An Analysis of Nano Sized Powder of Jackfruit Seed for Bio-Bag Purpose

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Abstract – This paper reports on an investigation into the ability of nano sized jackfruit seed powder for bio-bag purpose. This approach is simple, faster, eco-friendly, cost effective and suitable for large scale production. X-Ray diffraction studies analysis particles size. Proximal, mineral, phytochemical analysis shows carbohydrate like contents, Fe2+ chelating, scavenging activities also founded. Using required incredents bio-bag sheet was formed.

Index Terms – Nano size jackfruit seed powder, minerals, various analysis, Fe2+chelating activity, scavenging activity, bio-bag.

1. INTRODUCTION

The scientific name of jack fruit is Artocarpus heterophyllus Lam. It belongs to mulberry family (Moraceae). This tree is the only one which yields heavier while compared with the other trees. Its parts also contain some medicinal properties. It has its native as in India as well as Malaysia. Jack fruit seeds are rich in nutritious. Minerals, magnesium and manganese also took a part in it [1]. Jacalin and artocarpin are the lectins were detected in the jack fruit seeds. Jacalin is used to evaluate the immune status of patients who infected with HIV1 and also used in tumours detection [2].

In the jack fruit seed, starch contamination is there. Using this starch we can able to produce starch based materials. Now a days in bioplastics, starch occupying a major role [10]. Thermo plastic starch is one of the material obtained after starch is heated with the plasticizer like glycerol. Thermo plastic starch is also obtained using starch and natural rubber [3].

2. RELATED WORK

In 2007 Torres et al., explored some natural fibres reinforcement for thermo plastic starch. They used starch (sweet potato, potato, corn), plasticizer (ethylene glycol, glycerol, chitosan, water and propylene glycol) and fibre (jute, sisal and cabuya). These materials combined with compression molding with certain conditions. Form individual assessment potato starch, sisal and ethylene glycol gave the highest tensile strength [4].

In 2007 Abel Jerez et all., analysis the effect of thermo mechanical processing on protein based bioplastics. They valued linear viscoelastic moduli values similar to synthetic polymers such as low density polyethylene (LDPE) and high density polyethylene (HDPE) [5].

In 2009 Prakash O., Kumar R., Mishra A., Gupta R. Overviewed about Artocarpus heterophyllus (Jackfruit). According to them the seeds of jack fruit are about 3-5 mm thick and have a milder and less juicy is arounded by the sweet yellow sheaths. Seeds are separated by horny endocarpus and it was enclosed by sub-gelatinous exocarpus (1mm thick) a thin whitish membrane. They are oval, oblong ellipsoid or rounded shape, light brown colour in nature, 2-3 cm (0.8-1.2 inch) in length and 1-1.5 cm (0.4-0.6 inch) in diameter. Up to 500 seeds can be found in each fruit [6].

In 2011 Dharini Soni, Mamta Saiyad made analysis on biodegradable polyethylene bags. Starch based polymers, bacteria based polymers, starch or polyester blends, oxo-biodegradable polymers, photodegradable polymers and water-soluble polymers were described here. According to them by using degradable plastics formers can protect their horticultural crops from harsh elements [7].

In 2015 Yong Yang et all., analysis two different thermoplastic starches which are maleic anhydride grafted starch and epoxidized cardanol grafted starch. Using these two different TPS without adding any plasticizer they successfully prepared blends by chemical modification. The structure and properties were characterized by NMR, XRD and SEM [8].

In 2015 Vikas Mishra, Akash Patel et all researched on preparation of bio-bag using banana peel as an alternative of plastic. They use banana peel and glycerol as a plasticiser. Degradable sheet was formed successfully with capable to carry 2.5 kg of weight and it degraded after 12 months [9].

3. EXPERIMENTAL DETAILS

3.1 Microscopic Experimentation:

Jackfruit seeds were collected from Paramanvilai, Nagercoil, Tamilnadu, India. The seeds were cleaned and the white arils (seed coats) were peeled off. A microscopic experiment of jackfruit seed powder (starch granules) suspended in water was photographed with a magnification of ×400.

3.2 XRD Analysis:

Seeds were sun dried for 5 days without remove the thin outer brown covers the fleshy white cotyledons. For these experimental purposes, 100 gm dried seeds were grinded and crushed well and uniformly for 15 minutes and made them as nano sized powder. The powdered materials were packed in air tight cover and stored in normal room temperature until use. XRD analyses of the prepared sample of jackfruit seed nanoparticles were obtained. X-rays of wavelength (λ)=1.54056 Å and data was taken for the 2θ range of 10° to 80° with a step of 0.02°. XRD analysis gave size of the particles.

3.3 Proximal Analysis:

Jackfruit seed samples were dried by applied heat energy through oven. To obtain moisture content weigh the samples before and after. The ash content too obtained by weighing the samples before and after burning it. Macro Kjeldhal method was used for estimation of total nitrogen and crude protein content. Using petroleum ether as a solvent, the fat content was determined by Soxhlet extraction method. Total carbohydrate was estimated by the formula,

Total carbohydrates = 100 – moisture content (%) - protein content (%) - crude fat (%) - ash (%).

3.4 Mineral Analysis:

1 gm of sample powder was fully dissolved by 5 ml of concentrated nitric acid in microwave. The sample was cooled and then added 25 ml distilled water with it after dissolvation. Now it becomes like plasma. The minerals present are analyzed by inductively coupled plasma optical emission spectrometry (ICPOES).

For the mineral analysis plasma conditions are:

- Argon on 151/min
- Auxiliary 0.21/min
- Nebulizer flow at 0.851/min
- RF power on 1300 W
- Chiller at 15°C

3.5 Phytochemical Analysis:

Total phenolic content of the sample determined by two solvent systems were Folin Ciocalteu reagent method and expressed in terms of µg Gallic acid equivalents (GAE) /mg of dry extract. Using aluminium chloride colorimetric method the total flavonoids content was determined and expressed in terms of µg rutin equivalents (RE) /mg of dry extract.

3.6 Determination of Antioxidant activity (1,1-Diphenyl-2-picrylhydrazyl radical Scavenging activity):

The principle behind 1,1-Diphenyl-2-picrylhydrazyl (DPPH) radical assay holds that the antioxidants react with the stable 1,1-Diphenyl-2-picrylhydrazyl radical and changes it into 1,1-diphenyl-2-picryl hydrazine. Briefly, 0.3 mg/ml extracts were mixed with 1 ml of methanolic solution of 0.1M DPPH. The mixture was centrifuged and put at room temperature for 30 min and absorbance was measured at 517 nm in a spectrophotometer. To calculate the scavenging activity the formula is,

Scavenging activity (%) = (1-Absorbance sample/ Absorbance control) x 100

3.7 Fe2+ chelating activity:

The chelating activity of extract on Fe2+ was easily measured. 1 ml of extract was incubated with 2 M of $FeCl_2$. The reaction was started by the addition of 5 M of ferrozine. After 10 min, the absorbance of ferrous ion-ferrozine complex at 562 nm was read by the spectrophotometer.

Chelating activity (%) = (1-Absorbance sample/ Absorbance control) x 100.

4. RESULTS AND DISCUSSIONS

4.1 Microscopic Experimentation:

In Fig: 1 the photographed image shows the ×400 magnification image. In micrometer range the starch granules clearly noticed.

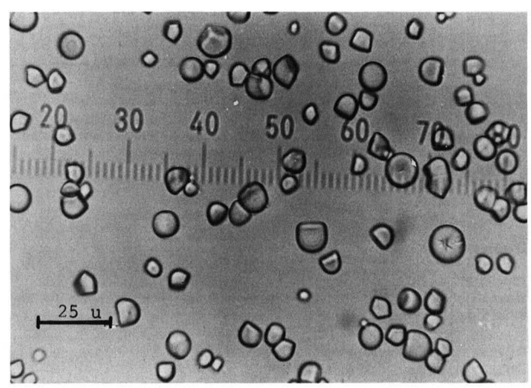

Fig 1: Jackfruit seed powder (starch granules) suspended in water was photographed with a magnification of ×400.

4.2 X-Ray Diffraction Studies - Peak Indexing:

The XRD pattern of the jackfruit seed nanoparticles is shown in Fig.2. Indexing process pattern is done and miller Indices (h k l) to each peak is assigned and that details are in Table:2. A number of Bragg reflections can be seen which correspond to the (111), (200), (211) (311) and (322) reflections. The diffraction peaks are broad which indicating that the crystallite size is very small. The maximum nano size of the jackfruit seed nanoparticles estimated from Debye–Scherrer formula is 12nm.

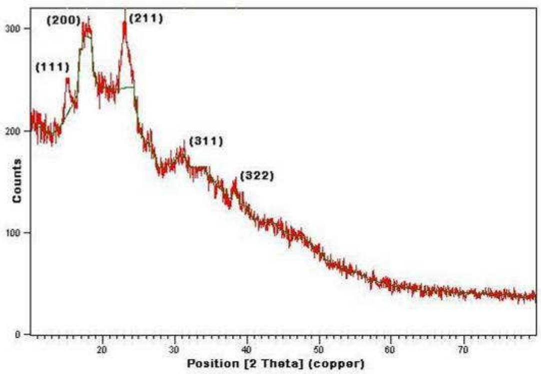

Fig :2 XRD pattern of the jackfruit seed nanoparticles.

2θ	**θ**	**Sinθ**	**$Sin^2θ$**
15.14	7°34'	0.1316	0.0173
17.71	8°51'	0.1538	0.0236
23.05	11°31'	0.1996	0.0398
31.23	15°36'	0.2689	0.0723
38.37	19°11'	0.3285	0.1079

Table:1 Calculated value of $Sin^2θ$.

Difference for successive $Sin^2θ$	**LCM for Difference in successive $Sin^2θ$ (N_0)**	**N= $Sin^2θ/N_0$ (Taking the integer value)**	**h, k, l**
0.0063		3≈ (2.7)	1,1,1
0.0162	0.0063	4≈(3.7)	2,0,0
0.0325		6≈(6.3)	2,1,1
0.0356		11≈(11.4)	3,1,1
--------		17≈(17.1)	3,2,2

Table:2 Calculated h,k,l values

Average particle size has been calculated by using Debye-Scherrer formula by considering the peak at degrees. The Debye-Scherrer formula is

D=0.9 λ /β cosθ

Where here,

λ → wave length of X-Ray (0.1541 nm)

β → FWHM (full width at half maximum) value

θ → diffraction angle

D → particle diameter size.

The value of d (the interplanar spacing between the atoms) is calculated using

Bragg's Law,

n λ = 2d Sin θ

2d=n λ / Sin θ

d= n λ / 2Sin θ

where,

λ → wave length of X-Ray (0.1541 nm)

d → interplanar space

θ→ diffraction angle

n → order of reflection

Interplanar space (d) = λ / 2 Sinθ (nm)	**Lattice constant (a)= $d(N)^{1/2}$ ($x10^{-10}$m)**	**FWHM (β) (radians)**	**Particle diameter size. (D) = 0.9 λ /β cosθ (nm)**
5.8531	10.1378	0.00930	15.043
5.0083	10.0166	0.00450	31.191
3.8591	9.4528	0.01167	12.128
2.8645	9.5004	0.00560	25.713
2.3448	9.6678	0.00405	36.257

Table:3 calculations for determine the particle diameter size

4.3. From Proximal analysis:

Protein	**Moisture**	**Ash**	**Crude Fat**	**Total Carbohydrate**
11.85 ± 0.45	61.8 ± 0.09	0.15 ± 0.01	1.000 ± 0.006	25.194 ± 0.444

Table:4 The total carbohydrate content from proximal analysis.

Jackfruit seeds were found to be rich moisture content then in proteins. And carbohydrate level was also at high.

4.4. Form Mineral analysis

Analyte	Concentration
K	785.6 ± 1.24
Ca	30.47 ± 0.50
Na	27.39 ± 0.26
Ba	0.265 ± 0.42
Zn	2.320 ± 0.15
Ar	0.067 ± 0.43
Sn	0.032 ± 0.05
Cr	0.028 ± 0.1
Cd	0.014 ± 0.002

Table:5 Mineral analysis on jackfruit seed sample

ICPOES studies demonstrated jackfruit seeds to be highly rich in K followed by Ca and Na. Seeds were also found to be an important source of microelement Zn.

4.5 From Phytochemical Analysis

Jackfruit seed extracts	Total phenolic content (µg GAE/ mg extract)	Total flavonoid content (µg RE/ mg extract)
Acetone	1.51 ± 0.009	290.6 ± 4.14
Dichloromethane: methanol (1:1)	2.17 ± 0.012	457.1 ± 5.85

Table:6 Analysis of total phenolic and flavoid content.

The phytochemical content of jackfruit seed sample was analysed. Polyphenolics are known to function as antioxidant. Flavonoids prevent platelet stickiness and hence platelet aggregation. From the study of two extracts of jackfruit seed powder sample showed that dichloromethane: methanol (1:1) solvent system was able to extract more phytochemicals while compared with acetone.

4.6 Determination of Antioxidant activity (1,1-Diphenyl-2-picrylhydrazyl radical scavenging activity):

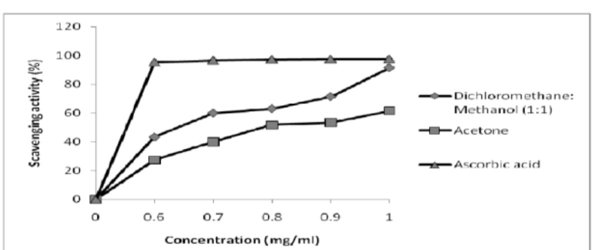

Fig:3 Concentration–response of the jackfruit seed extracts and the standard, ascorbic acid.

DPPH has been widely used to evaluate the free-radical scavenging ability of antioxidant compounds. The dichloromethane: methanol (1:1) extract showed higher radical scavenging activity than acetone extract. Both the extracts were significantly different (for maximum 2.182-1.519=0.663; for minimum 2.158-1.501=0.657) in their values.

4.7 Fe2+ chelating activity:

By Fenton reactions the transition metal, iron, is capable of generating free radicals from peroxides. Minimizing Fe2+concentrations in Fenton reactions by metal chelation affords protection against oxidative damage. In this assay, both extracts (dichloromethane and methanol) interfered with the formation of ferrous and ferrozine complex.

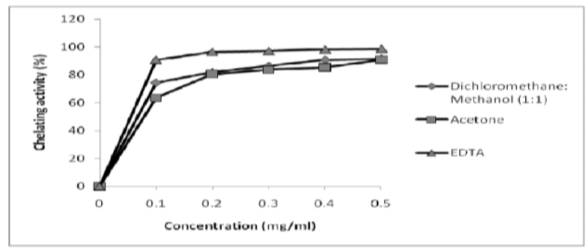

Fig: 4 Concentration–response of the seed extracts and the standard, Na2EDTA.

4.8 Gel Rigidity:

The gel rigidity was determined using an exchange ridgelimeter. For that analysis 25g jackfruit seed powder sample mixed with 300ml of distilled water to make suspended solution. Apply 95°C heat with continuous stir. After that to avoid air bubbles the suspended solution poured in molds and make the surface smooth and even. After one day at room temperature the gel was removed from the molds. After one minute of equilibrium time the sag value is measured for t=0 minutes and t=10 minutes. The apparent rigidity was then calculated with the following formula.

[$A_R = sag_{t10} / (sag_{t10} - sag_{t0}) \times 100$]

Starch	Temperature of maximum viscosity(°C)	Sag value		Apparent rigidity
		t=0 min	t=10 min	
Jack fruit seed	95.0	0.0	0.0	--------
Rice	92.5	9.7	9.8	0.9800
Potato	67.0	13.7	13.9	0.6950
Arrow root	79.5	15.3	15.7	0.3925
Tapioca	70.0	25.5	26.2	0.3742

Table:7 Sag and Apparent Rigidity value of sample compared with other starches.

4.9 Gelatinization and peak viscosity using Amylograph:

Evaluation of pasting characteristics of sample starch at 8% and 10% using Brabender Amylograph. The 25g sample was suspended in 300ml of distilled water and apply heat by applying 1.5°C to 95°C. From graph obtained the peak velocity and gelatinization range.

Characteristic	**Concentration**	
	8%	**10%**
Initial temperature	70°C	70°C
Peak viscosity temperature	95°C	95°C
Peak viscosity	420 AU	860 AU
Viscosity at constant temperature 95°C	450 AU	840 AU
Viscosity at 50°C (By cool rate)	640 AU	1000 AU

Table:8 characteristics of paste viscosity of sample at 8% and 10% concentrations

5. CONCLUSION

Jackfruit seed powder sample were found to be rich in carbohydrates and minerals with moderate amount of phytochemicals properties and also studied on scavenging as well as chelating activities. By the chelating activity we well clear that it bond with the metal ions. From the amylograph gelatinization and peak viscosity determined.

These above properties show that through the jackfruit seed powder we can able to make the bio-bag sheet. By thus 25g of jackfruit seed powder, 1% 3ml of glycerol which is act here as plasticizer, 1g of alum for water resistance, 5ml of palm oil, 50 ml of water were taken in a beaker and stir well. Then apply constant heat 95°C upto solution becomes like semisolid. Then put it on the mold and give an even and smooth surface. Then after put the mold inside the oven at 130°C for 7min. After the time duration a thick sheet was formed. That thick sheet is placed in a certain place and noticed it's degrade period in days.

Fig:5 Formed thick sheet.

Fig:6 After 5 days from the formation date.

Fig:7 After 10 days from the formation date.

Fig:8 After 15 days from the formation date.

Fig:9 After 20 days from the formation date.

This formed thick sheet degrades in 20 days. From 11 to 15 days the fungi affects the thick sheet (shown in Fig:8). By adding anti microbial agents with the incredents we can increase the degrade time by days to several months. Using glues it is easy to make the bio-bag.

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