International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 30, Issue 8, August 2024 pp 194-201. **ijppr.humanjournals.com** ISSN: 2349-7203

The Utilization of Natural Starch and Its Modifications as Excipients in Pharmaceutical Dosage Forms

Mr. Saud Mulla, Mrs. Divya Musale, Mr. Aniket Naik, Mrs. Sadiya Naikwadi, Mr. Rihan Naikwadi

1. Department of Pharmaceutics, Sarojini College of Pharmacy, Shivaji University, Kolhapur, India.

Received: 2024-08-01 Revised: 2024-08-05 Accepted: 2024-08-10

ABSTRACT

This project explores the use of natural starch and its modified forms as excipients in pharmaceutical formulations, focusing on their advantages over synthetic excipients. It highlights the abundance, biocompatibility, biodegradability, and versatility of natural starch in forming derivatives with enhanced functionalities. The project aims to explore the diverse applications of natural starch and its modified forms in pharmaceutical dosage forms, focusing on potential advantages such as improved drug delivery, stability, and patient acceptability. The research methodology includes physical and chemical characterization techniques like FT-IR, DSC, XRD, and SEM. The study also discusses the formulation and evaluation of paracetamol tablets using tapioca starch as a binder, including pre-formulation studies, tablet preparation techniques, and post-formulation analysis. The findings of pre-formulation and post-formulation studies will be used to evaluate the suitability of *tapioca starch* as a binder in tablet formulations, comparing it to synthetic starch. The project aims to contribute to the understanding of natural starch and its modified forms as viable alternatives to synthetic excipients in pharmaceutical formulations. Overall, the project aims to contribute to the understanding of natural starch and its modified forms as viable alternatives to synthetic excipients in pharmaceutical formulations, with a focus on tapioca starch and its potential applications in tablet formulations.

Keywords: Tapioca Starch, FT-IR, DSC, XRD, SEM

INTRODUCTION

Traditional pharmaceutical formulations often rely on synthetic excipients, raising concerns about environmental impact, safety, and biodegradability. Natural starch, derived from plants like corn, potato, or tapioca, offers a sustainable and biocompatible alternative. This proposal investigates the feasibility of using natural starch in various dosage forms, such as tablets and granules. Native starch consists of two distinct polysaccharides: amylose and amylopectin, which exhibit characteristics of particular interest to the pharmaceutical industry.

Tapioca starch, also known as Casava Starch, Casava, Manioc, Manioca, and Yuca, is a common excipient used in the pharmaceutical industries as a binder and disintegrant in tablet formulation. It belongs to the Euphorbiaceous family and is cultivated in Tamil Nadu, Kerala, and Part of Andra Pradesh. Native tapioca starch is mostly used as a binder in the form of starch paste in wet granulation processes.

Modifications of natural starch can enhance its functionalities, making it a versatile option for various drug delivery systems. This proposal seeks to explore the possibilities of utilizing both natural starch and its modified forms to address the evolving needs of pharmaceutical formulations. The modification can be done through physical, chemical, and mechanical methods, with the latter being known as pre-gelatinization.

International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 30, Issue 8, August 2024 pp 194-201. **ijppr.humanjournals.com** ISSN: 2349-7203

MATERIALS AND METHODOLOGY.

MATERIALS.

Tapioca (Unicorn logestics Pvt. Ltd, Kerala), Paracetamol (Acetaminophen, Loba Chemie Pvt. Ltd, Mumbai), Lactose (Ariheet Pharmachem LLP, Mumbai), Talc (Hydrous magnesium silicate, Loba Chemie Pvt. Ltd, Mumbai), Magnesium Stearate (Octadecanoic acid, magnesium salt., Loba Chemie Pvt. Ltd, Mumbai), Sodium Metabisulphate (Loba Chemie Pvt. Ltd, Mumbai).

METHODOLOGY.

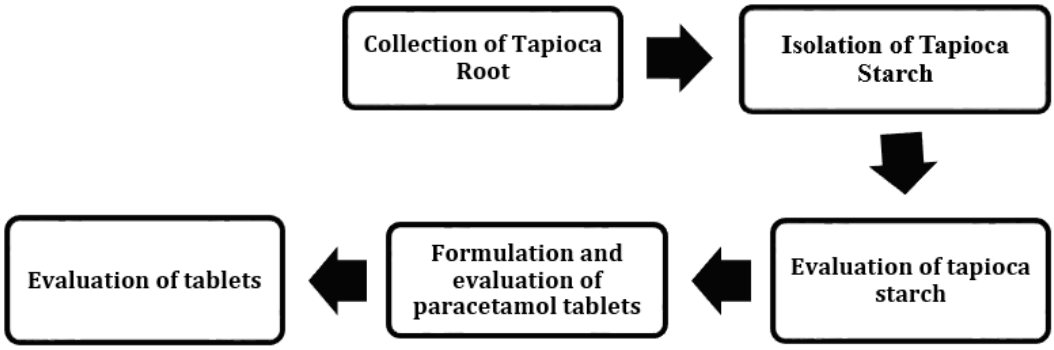


Fig 1: Outline of Methodology.

1. Isolation of Tapioca Starch:

Collect from the market then clean with water (removal of sand particles), Peel out the Tapioca Root, Cut into equal pieces, Immediately deep into prepared solution pf 1% sodium metabisulphite (anti-oxidant), Tapioca was graded, keep aside for settling (approx. 30 min), then screening with muslin cloth, then keep aside for 24 hours, after keeping aside for 24 hours, then remove the supernatant, the removed supernatant is kept in centrifuge at 3000 rpm, then the bottom settled starch is removed in tray, then sundried for 24 hours.

2. Preparation of 1% Sodium Metabisulphite:

1. Weigh out 2.5 gm of Sodium Metabisulphite.
2. In a 150 ml acid washed beaker, dissolve the sample in 100 ml of deionized distilled water.
3. Under a hood, acidify the solution with conc. HNO3 to pH of less than 2.
4. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil.

3. Evaluation of tapioca starch:

Bulk and tapped density of starch:

Exactly 50 gm of starch powder was weighed on chemical balance and transferred into a 100 ml measuring cylinder. The cylinder was dropped on a wooden platform from a height of 2.5 cm three times at 2 second interval. The volume occupied by the starch recorded as the bulk volume. The cylinder was then tapped on the wooden platform until the volume occupied by the starch remained constant. This was repeated three times for starch powder. The data generated were used in computing the Carr's index and Hauser' ratio for the starch.

International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 30, Issue 8, August 2024 pp 194-201. ijppr.humanjournals.com ISSN: 2349-7203

4. Formulation of paracetamol tablets:

a. Formulation of Paracetamol tablets

For the evaluation of the starch as binder, Lactose was used as a glidant, Magnesium Stearate as Lubricant, Talc as Diluent in the prepared paracetamol tablet. The composition of tablet formulation containing Paracetamol is given in (Table no.1).

Table no.1 Formulation of tablet

	Formulation of Extracted Tapioca Starch			**Formulation of Synthetic Starch**		
Ingredients	I	II	III	IV	V	VI
Paracetamol(gm)	10	10	10	10	10	10
Lactose(gm)	10	10	10	10	10	10
Magnesium Stearate (gm)	1	1	1	1	1	1
Tapioca Starch (gm)	5	5	5	-	-	-
Synthetic Starch (gm)	-	-	-	5	5	5
Starch Slurry	1	2	4	1	2	4
Talc (gm)	1	1	1	1	1	1

b. Wet granulation and compression

Wet granulation method was used for all tablet production The calculation is made for 20 tablets in each batch in case accurately weighed quantities of each ingredient were mixed in a mortar and Pestle an appropriate quantity of the starch mucilage was added as a granulating agent and mixed for 20 min in a mortor. The damp mass was sieved with sieve no 22 and dried at Sun Rays. The dried granular mass was passed through sieve no 40 to obtain uniform sized granules.

Tablets each containing 500 mg of Paracetamol were also prepared employing Tapioca starch as per the formula given in Table no 1.

5. Evaluation of tablets:

a. Hardness test:

Five tablets were selected at random from each batch to perform this test Monsanto hardness tester was used to measure the hardness. Tablet was placed between spindle and anvil of the tester and the calibrated scale adjusted to zero, then applied a diametric compression force on the tablet and the position on the calibrated scale at which the tablet broke was recorded in Kg/cm^2 A mean hardness was calculated for each batch The results are given in Table no 4.

b. Weight Uniformity test:

Twenty tablets from each batch were selected randomly and weight individually using a highly sensitive electronic balance. Their mean weights were calculated for each batch.

c. Friability test:

Ten tablets were selected at random, dusted and weighed together using weighing balance and then placed in the friabilator the machine war operated for 4 min at 25 rotations per min and then stopped the tablets were dusted and again reweighed the percentage losses were calculated for each batch of the tablets.

Percent Friability = Initial weight - Final weight/Initial weight × 100

International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 30, Issue 8, August 2024 pp 194-201. **ijppr.humanjournals.com** ISSN: 2349-7203

d. Disintegration time:

Two tablets selected at random from each batch were placed one in each of the cylindrical tubes of the basket but no disc was used. The time taken for each tablet to break up into small particles and pass out through the mesh was recorded. Mean disintegration time was calculated for each batch.

e. Dissolution time:

Paracetamol release from the tablets prepared was studied using 8 station dissolution rate test apparatus employing a USP-11 (paddle) stirrer at 100 rpm and at37±0.5°C Phosphate buffer of pH 7.4 (900 ml) was used as dissolution fluid.

Samples of 5 ml of each were withdrawn at different time intervals. Each sample withdrawn was replaced with an equal amount of fresh phosphate buffer pH 7.4. Samples were suitably diluted and measured at 376 nm for paracetamol solution was made up to volume with methanol and mixed well, and then the solution was filtered through Whatmann filter paper No: 42. From the filtrate 1 ml was pipetted out and diluted with 10 ml of phosphate buffer of pH 7.4. The resulting solution from each sample was measured at 376 nm for the drug content. The results are given in Table.

Using a Shimadzu UV-150 double beam UV Spectrophotometer. The results of in vitro release profiles obtained for all the formulations were fitted into four models of data treatment as follows:

1. zero-order kinetic model.

2 First-order kinetic model

3 Higuchi's model

4. Korsmeyer-Peppas equation.

5. Hixson Crowell model.

RESULT AND DISCUSSION:

1. Tapioca Starch Analysis:

the Pre-Formulation study of Tapioca starch were evaluated for parameters such as Solubility, Melting point, pH, Angle of Repose, Bulk density, tapped density, Carr's index, Housner's ratio are shown in table 2.

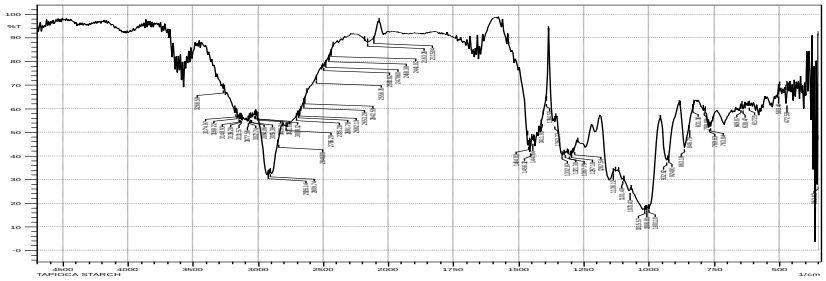
Table no.2 Study of Tapioca Starch

	Parameters	**Observed Value**	**Standard Value**
1.	**Confirmatory Test**		
	a. Iodine Test	Color Change Blue to Black	Color Change Blue to Black
2.	**Solubility**		
	a. Water	Partially Soluble	Partially Soluble
	b. Chloroform	Insoluble	Insoluble
	c. Alcohol	Completely Soluble	Completely Soluble
3.	**pH**	5-6	5-7
4.	**Melting Point**	168˚C	169.2˚C
5.	**Micromeritics Study**		
	a. Bulk Density (gm/ml)	0.5	0.54 - 0.58
	b. Tapped Density (gm/ml)	0.65	0.65
	c. Hausner's Ratio	1.3	1.86
	d. Carr's Index	24.24	46.2
	e. Angle of Repose(ɵ)	43.1˚	42.82±0.21

International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 30, Issue 8, August 2024 pp 194-201. **ijppr.humanjournals.com** ISSN: 2349-7203

2. FT-IR Analysis:

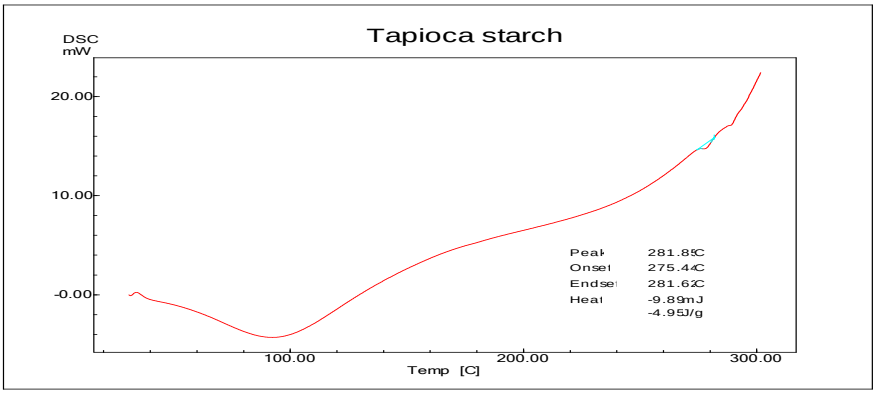
FT-IR spectroscopy is a powerful analytical technique used to identify chemical structures and functional groups in various materials. When applied to tapioca starch, FT-IR analysis provides detailed insights into its molecular composition and structural characteristics, which are crucial of understanding its properties and potential applications.



Graph no. 1 IR Spectra of Tapioca Starch.

3. DSC Analysis:

DSC measures the heat flow into or out of a sample as it is heated, cooled, or held at a constant temperature. This technique can identify phase transitions, such as melting, crystallization, and gelatinization, by detecting changes in the heat capacity of the sample. The resulting data is plotted as a thermograph, where peaks represent endothermic or exothermic events.



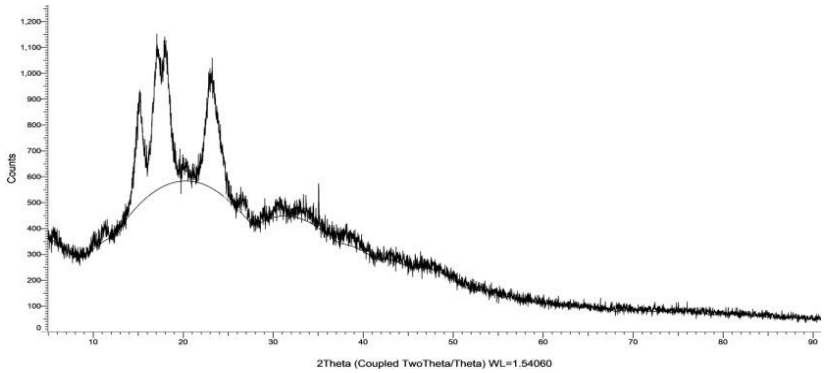
Graph no.2 DSC Thermogram of Tapioca Starch

4. X-ray Diffraction:

X-ray diffraction (XRD) is a crucial analytical technique used to examine the crystalline structure of materials, including biological macromolecules like starch. When applied to tapioca starch, XRD provides detailed insights into its crystalline arrangement, degree of crystallinity, and structural changes under different conditions. These insights are vital for applications in food science, material science, and industrial processes.

XRD works by directing X-rays at a material and measuring the intensity and angles of the X-rays that are scattered by the atoms within the material. The resulting diffraction pattern, or diffractogram, consists of peaks corresponding to the specific arrangements of atoms in the crystalline regions of the material. These patterns help identify the types of crystalline structures present and their relative amounts.

International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 30, Issue 8, August 2024 pp 194-201. **ijppr.humanjournals.com** ISSN: 2349-7203



Graph no.3 Commander Sample ID (Coupled Two Theta/Theta)

5. SEM:

SEM (Scanning Electron Microscopy) analysis is a powerful technique used to examine the surface structures and compositions of materials at high magnification and resolution.

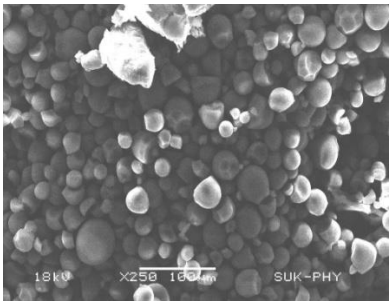


Fig. no. 2

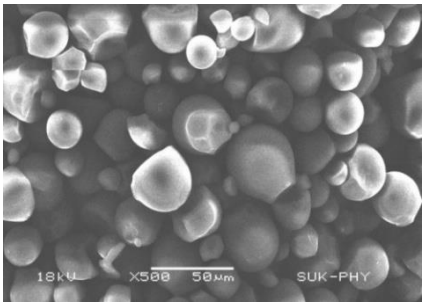


Fig.no.3

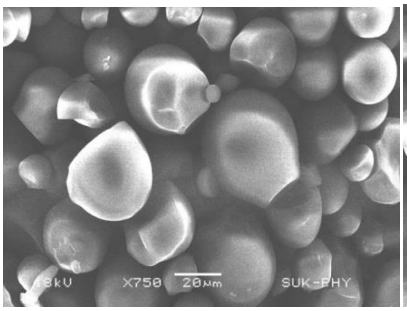


Fig.no.4

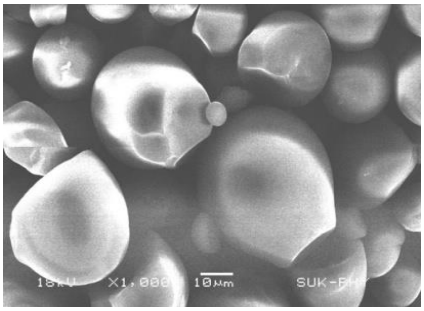


Fig.no.5

6. Pre–Formulation Study of Tapioca starch (granules of Paracetamol with tapioca starch):

The Pre-Formulation study of Tapioca starch the prepared granules of Paracetamol with tapioca starch as binder were evaluated for parameters such as Angle of Repose, Bulk density, tapped density, Carr's index, Housner's ratio are shown in table no. 3.

The Pre-Formulation study of Synthetic starch the prepared granules of Paracetamol with synthetic starch as binder were evaluated for parameters such as Angle of Repose, Bulk density, tapped density, Carr's index, Housner's ratio are shown in table no .3.

International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 30, Issue 8, August 2024 pp 194-201. ijppr.humanjournals.com ISSN: 2349-7203

Table no.3 Pre-Formulation Studies

	Formulation of Extracted Tapioca Starch			Formulation of Synthetic Starch		
Granule Parameter	I	II	III	IV	V	VI
Angle of Repose (θ)	39.77	38.99	36.95	33.97	37.45	36.87
Bulk Density (gm/ml)	0.52	0.54	0.56	0.5	0.45	0.43
Tapped Density (gm/ml)	0.62	0.63	0.64	0.58	0.50	0.49
Carr`s Index	16.12	19.40	21.87	13.79	10	12.24
Housner`s Ratio	1.24	1.25	1.28	1.16	1.16	1.13

7. Post Formulation Study of Tablet:

Table no.4 shows the physical properties of Tapioca starch the prepared tablets of Paracetamol with tapioca starch as binder were evaluated for parameters such as avg. weight variation, hardness, thickness, diameter, friability, disintegration, dissolution are shown in table no. 4.

Tapioca starch showed significant binding property. The average weight variation of the formulated tablets was found to be within acceptable limits. The hardness of the tablets increased with the increase in binder concentration. The friability was found to be decreased as the binder concentration increases. The disintegration time was found to be increased with the increasing concentration of tapioca starch.

Table no.4 shows the physical properties of Synthetic starch the prepared tablets of Paracetamol with Synthetic starch as binder were evaluated for parameters such as avg. weight variation, hardness, thickness, diameter, friability, disintegration, dissolution are shown in table no.4.

Synthetic starch showed significant binding property. The average weight variation of the formulated tablets was found to be within acceptable limits. The hardness of the tablets increased with the increase in binder concentration. The friability was found to be decreased as the binder concentration increases. The disintegration time was found to be increased with the increasing concentration of Synthetic starch.

Table no.4 Post-Formulation Studies

	Formulation of Extracted Tapioca Starch			Formulation of Synthetic Starch		
Tablet Parameters	I	II	III	IV	V	VI
Weight Variation (%)	6.38	4.25	2.12	4.34	4.2	2.83
Hardness (kg/cm)	4.8	5.1	5.3	4.8	5.04	5.1
Thickness(mm)	0.66	0.67	0.65	0.65	0.7	0.66
Diameter(mm)	0.98	0.99	0.98	0.99	0.99	0.98
Friability (%)	0.225	0.25	0.305	0.205	0.240	0.30
Disintegration Time (min)	0.23±0.05	1.41±0.16	1.33±0.12	0.21±0.07	0.57±0.15	1.21±0.21
Dissolution Time (min)	65	67	68	66	69	71

DISCUSSION

The study conducted confirmatory testing on tapioca starch, which was found to be in compliance with standard specifications. IR, DSC, SEM, and XRD studies further confirmed that tapioca starch falls within the specified ranges. The results showed that the tablets formulated with tapioca starch showed significant binding properties, with the average weight variation within acceptable limits. The hardness of the tablets increased with the increase in binder concentration, while the friability decreased as the binder concentration increased. The disintegration time also increased with the increase in binder concentration. Similarly, the tablets formulated with synthetic starch showed significant binding properties, with the average weight variation within acceptable limits. The test results suggest that tablets formulated with natural starch as a binder exhibit superior binding properties compared to those containing synthetic starch.

CONCLUSION

This project outlines a comprehensive plan to investigate the potential benefits of natural starch and its modifications as excipients in pharmaceutical dosage forms. The outcomes of this research could contribute to the development of innovative formulations that address current challenges and meet the evolving demands of the pharmaceutical industry. The test results indicate that tablets formulated with natural starch as a binder exhibit superior binding properties compared to those containing synthetic starch. Through confirmatory testing encompassing solubility, pH, melting point, and micromeritics analysis, tapioca starch demonstrated compliance with standard specifications. IR, DSC, SEM, and XRD studies further confirmed that tapioca starch falls within the specified ranges. Pre-formulation studies underscored the consistency of tapioca starch with its designated standard values. Evaluation of the formulated tablets revealed values aligning with the specified standard range.

REFERENCES:

(1)Phukan M, Nongkhlaw ft. Starch: an overview of its conventional and unconventional sources, pharmaceutical and industrial applications. Current Trends in Pharmaceutical Research. 2022;9(1).
(2)Mateescu MA, Ispas-Szabo P, Assaad E. Starch and derivatives as pharmaceutical excipients: From nature to pharmacy. Controlled Drug Delivery the Role of Self-Assembling Multi-Task Excipients. 2015:21-84.
(3)Sivamaruthi BS, kumarNallasamy P, Suganthy N, Kesika P, Chaiyasut C. Pharmaceutical and biomedical applications of starch-based drug delivery system: A review. Journal of Drug Delivery Science and Technology. 2022 Oct 12:103890.
(4) Widodo RT, Hassan A, Liew KB, Ming LC. A directly compressible pregelatinised sago starch: a new excipient in the pharmaceutical tablet formulations. Polymers. 2022 Jul 28;14(15):3050.
(5) Moorthy SN. Tropical sources of starch. Starch in food: structure, function and applications. 2004:321-59.
(6)Gardouh A, Srag El-Din AS, Moustafa Y, Gad S. Formulation factors of starch-based nanosystems preparation and their pharmaceutical application. Records of Pharmaceutical and Biomedical Sciences. 2021 Jan 1;5(Pharmacology-Pharmaceutics):28-39.
(7)Kittipongpatana OS, Sirithunyalug J, Laenger R. Preparation and physicochemical properties of sodium carboxymethyl mungbean starches. Carbohydrate Polymers. 2006 Jan 18;63(1):105-12.
(8)Kadoli PS, DESAI SR PS, D'SOUZA JI. Study of Binding Efficiency of Tapioca Starch using Iornoxicam as a Model Drug. Int J Pharm Biol Sci Arch. 2012; 3:223-7.
(9)SOWMYA MP, Deepika CN, Vyshnavi D, Pavani GS, Puthri S, Reddy PH, Amaravathi T. Extraction of starch from different natural sources estimation and evaluation of its physicochemical properties as pharmaceutical excipient.
(10)Shahrim NA, Sarifuddin N, Ismail H. Extraction and characterization of starch from mango seeds. In Journal of physics: Conference series 2018 Aug 1 (Vol. 1082, No. 1, p. 012019). IOP Publishing.
(11)Tesfaye T, Ayele M, Ferede E, Gibril M, Kong F, Sithole B. A techno-economic feasibility of a process for extraction of starch from waste avocado seeds. Clean Technologies and Environmental Policy. 2021 Mar; 23:581-95.
(12)Hassan LG, Muhammad AB, Aliyu RU, Idris ZM, Izuagie T, Umar KJ, Sani NA. Extraction and characterisation of starches from four varieties of Mangifera indica seeds. IOSR Journal of applied chemistry. 2013;3(6):16-23.
(13)Srangsomjit N, Bovornratanaraks T, Chotineeranat S, Anuntagool J. Solid-state modification of tapioca starch using atmospheric nonthermal dielectric barrier discharge argon and helium plasma. Food Research International. 2022 Dec 1; 162:111961.
(14)Hu X, Guo B, Liu C, Yan X, Chen J, Luo S, Liu Y, Wang H, Yang R, Zhong Y, Wu J. Modification of potato starch by using superheated steam. Carbohydrate Polymers. 2018 Oct 15; 198:375-84.
(15) Rashid US, Simsek S, Kanel SR, Bezbaruah AN. Modified tapioca starch for iron nanoparticle dispersion in aqueous media: Potential uses for environmental remediation. SN Applied Sciences. 2019 Nov; 1:1-4.
(16) Huang CB, Jeng R, Sain M, Saville B, Hubbes M. Production, characterization, and mechanical properties of starch modified by Ophiostoma spp. BioResources. 2006;1(2):257-69.

How to cite this article:
Mr. Saud Mulla et al. Ijppr.Human, 2024; Vol. 30 (8): 194-201.
Conflict of Interest Statement: All authors have nothing else to disclose.