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Comparison of Physico-Chemical Properties of Modified Jackfruit Starch with Maize Starch

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Abstract: Jackfruit (*Artocarpus heterophyllus Lam*) is one of the most popular tropical fruits growing in Asia, in India it is generally found in west & south region of the country. Fruit is rich source of carbohydrate, fibre and total minerals. The objective of this study is to compare physico-chemical properties of modified jackfruit starch (MJS) using maleic acid to commercially available maize starch (MS). In isolation of starch, Slurry obtained by wet grinding was treated with 2 % NaCl, for 24 hrs, at 4^0C & centrifuge it at 10,000 rpm for 30 min, again treated with 0.1 N NaOH twice for 48 hrs at 4^0C again centrifuge for same parameter and finally treated with 80 % Ethanol. Starch powder was obtained using freeze drying. Functional properties of starch were compared with maize starch. WAC (115.00) gm of water / 100gm of starch at 27^0 C & OAC of jackfruit starch (JS) was found to be (256.9334) gm of oil / 100gm of starch at 27^0 C. Also JS has higher solubility (43.25%) at temperature 70^0C to 80^0C compared to MS solubility (40%). Isolated starch having moisture (11%), crude fat (0.0987%), protein (0.785%), crude fiber (8%) and total minerals (0.18%) was used for modification by acid hydrolysis using 10 ml, 15 ml & 20 ml of (10%) maleic acid. Modification was carried out in microwave synthesizer to minimize the process time rather than conventional process. Total time required for acid hydrolysis reduced to 2.5 min than 5 hrs (conventional process). The solubility of MJS has increased to (70%) at 70^0C to 80^0C.
Keywords: Jackfruit Seeds, Starch, Modification, Microwave, Solubility.

Introduction

The *Artocarpus heterophyllus* Lam is a species of tree of the mulberry family (***Moraceae***) is commonly known as jackfruit. It is native to Western Ghats of India and Malaysia. It produces heavier yield than any other tree and bear mass from 10 to 60 or even as much as 110 lb (4.5 – 20 or 50 kg), may be 100 or up to 300 seeds in single fruit, which is ample source of starch. Many parts of this plant, including the bark, roots, leaves, fruits and seeds have medicinal properties. Jackfruit (***Artocarpus heterophyllus* Lam.**) is a monoecious evergreen tree that is popular in several tropical countries. It is also called *jack-fruit*, ***phanas*** in India. It is an excellent example of a food prized in some areas of the world and allowed to go to waste in others[4]. The objective of this

study is to compare physico-chemical properties of modified jackfruit starch (MJS) using food grade maleic acid rather than H_2SO_4, HCl to commercially available maize starch (MS) to find substitute of maize starch[1,3].

Materials And Methods

Materials

The jackfruit seeds (*Artocarpus heterophyllus* Lam) are collected from the WESTERN AREA OF MAHARASHTRA GENERALY CALLED AS A KONKAN. The seed were cleaned, washed and sun dried the store at room temperature.

Isolation of Starch

Starch was isolated by precipitation and settling from slurry. In isolation of starch, Slurry was obtained by wet grinding after removal of spermoderm by soaking seeds in 2% NaOH for 5 minutes, filtered using 250-125 µ mesh size sieve. The filtrate was treated with 2 % NaCl, for 24 hrs, at 4^0C & centrifuge it at 10,000 rpm for 30 min, again treated with 0.1 N NaOH twice for 48 hrs at 4^0C again centrifuge for same parameter and finally treated with 80 % Ethanol. Starch paste was freeze dried at -50^0C to obtained starch powder[2].

Modification of Starch

1. Conventional Modification

It is a conventional method used for the modification of starch. In this method the 10ml, 10% maleic acid is used for modification. 5 gm of starch was dissolved in 10ml, 10% maleic acid into flask. Place this flask into the conventional oven at 45^0C to 50^0C, for 5 hrs for reaction and 10 hrs for drying. After drying the material was grind to get starch powder.

2. Microwave Modification[14]

Microwave Synthesizer (CEM Corporation USA) has two types of reaction systems, open & close vessel reaction. For modification of starch open vessel reaction system was used. 5gm of starch and 10 ml, 10% of maleic acid was taken in small reaction vessel and, then fitted into microwave synthesizer. Adjust the condition such as power required, time of reaction and temperature required. For hydrolysis of starch by acid solution the conditions required are,
Power= 3 watt, Time = 2.5 min, Temperature=35ºc. Removed starch dried in oven at low temperature then grind.

Product Analysis

A) Chemical Properties

The proximate analysis of jackfruit flour was carried out according to the standard AOAC procedure[7].

- % moisture was determined by weight loss during drying divided by weight of sample taken for estimation.
- Total minerals can be determined by placing sample at 550^0C in muffle furnace for 5 to 6 hrs. % minerals can be determined by change in weight.
- Protein content was estimated by micro kjeldhal method and
- Fat was determined by Soxhlet extraction method.
- % starch was estimated by spectrophotometrically using Anthrone method[6].
- Amylose content of starch can also be estimated by spectrophptometrically at 620 nm using potato amylose as standared[6.] Amylopectin can be Calculated by taking difference between total starch and amylose content.

B) **Functional Properties**

- **Water Absorption Capacity**

  Two grams of starch was taken and 50ml quantity of water added to get a dough of moderately stiff consistency. The amount of water required was noted and expressed in percent[5].

- **Fat Absorption Capacity**

  Two gram of starch sample & 50 ml water was taken in a centrifuge tube and weight was recorded. Six milliliters of refined oil was added to the flour and centrifuged at 4000rpm for 25min. Free oil was decanted and weight of the centrifuge tube was noted[5].

- **Swelling Power**

Swelling power and per cent solubility of starch was determined according to the method of Schoch (1964)[8,11].

About 2 gm (W1) of jackfruit starch was taken in a centrifuge tube and weighed the centrifuge tube with sample (W2) and 50ml of distilled water was added. Then it was allowed for 30min in a boiling water bath at 100°C. The contents were cooled and centrifuged at 5000rpm for 10min. The supernatant was carefully decanted in a test tube. The water adhering to the sides of centrifuge tube was wiped well and weight of the centrifuge tube was taken with swollen material.

Results and Discussion

Analysis of Jackfruit Seeds

The composition analysis of jack seed flour reveals its importance as a source of protein (6.856 %), carbohydrates (70.26 %), crude fibre (8 %) and total mineral matter (3.1%). However, the analysis of protein content of jack seed flour by Tananuwong *et al.* (2002) documented higher (11.17 %) i.e., two per cent more than the value of present study. Similarly, it is interesting to note that, Rajarajeshwari and Jamuna (1999) documented extraordinarily high (21.30 %) protein content in jack seed flour. On the contrarily Kumar *et al.* (1988) reported lower value of 6.75 per cent of protein in jack seed flour. These variations may be attributed to processing and varietal variations. The analysis of fat content of jack seed flour by Bobbio *et al*. (1978); Kumar *et al.* (1988) and Tananuwong *et al.* (2002) documented the values of 0.5, 0.78 and 0.99 per cent of fat, respectively which are slightly lower than the value of present study.

Amylose and Amylose Pectin Content

Amylose content in the jackfruit starch is nearly about 40 % and modified starch gives 80% Amylose content, so here after modification, nearly about 100% amylose is increased and amylo pectin content is decreased & because of that solubility increases[9,10].

Analysis of Jackfruit Seed Starch

After isolation of starch by precipitation the jackfruit starch content nearly (81%) starch, (11%) moisture, (0.18%) ash, (0.98%) protein and Starch contains very low percentage of fat (0.0987%).

Table No. 1

Determination	Percentage (%)
Moisture	6.98
Crude protein	6.856
Crude FAT	0.4
Crude fiber	8
Ash	3.1
Total starch	70

Functional Properties of Starch:

1. Water Absorption Capacity

Water absorption capacity of the different starch at different temperature gives the different results shown in Table No 4. At low temperature water absorption capacities are low and for 100^0C temperature it became high. At 60^0C jackfruit starch has (137.06)WAC which would increase to (445.56), (432.5) in conventionally modified starch and microwave modified starch respectively. The WAC of starches is different for different starches may be attributed to differences in amylose and amylopectin content. The WAC of maize starch increase with increasing amylose content. Loose association of amylose and amylopectin molecules in starch granules has been reported to be responsible for variation in the WAC of starches. The engagement of hydroxyl groups to form hydrogen and covalent bonds between starch chains lowers the WAC[12, 13].

2. Swelling Power Capacity

The Swelling Capacity of Starch (Wt. of Sediments / gm of Starch) of different three types determined at different temperature as present in above a significant variation among different starches ranging from 3-6at room temperature. The values increased steadily with increase in temperature unit. The largest swelling capacity was obtained for microwave modified (7.55) at 100^0C temperature which is higher than (6.37) of same starch at room temperature. Swelling Power of the different starch at different temperature gives the different results. The change in SPC at a different temperature may because of change of amylose content of starch due to acidy hydrolysis. The percent change of swelling power from 60^0C temperature to 100^0C temperature is only 1 to 2 % with compared to room temperature it was 2 to 3%. Less change was observed due to less percent of amylose pectin. Literature has reported that amylose pectin molecule has been responsible for swelling of starch molecule. Therefore decrease of amylose pectin content due to microwave acid hydrolysis imparts less change in swelling power[4].

3. Solubility

The % solubility (calculated as % dry solids) of starches isolated from jackfruit seeds. Modified jackfruit starch gives higher solubility at room temperature. As soon as the temperature increases the starch solubility in the water has also been increases. Modified starches give higher solubility. The change in functional properties of starch with respect to temperature has been attributed due to amylose and amylopectin content of the starch. The modified starch nearly content 80% amylose which imparts changes in WAC and solubility properties. The results shows that increase of straight chain amylose content increases solubility of starch at room temperature which is further increase with increase in temperature units.

Chemical Analysis of Jackfruit Starch

Table No. 2

Determination	Percentage (%)
Moisture	11
Crude protein	0.875
Crude fat	0.0987
Ash	0.18
Starch	81

Prorerties Oof Diferent Starches At Room Temperature

Table No. 3

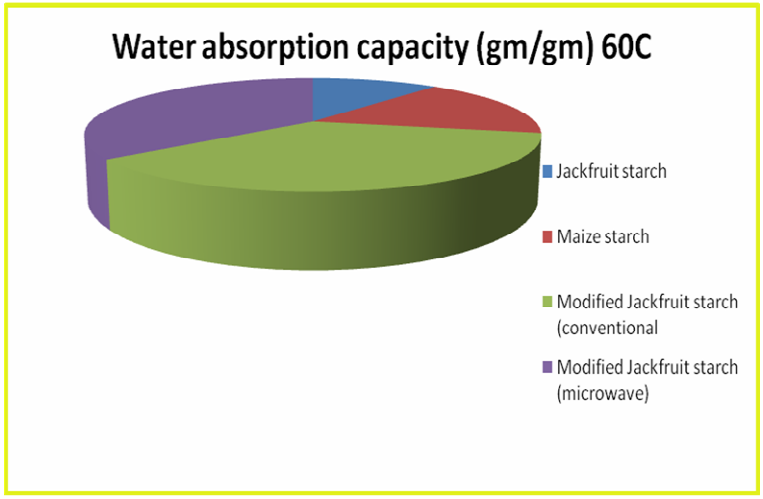
Prorerties	Jackfruit starch	Maize starch	Modified Jackfruit starch (conventional)	Modified Jackfruit starch (microwave)
Water absorption capacity (gm/100gm)	115	135.08	205.3	189.0
Swelling power (%)	3.7522	3.127	4.37	6.37
Solubility in water (gm/100gm)	37.28	36.29	41.32	64.5

Water Absorption Capacity

Table No. 4

Properties	Temperature	Jackfruit Starch	Maize Starch	Modified Jackfruit Starch (Conventional)	Modified Jackfruit Starch (Microwave)
Water Absorption Capacity (gm/100gm)	60^0C	137.06	208.32	445.56	432.5
	70^0C	268.32	634.19	385.46	501.23
	80^0C	452.49	761.45	561.009	558.25
	100^0C	512.25	723.58	632.6007	624.5

Graph No. 2

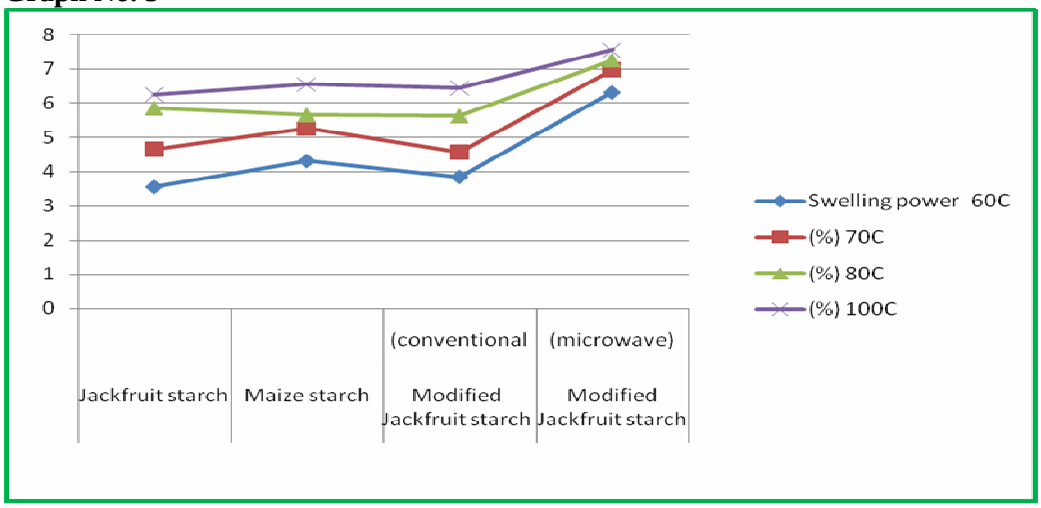


Swelling Power

Table No. 5

Properties	Temperature	Jackfruit Starch	Maize Starch	Modified Jackfruit Starch (Conventional)	Modified Jackfruit Starch (Microwave)
Swelling Power (%)	60^0C	3.56	4.32	3.85	6.32
	70^0C	4.65	5.25	4.56	6.97
	80^0C	5.85	5.65	5.62	7.25
	100^0C	6.25	6.55	6.45	7.55

Graph No. 3

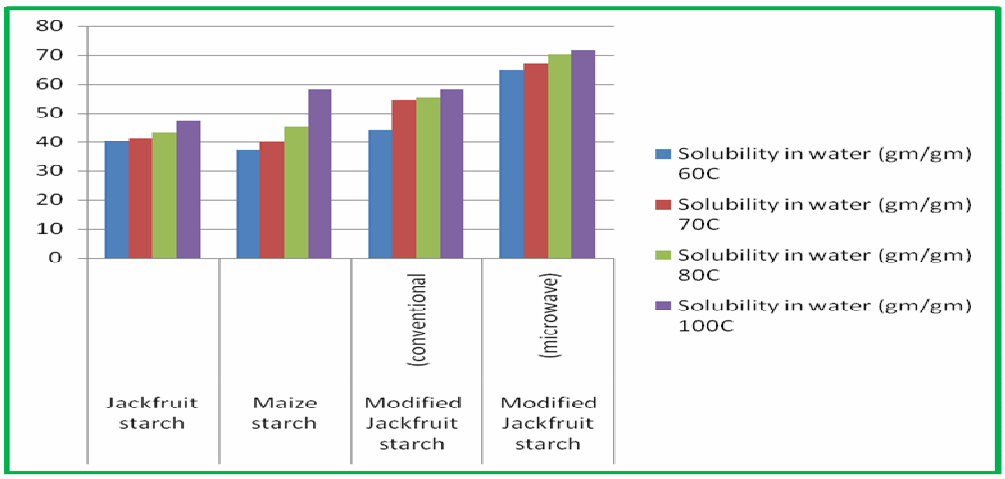


Solubility In Water

Table No. 6

Properties	Temperature	Jackfruit Starch	Maize Starch	Modified Jackfruit Starch (Conventional	Modified Jackfruit Starch (Microwave)
Solubility In Water (gm/100gm)	60^0C	40.2	37.12	44.25	64.84
	70^0C	41.26	40.1	54.32	67.25
	80^0C	43.25	45.23	55.26	70.2
	100^0C	47.25	58.23	58.25	71.54

Graph No. 4



Conclusion

The jackfruit starch content nearly 81% starch, 11% moisture, 0.18% ash. Starch contains very low percentage of fat (0.0987%) & protein (0.987). At low temperature water absorption capacities are low and for 100^0C temperature it is high. Also microwave modified starch gives higher Water absorption capacity than conventional modified starch, maize starch and native jackfruit starch. Amylose content in the jackfruit starch is nearly about 40 % and modified starch gives 80% amylose content, so here after modification nearly about 100% amylose is increased and amylo pectin content is decreased & because of that solubility increases. Microwave modified starch gives higher Swelling Power than conventional modified starch, maize starch and native jackfruit starch.

Modification of the starch is the method where chemically or physically change the properties of the starch. The microwave method gives the good results as compare to the conventional method. The microwave method is also the time saving method as compare to the conventional method also it requires low temperature and low energy. Maleic acid acts on the 1-6 linkage of the amylopectin which breaks the chain and makes the monomer because of that solubility increases.

Finely here we conclude that all properties of the starch is depends on the temperature and type of the starch

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