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Isolation of Starch from Jackfruit Seed and Evaluation of its Binding and Disintegrating Properties.

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Abstract:

In this study, jackfruit seed flour was prepared and starch was extracted using different extraction conditions such as (distilled water method and alkaline method). The results showed that distilled water method gave highest yield compared to alkali method. Starch identification tests were carried out on isolated material as confirmation tests. To evaluate the binding properties of seed starch, using Paracetamol as model drug tablets were prepared by wet granulation method. Micromeritic properties for granules and powder mixture give good and passable flow properties. Post compression studies also give good results and the prepared tablets were also evaluated for *in vitro* drug release studies which were then compared with the marketed tablets P-250 apex. The r^2 values of regression plots for First order and Zero order were considered for both the binding (F1, F2, F3) and disintegrating (S1, S2, S3) properties, r^2 values for the First order was found to be more than Zero order. Hence it was confirmed that the drug release follows first order kinetics. Therefore the release rate in formulations depends on concentration or amount of drug incorporated. Compatibility studies were conducted by FTIR spectrometer and concluded that there was no interaction between seed starch and drug. The overall results showed that jackfruit seed might be used good source of starch as well as extracted starch could be used as binding agent and disintegrating agent in pharmaceutical formulations.

Keywords: Paracetamol, Jackfruit seed, Starch, Binding properties, Disintegrating properties.

Introduction:

The international pharmaceutical excipient council (IPEC) defines excipients as substances, other than the active pharmaceutical ingredient (API) in finished dosage form, which have been appropriately evaluated for safety and are included in a drug delivery system to either aid the processing or to aid manufacture, protect, support, enhance stability, bioavailability or patient acceptability, assist in product identification, or enhance other attributes of the overall safety and effectiveness of the drug delivery system during storage or use [1].

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Starch is the major dietary source of carbohydrates, and available as natural, biodegradable polymer by many plants as a source of stored energy. It is commonly found in staple crops such as rice, corn, wheat, cassava and potato. Chemically, starches are polysaccharides, composed of a number of monosaccharide's or sugar (glucose) molecules linked together with ┘-D-(1-4) and/or ┘-D-(1-6) linkages [2]. The starch consists of two main structural components, the amylose, which is essentially a linear polymer in which glucose residues are ┘-D-(1-4) linked typically constituting 15% to 20% of starch, and amylopectin, which is a larger branched molecule with ┘-D-(1-4) and ┘-D-(1-6) linkages and is a major component of starch. Amylopectin on the other hand has a molecular mass of 107 to 109 g/mol. It is highly branched and has an average degree of polymerization of 2 million, making it one of the largest molecules in nature. Chain lengths of 20 to 25 glucose units between branch points are typical. About 70% of the mass of starch granule is regarded as amorphous and about 30% as crystalline. The amorphous regions contain the main amount of amylose but also a considerable part of the amylopectin. The crystalline region consists primarily of the amylopectin [3]. Starch has been explored as a potential biomaterial in pharmaceutical industry because of its unique physicochemical and functional characteristics. Native starches are also well explored as binder and disintegrant in solid dosage form. It has also been used for a wide range of specialized drug delivery applications, such as delivery of challenging molecules and targeting to specific sites in the body. Although several official native starches with different proprietary identities are available, new sources will continue to evolve with the spate of economic and scientific interest in starch and starch-based products [4].

Jackfruit (*Artocarpus heterophyllus* Lam.) is a species of tree of the mulberry belongs to family (Moraceae) is integral part of common Indian diet and commonly known as "Kathal" is a fairly large sized tree and bears the largest fruit among the edible fruits. It produces heavier yield than any other tree and bear the largest known edible fruit (up to 35kg). Many parts of this plant, including the bark, roots, leaves, fruits and seeds have medicinal properties. Jackfruit tree is native to India and popular in several tropical and sub-tropical countries and the fruit is known as the 'poor man's fruit' in eastern and southern parts of India [5].

Materials and Methods:

Drug and Chemicals:

The drug used for the study was paracetamol. All the chemicals/solvents were of analytical/laboratory grade and obtained commercially.

Sample Collection and Seed Treatment:

Seeds of ripe Jackfruit were collected from the local market, Guntur. The ripened fruits were cut manually with a sharp knife and the seeds were collected from the bulbs. The collected seeds were washed with tap water to remove their impurities. The white aril (seed coats) and brown layers (Spermoderm covering) were peeled off manually and washed with running water again. The cotyledon was used to prepare the flour [6-8].

Preparation of Jackfruit Seeds Flour:

The washed seeds were sliced into small pieces (2-2.5 mm thickness) with knife. Then the seed was dried at a cabinet drier at 60°C for 24 hour followed by grinding into flour by using a blender. The flour was sieved through a sieve (42 mesh size) and packed in a plastic bag. The obtained flour was sealed and stored in a refrigerator (<5°C) for further use [7-8].

Extraction of Jackfruit Seed Starch Using Distilled Water Method:

The extraction of jackfruit seed starch was carried out according to the Distilled Water method. 5gm jackfruit seed flour was added into 100 ml distilled water and soaked (6 h and 8 h) at room temperature then stirred constantly. The slurry was filtered through 200 mesh stainless sieve and remaining sediment was washed with distilled water for three times. The filtrates were combined and precipitated overnight at 4°C.

The supernatant was discarded and the crude starch was cleaned with distilled water. This step was repeated three times and starch cake was dried at 40°C for 4 h in oven dryer. The starch was ground with a mortar and pestle. The starches were packed in a plastic bag and kept at room temperature until further use.

Extraction of Jackfruit Seed Starch Using Alkali Method:

Jackfruit seed flour (5gm) was added in various concentrations (0.1%, 0.25% and 0.5%) of alkali such as NaOH and soaked (6 h and 8 h) at room temperature then stirred constantly. The slurry was filtered through 212 mesh stainless sieve. The remaining sediment was washed with distilled water for 3 times. The filtrates were combined and precipitated overnight at 4˚C. The supernatant was discarded and the crude starch was cleaned with distilled water. These steps were repeated three times and starch cake was dried at 40˚C for 24 h in oven dryer. The starch was ground with a mortar and pestle. The starches were packed in a plastic bag and kept at room temperature until further use. Optimum conditions 0.5% NaOH and 6 h soaking time were selected on the basis of the yield.

Method of preparation of Paracetamol tablets using jackfruit seed starch:

A weighed quantity of Paracetamol was taken in a mortar. Then all the ingredients in required amounts were also added to mortar in a geometric fashion and blended well. The blend was passed through sieve no 40 to distribute the drug uniformly throughout the mixture. Again the mixture was transferred into mortar jackfruit seed starch paste in little quantities was added until a damp mass was obtained. The damp mass was passed through the sieve with mesh size 10. Wet granules thus obtained were placed on a tray and kept in hot air oven at 60˚c till the granules dried. The dried granules were again sieved through sieve with mesh size 16. Over dried granules were retained on the sieve, if any were present. The dry granules were mixed with 0.1gm each of talc and magnesium stearate. The remaining 50% of sodium glycolate was also added & properly mixed, before they were subjected to punching machine. The required quantities of granules were poured into die cavity. The volume was increased by turning the weight adjustment knob to left or right side. Distance travelled by the upper punch into die cavity was adjusted by rotating the hardness adjustment knob to the left or right. Then the granules were compressed into tablets using 16 station tablet compression machine (Rimek).

Result and Discussion:

Formulation of Tablet:

The composition of formulation of Paracetamol tablets by seed starch as binder and seed starch as disintegrant is depited in **Table 1** and **2**.

Table 1: Formulation of Paracetamol tablets by seed starch as binder

Sr. No	Ingredients	Quantity per tablet (mg) in batch		
		F1	F2	F3
1	Paracetamol	250	250	250
2	Sodium starch glycolate	15	15	15
3	5% seed starch	q.s.	-	-
4	10% seed starch	-	q.s.	-
5	10% starch	-	-	q.s.
6	Magnesium stearate	5	5	5
7	Talc	5	5	5
8	Lactose	125	125	125
9	Total weight(mg)	400	400	400

Table 2: Formulation of Paracetamol tables by seed starch as disintegrant

Sr. No	Ingredients	Quantity per tablet (mg) in batch		
		S1	S2	S3
1	Paracetamol	250	250	250
2	Sodium starch glycolate	-	-	15

3	Seed starch	7.5	15	-
4	Xanthum gum	25	25	25
5	Magnesium stearate	5	5	5
6	Talc	5	5	5
7	Lactose	107.5	100	85
8	Total weight(mg)	400	400	400

Micromeritic, Post compression Properties and Dissolution Profile of Paracetamol Tablet:

Micromeritic properties of granules containing Paracetamol using seed starch as binder and disintegrant is given in **Table 3, 4** respectively. Whereas the post compression properties of granules containing Paracetamol using seed starch as binder and disintegrant is given in **Table 5, 6** respectively. In addition the dissolution profile of tablets containing Paracetamol is depicted in **Table 7, 8, 9** and **10**.

Table 3: Micromeritic properties of granules containing Paracetamol using seed starch as binder

Sr. No	Parameters	Formulation codes		
		F1	F2	F3
1	Angle of repose	28.26±0.55	28.03±0.33	27.9±0.86
2	Bulk density	0.32±0.03	0.32±0.05	0.31±0.83
3	Tapped density	0.36±0.33	0.35±0.53	0.34±0.42
4	Carr's index	11.11±0.11	8.57±0.62	8.82±0.32
5	Hausner's ratio	1.125±0.09	1.093±0.03	1.096±0.05
6	Porosity	11.2±0.002	8.6±0.01	8.9±0.005

mean±SD, n=3

Table 4: Micromeritic properties of Powder mixer containing Paracetamol using seed starch as disintegrant

Sr. No	Parameters	Formulation codes		
		S1	S2	S3
1	Angle of repose	36.09±0.03	33.03±0.09	32.9±0.04
2	Bulk density	0.104±0.05	0.102±0.01	0.103±0.04
3	Tapped density	0.119±0.05	0.115±0.02	0.116±0.08
4	Carr's index	12.7±0.08	11.4±0.07	11.3±0.09
5	Hausner's ratio	1.144±0.05	1.127±0.02	1.128±0.04
6	Porosity	12.61±0.07	11.31±0.05	11.21±0.03

mean±SD, n=3

Table 5: Post compression properties of tablets containing Paracetamol using seed starch as binder

Sr. No	Parameters	Formulation codes			
		F1 (5% seed starch)	F2 (10% seed starch)	F3 (10% commercial starch)	Marketed (P-250apex)
1	Thickness (mm)	1.4±0.033	1.45±0.05	1.4±0.04	1.4±0.09
2	Weight variation (mg)	398.8±0.16	398.9±0.74	399.6±0.76	399.8±0.98
3	Hardness (kg/cm^2)	4.2±0.9	7.4±0.08	5.1±0.8	8.9±0.08
4	Friability (%)	0.04	0.06	0.05	0.04
5	Disintegration time	1.10±0.03	3.59±0.02	2±0.04	0.38±0.06
6	Drug content (%)	98.44±0.08	98.83±0.017	98.03±0.06	99.45±0.88

mean±SD, n=3

Table 6: Post compression properties of tablets containing Paracetamol using seed starch as disintegrant

Sr. No	Parameters	Formulation codes			
		S1 (5% seed starch)	S2 (10% seed starch)	S3 (10% commercial starch)	Marketed (P-250apex)
1	Thickness (mm)	1.5±0.03	1.45±0.05	1.4±0.04	1.4±0.09
2	Weight variation (mg)	399.3±0.16	399.5±0.04	399.7±0.06	399.8±0.08
3	Hardness (kg/cm^2)	5.4±0.04	6±0.03	5.8±0.02	8.9±0.08
4	Friability (%)	0.04	0.04	0.05	0.04
5	Disintegration time	1.28±0.003	0.59±0.002	0.51±0.003	0.38±0.002

6	Drug content (%)	98.44±0.05	98.33±0.006	98.95±0.09	99.45±0.08

mean±SD, n=3

Table 7: Dissolution profile of tablets containing Paracetamol using seed starch as binder

Sr. No	Time	% Drug release from Paracetamol tablets			
		F1	F2	F3	Marketed tablet
1	0	0	0	0	0
2	5	81.54±0.09	15.12±0.03	75.51±0.06	85.3±0.01
3	10	81.54±0.03	42.57±0.08	75.42±0.08	85.5±0.04
4	15	81.45±0.09	57.24±0.05	75.33±0.05	86.01±0.05
5	30	81.45±0.04	65.07±0.03	80.91±0.08	86.5±0.06
6	45	81.54±0.08	76.14±0.05	81.09±0.08	86.7±0.08
7	60	81.45±0.02	79.29±0.008	81.18±0.01	86.9±0.08

mean±SD, n=3

Table 8: log% drug unreleased from Paracetamol tablets

Sr. No	Time	Log% drug unreleased from paracetamol tablets			
		F1	F2	F3	Marketed tablet
1	0	2	2	2	2
2	5	1.266±0.01	1.928±0.03	1.388±0.08	1.1673±0.09
3	10	1.266±0.03	1.759±0.03	1.39±0.06	1.1613±0.04
4	15	1.268±0.03	1.631±0.03	1.392±0.02	1.1448±0.07
5	30	1.268±0.05	1.543±0.03	1.28±0.02	1.1303±0.05
6	45	1.266±0.08	1.377±0.05	1.276±0.08	1.1238±0.09
7	60	1.268±0.02	1.316±0.02	1.274±0.009	1.1172±0.04

mean±SD, n=3

Table 9: Dissolution profile of tablets containing Paracetamol using seed starch as disintegrant

Sr. No	Time	% Drug release from Paracetamol tablets			
		S1	S2	S3	Marketed tablet
1	0	0	0	0	0
2	5	54.74±0.03	81.54±0.09	75.55±0.06	85.33±0.06
3	10	56.45±0.02	81.54±0.03	75.57±0.08	85.51±0.04
4	15	58.75±0.05	81.45±0.09	75.83±0.05	86.04±0.05
5	30	69.53±0.06	81.45±0.04	81.99±0.08	86.55±0.06
6	45	69.55±0.05	81.54±0.02	82.06±0.08	86.7±0.08
7	60	69.56±0.02	81.45±0.02	82.17±0.01	86.9±0.08

mean±SD, n=3

Table 10: log% drug unreleased from Paracetamol tablets

Sr. No	Time	Log% drug unreleased from Paracetamol tablets			
		S1	S2	S3	Marketed tablet
1	0	2	2	2	2
2	5	1.876±0.01	1.266±0.03	1.388±0.08	1.1673±0.09
3	10	1.803±0.03	1.266±0.03	1.387±0.06	1.1613±0.04
4	15	1.645±0.01	1.268±0.03	1.383±0.02	1.1448±0.07
5	30	1.483±0.05	1.268±0.03	1.255±0.02	1.1303±0.05
6	45	1.483±0.08	1.266±0.05	1.253±0.08	1.1238±0.09
7	60	1.483±0.07	1.268±0.08	1.251±0.09	1.1172±0.04

mean±SD, n=3

Drug Release Studies:

The % drug release of formulations F1-F3, marketed tablets is represented in **Figure 1** whereas the % drug release of formulations S1-S3, marketed tablets is represented in **Figure 2**.

The zero order plots of formulations F1-F3, marketed tablets and S1-S3, marketed tablets is given in **Figure 3** and **4** respectively. The first order plots of formulations F1-F3, marketed tablets and S1-S3, marketed tablets is given in **Figure 5** and 6 respectively.

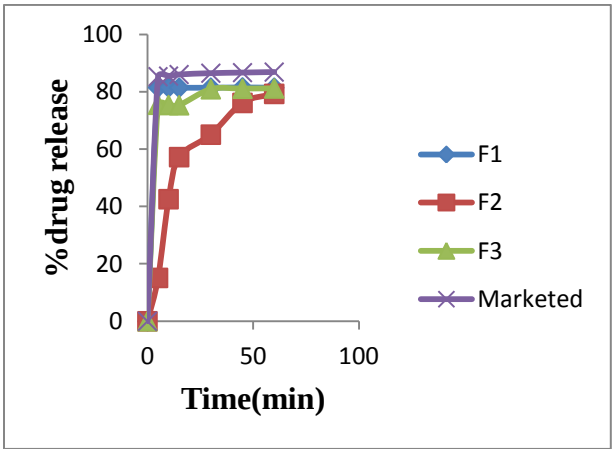

Figure 1: % Drug release of formulations F1-F3 and marketed tablets

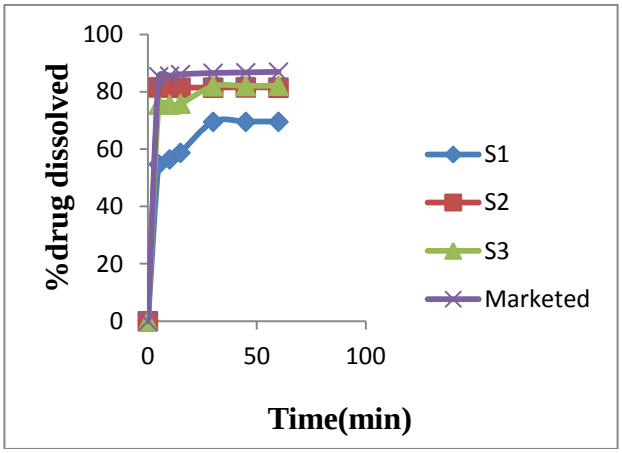

Figure 2: %Drug release of formulations S1-S3 and marketed tablets

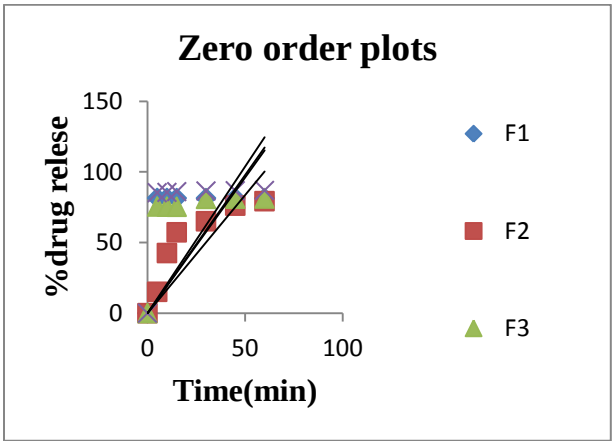

Figure 3: Zero order plots of formulations F1-F3 and marketed tablets

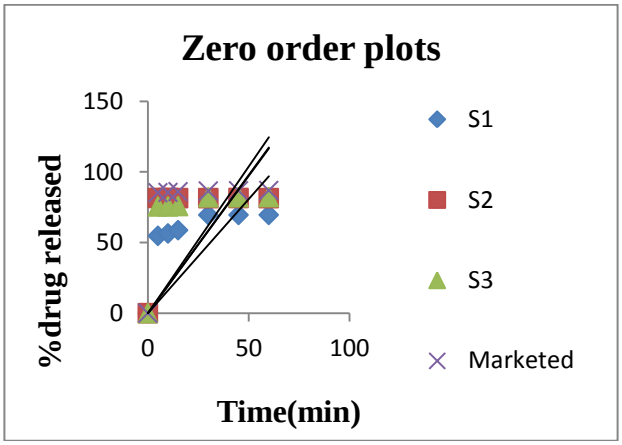

Figure 5: Zero order plots of formulations S1-S3 and marketed tablets

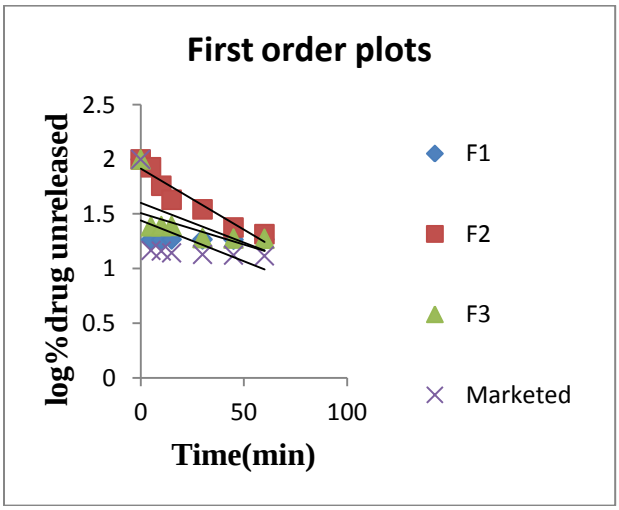

Figure 5: First order plots of formulations F1-F3 and marketed tablets

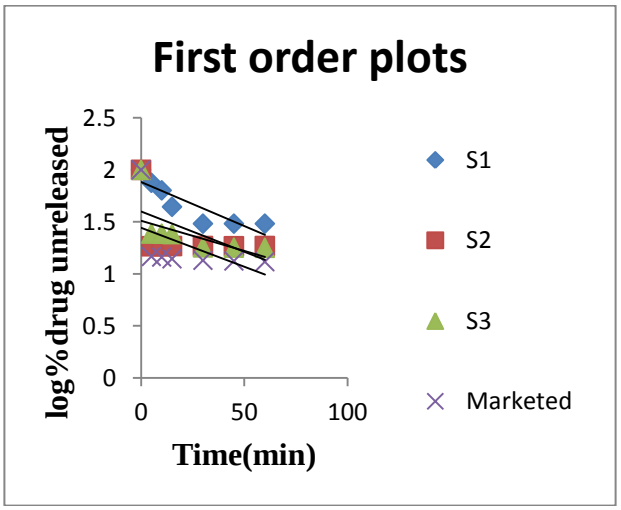

Figure 6: First order plots of formulations S1-S3 and marketed tablets

Regression values of Paracetamol Tablets:

The regression values of Paracetamol tablets of formulations F1-F3, marketed tablets and S1-S3, marketed tablets are depicted in **Table 11** and **12** respectively.

Table 11: r^2 values for formulations of binding properties

S. No	Formulation codes	Zero order	First order
1.	F1	0.2166	0.2262
2.	F2	0.7757	0.9142
3.	F3	0.2906	0.3953
4.	Marketed	0.2315	0.2635

Table 12: r^2 values for formulations of binding properties

S. No	Formulation codes	Zero order	First order
1.	S1	0.4357	0.7785
2.	S2	0.2160	0.216
3.	S3	0.3007	0.3953
4.	Marketed	0.2315	0.2635

The FTIR spectra of commercial starch, seed starch, paracetamol and API+seed starch are represents in **Figure 7-10.**

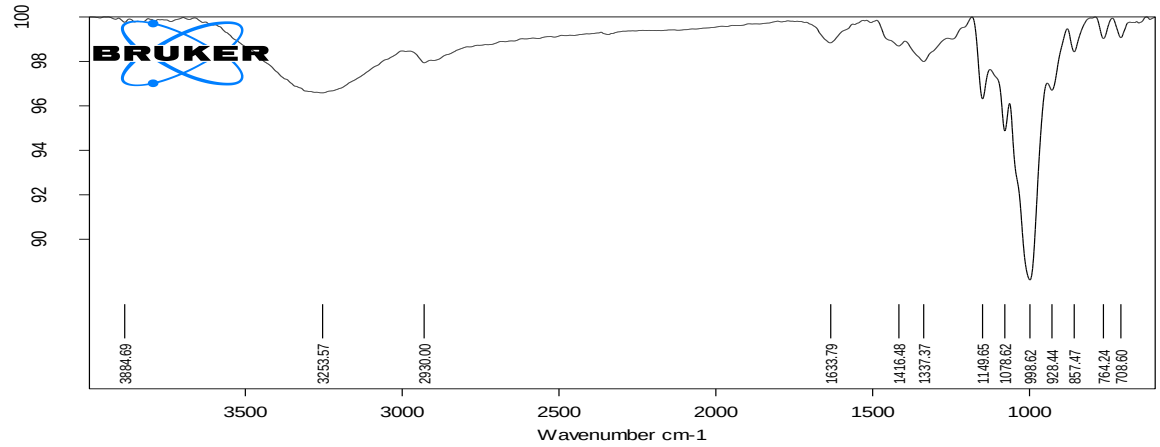

Figure 7: FT-IR spectrum of commercial starch

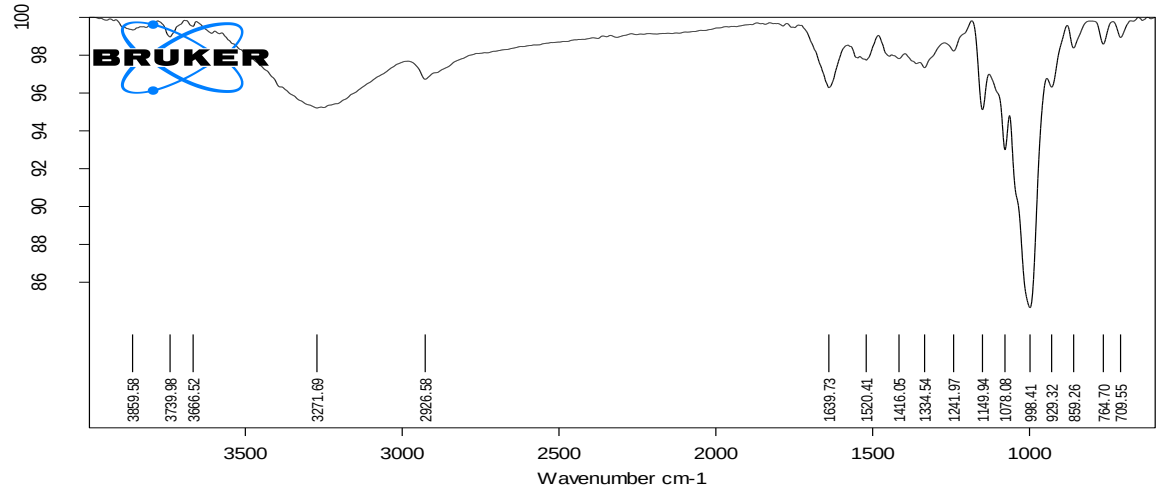

Figure 8: FT-IR spectrum of seed starch

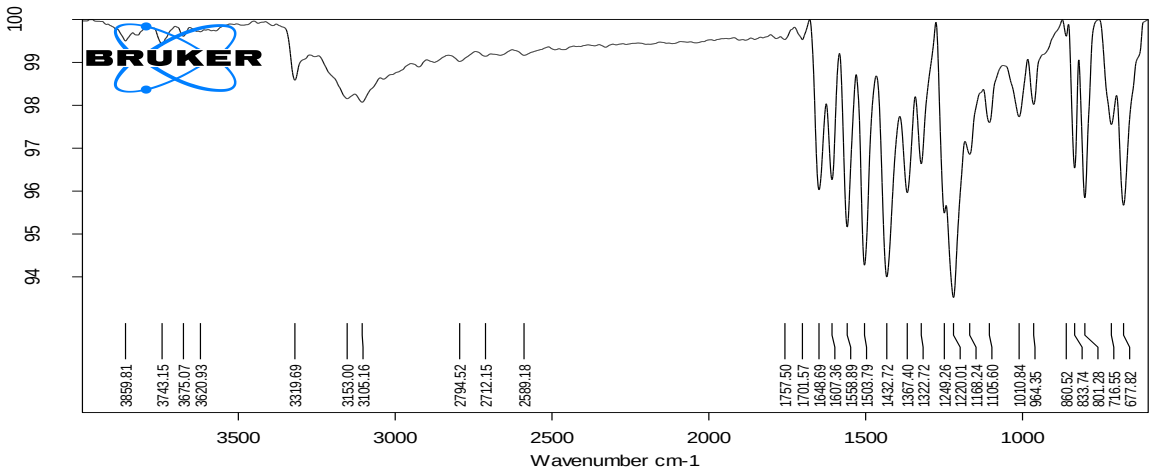

Figure 9: FT-IR spectrum of Paracetamol

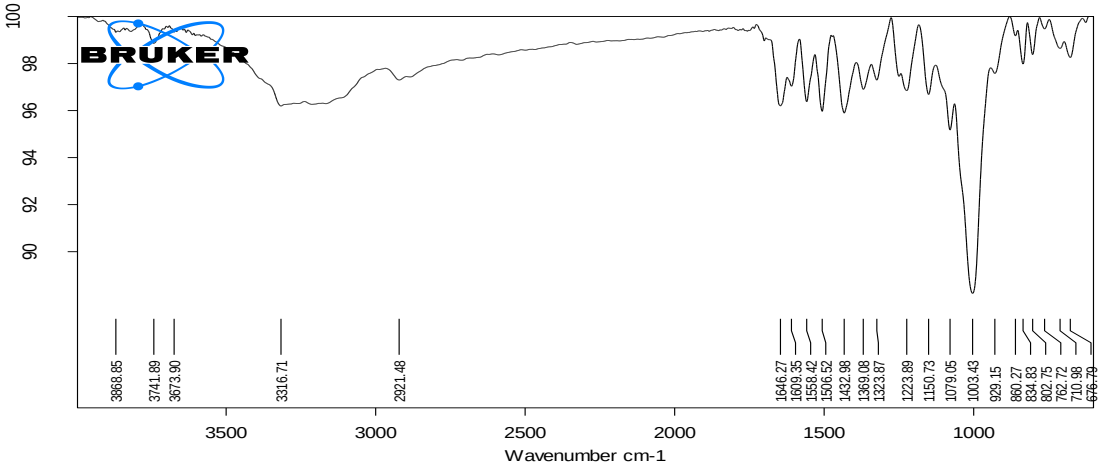

Figure 10: FT-IR spectrum of API+ seed starch

Conclusion:

In this study, jackfruit seed flour was prepared and starch was extracted using different extraction conditions such as (distilled water method and alkaline method). The results showed that distilled water method gave highest yield compared to alkali method. Starch identification tests were carried out on isolated material as confirmation tests. To evaluate the binding properties of seed starch, using Paracetamol as model drug tablets were prepared by wet granulation method. The dried granules were evaluated for pre compression characteristics and found that the granules possessed excellent flowable and compressible properties. Post compression parameters were also determined systematically and the results are satisfactory and within the Indian pharmacopoeial limits. The binding ability of seed starch is also compared with commercial starch and it is observed that seed starch surprisingly superior to commercial starch in binding ability. For determining the disintegration properties of seed starch again Paracetamol was chosen as model drug and tablets were prepared by direct compression and compared with the super disintegrant sodium starch glycolate. Micromeritic properties for granules and powder mixture give good and passable flow properties. Post compression studies also gives good results i.e., obey the pharmacopoeial limits. The prepared tablets were evaluated for *in vitro* drug release studies and compared with the marketed tablets P-250apex. The r^2 values of regression plots for First order and Zero order were considered for both the binding (F1, F2, F3) and disintegrating (S1, S2, S3) properties, r^2 values for the First order was found to be more than Zero order.

Hence it was confirmed that the drug release follows first order kinetics. Therefore the release rate in formulations depends on concentration or amount of drug incorporated. Compatibility studies were conducted by FTIR spectrometer and concluded that there was no interaction between seed starch and drug and the comparison between seed starch and commercial starch gives near peaks. The overall results showed that jackfruit seed might be used good source of starch as well as extracted starch could be used as binding agent and disintegrating agent in pharmaceutical formulations.

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