Properties of Starch

The pH, amylose content (%) and ash content (%) of Sindhoori, Totapuri and Bagenpalli Starch is depicted in Table 3.

Table 3: Physicochemical Properties of Starch

Starch	pH	Amylose content (%)	Ash content (%)
Sindhoori	4.2	11.3	0.12
Totapuri	3.8	16.3	0.15
Bagenpalli	4.0	9.1	0.13

From the table 3 it is found that the values of the physicochemical properties are comparable with the standard value. Low ash content depicts low amount of minerals present in the starch. Thus, it indicates that the starch is of good quality.

F. Purity Test

The purity test is determined in Bangalore Test House as per the IS: 4706 (Part – II) 1978 method. The value obtained is shown in Table 4.

Table 4: Comparison of Purity of Starch

Starch	Trail number	Percent purity
Sindhoori	Trail 1	51.20
	Trail 2	91.14
	Trail 3	97.18
Totapuri	Trail 1	69.38
	Trail 2	97.82
Bagenpalli	Trail 1	97.73
Market	Trail 1	92.59

The purity obtained in trail 1 is comparatively very low. This is due to the reason that in Trail 1 one fold of muslin cloth is used. Later on modification of the filtering process produced more purity. The purity obtained in Bagenpalli Mango kernel sample is highest.

G. Adhesive Produced

Table 5 shows the amount of Gelatinization Enhancer (HCl) and Viscosity Enhancer (borax) added for the preparation of adhesive.

Table 5: Adhesive Produced

Trail Number	Amount of starch added (g)	Volume of 0.01M HCl added (g)	Volume of 0.01M HCl added (g)	Amount of Glue obtained (g)	Water evaporated (ml)
1	10	50	6	25	41

The amount of glue produced during the process is verified using the material balance. Using mass balance, the water evaporated can be calculated as,

Mass in = mass out

$W_{starch} + V_{HCl} + W_{Borax} = W_{glue} + W_{evap}$

$10 + 50 + 6 = 25 + W_{evap}$

Water evaporated, W_{evap} = 41ml

IV. CONCLUSION

The disposal of mango seed kernel can be overcome by producing starch from the kernel. At a solid to solvent ratio of 1:14 maximum yield of starch is obtained. Sindhoori mango shows the maximum yield of 59.06% starch. The purity test also reveals that the starch produced from mango seed kernel is 97.82% when compared to the market starch that is 92.59%. Even though there are some difference in physicochemical properties of the starch of different variety of mango the results indicated that the starch is of good quality. The physicochemical properties also reveals that the starch obtained can be used as both food and non-food purposes. Thus the results obtained are suggestive that Mango seed kernel is a good source of starch and can be utilized for industrial purposes.

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