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SAGO -A POLYMER, IT'S APPLICATIONS AND UTILISATION OF ITS

1Gund Nisha, 2Shweta karpe, 3Dr.Bafna Yogesh

1Student, 2Professor, 3Principal

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ABSTRACT

Indian sago starch extracted from Tapioca roots finds its application not only as a food but also numerous commercial applications. In the present review we are discussing concisely the extraction, physiochemical properties, chemical modifications and pharmaceutical applications of Indian sago starch. The sago starch is a cheap, easily available, biodegradable and a versatile polymer. Starch has always been an important excipient in the pharmaceutical industry. It is conventionally used as a binder, disintegrant, diluent. granulating agent. It is also a starting material for many other chemicals like ethanol, glucose and cyclodextrin. Several modifications were attempted on native starch to improve and modulate its physiochemical properties.

Keywords: Sago starch, tapioca, cyclodextrin, artificial skin, edible film.

INTRODUCTION

Topical route is a basic raw material for Sago and starch.Worldwide production of synthetic polymer reached 130 million tons per year at the end of the 20th century while the demand for biodegradable polymer is reported to be growing by 30% each year. Polyethylene is widely used in medical devices and pharmaceutical packaging there are various types of polymer such as linear load density polyethylene(LLDPE),high density polyethylene(HDPE) Low density polyethylene(LDPE) These all polymers having different functionalities

Polymer are degraded by the use of some microorganisms such as polylactic acid.topica roots contains about 60 to 70% moisture content, 5 to 13% starch 20 to 31% carbohydrate and 7 to 12% proteins .Sago is mix

with hot water to form a glue like mass which is commonly eaten as a source of carbs with fish or vegetables it is also common to bake Sago into bread, biscuit and crackers Sago prepared from carbohydrate material stored in the trunks of several palms ,the main source being the true sago palm ,metroxylon sago

Fig (1) Sago palm (Metroxylon sagu)

Topica sago is known as Sago(Sabudana in Hindi) in India .it is a product prepared from the milk of topica root .Sago granules typically have a size range from 1.0 to 8.0 mm depending on the requirement. Sago starch is evidently hydrophilic polymer ,which is an interesting material to develop to remove water from alcohol .Sago starch is not toxic material, cheap and available easily .Sago starch has a large amount of hydroxyl group(-OH), which make it the surface of Sago membrane is very affinity towater. Sago starch itself having poor stability hence various chemical and physical changes or modifications is required to improve the properties of Sago

Fig (2)

PRODUCTION(EXTRACTION)

The extraction and isolation of sago consist of step by step procedure starting from washing ofTapioca roots to presenting them into shiny pearls. The major steps are discussed below:

1) The Tapioca roots are collected and sliced in suitable sizes and the sliced roots are subjectedto a thorough washing.

2) The washed roots are peeled, the outer skin is removed.

3) The peeled roots are subjected to crushing by moving them between the rollers. The pulp isobtained.

4) Pulp obtained is sent to the shifter for separating the course particles and the fineones.

5) Course particles are again made to pass through the roller to make them fine.

6) The milk obtained is allowed to settle down starch particles for 3-8 hours in the settling tank. Here the non-starch part separates from the starch part.

7) From the settling tank, the settled starch is partially dried .The dried cake is crushed downand is sent for further processing such as granulation, roasting and solar drying.

8) Finally it is marketed as shiny as sabu pearls .

Fig (3)Sago logs arriving at a starch factory in Mukah, Sarawak, Malaysia.

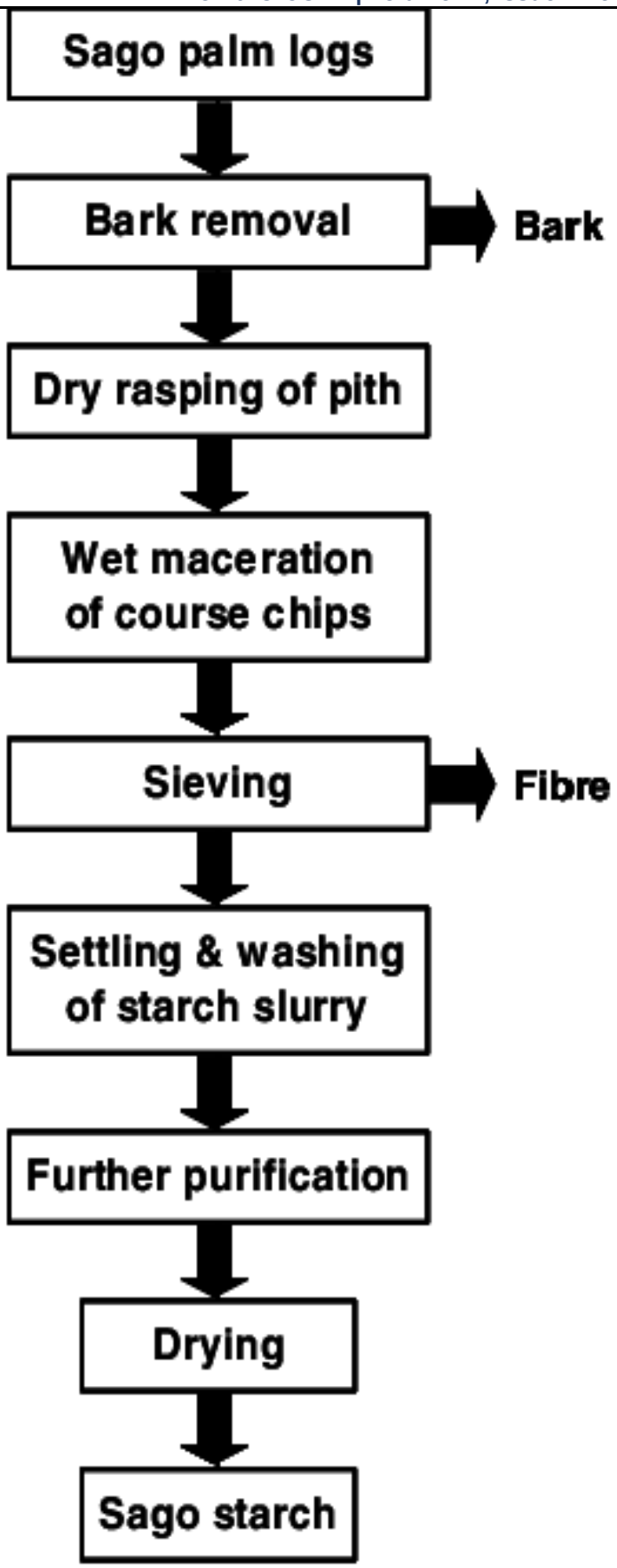


Fig (4) Production of Sago Starch

UTILISATION

❖ Methods:-

1. Sago starch treated with acrylic acid

Five grams of dried sago starch was added to 50 mL of distilled water at 75 °C for 30 minutes in a conical flask. The slurry was cooled to 30 °C, and the temperature was maintained for 10 min. Then, 10 mL of 0.01 M ceric ammonium nitrate (CAN) was added, followed by 10 mL of 0.01 M acrylic acid. Next, another 30 mL of distilled water was added into the conical flask. The solution was left for 10 min before it was heated to 60 °C. After that, the mixture was neutralized with 5% sodium hydroxide, with constant stirring, until the solution turned into a reddish brown color. It was then allowed to further react at 60 °C until the solution turned a pale yellow. The slurry was cooled down to 25 °C before it was adjusted to a pH of 7 via glacial acetic acid. The precipitate was later washed with methanol and ethanol and dried in an oven at 70 °C for 24 h before it was powdered.

2. Sago starch treated with benzene diazonium chloride

To prepare benzene diazonium chloride, 15 mL of aniline was dissolved into a mixture of 40 mL of concentrated hydrochloric acid and 40 mL of water. The solution then was filled in a flask and cooled to 5 °C by immersing it into a mixture of ice and water. Next, 12.5 g of powdered sodium nitrite was dissolved in 30 mL of water, and was added dropwise to the aniline hydrochloride solution, and was further cooled to 5 °C. After that, 10 g of dried sago starch was added into the solution. The reaction was allowed to react for one hour in an ice-water bath. Finally, the treated sago starch was filtered and dried at 25 °C for 24 h.

3. Sago starch treated with tetrahydrofuran

A total of 50 g of PLA and 10 g of sago starch was mixed in a beaker; 10 mL of tetrahydrofuran solvent was added. The mixture was stirred for 12 h before casting. The casted plates were dried at ambient temperature for 12 h and peeled from the casting surface

❖ Testing:- Tensile test

The tensile strength and modulus of elasticity were analyzed and compared by referring to the weight percentage of the treated sago starch. The tests were conducted with a Universal Testing Machine (Shimadzu, Kyoto, Japan) with a loading capacity of 300 kN and a cross head speed of 1 mm/min. The test was conducted according to ASTM standard D638-14 (2014) and analyzed at room temperature with a stretch rate of 1 mm/min (similar to the crosshead speed). The average values of the tensile strength.

UTILISATION OF SAGO WASTE WATER

❖ Sago Waste:

During the processing of sago starch, three major by-products are generated, namely bark of sago trunk, fibrous pith residue, which is also known as hampas, and wastewater .Bark and hampas are classified as solid residues whereas wastewater is a liquid residue .Sago wastes consist of non- starch polysaccharides (NSP) or lignocellulosic materials, i.e., cellulose, hemicellulose, and lignin. In a day, 15.6 tons of woody bark, 238 tons of wastewater, and 7.10 tons of fibrous pith residue are generated from approximately 600 logs of sago palm .

❖ Processing and utilization of sago waste water:-

After the separation of starch from the pith, the wastes are in the form of bark, the solid component known as hampas and waste water. The waste water is usually discharged into the rivers, each factory producing about 10-22 tons waste water per day (Phang et al., 2000). The effect of treated sago effluent on the fish tissues of the Indian carp Cirrhinus miri- gala is such that histologically tissues showed varied degrees of damage suggesting the study to be useful as an indicator of water pollution .

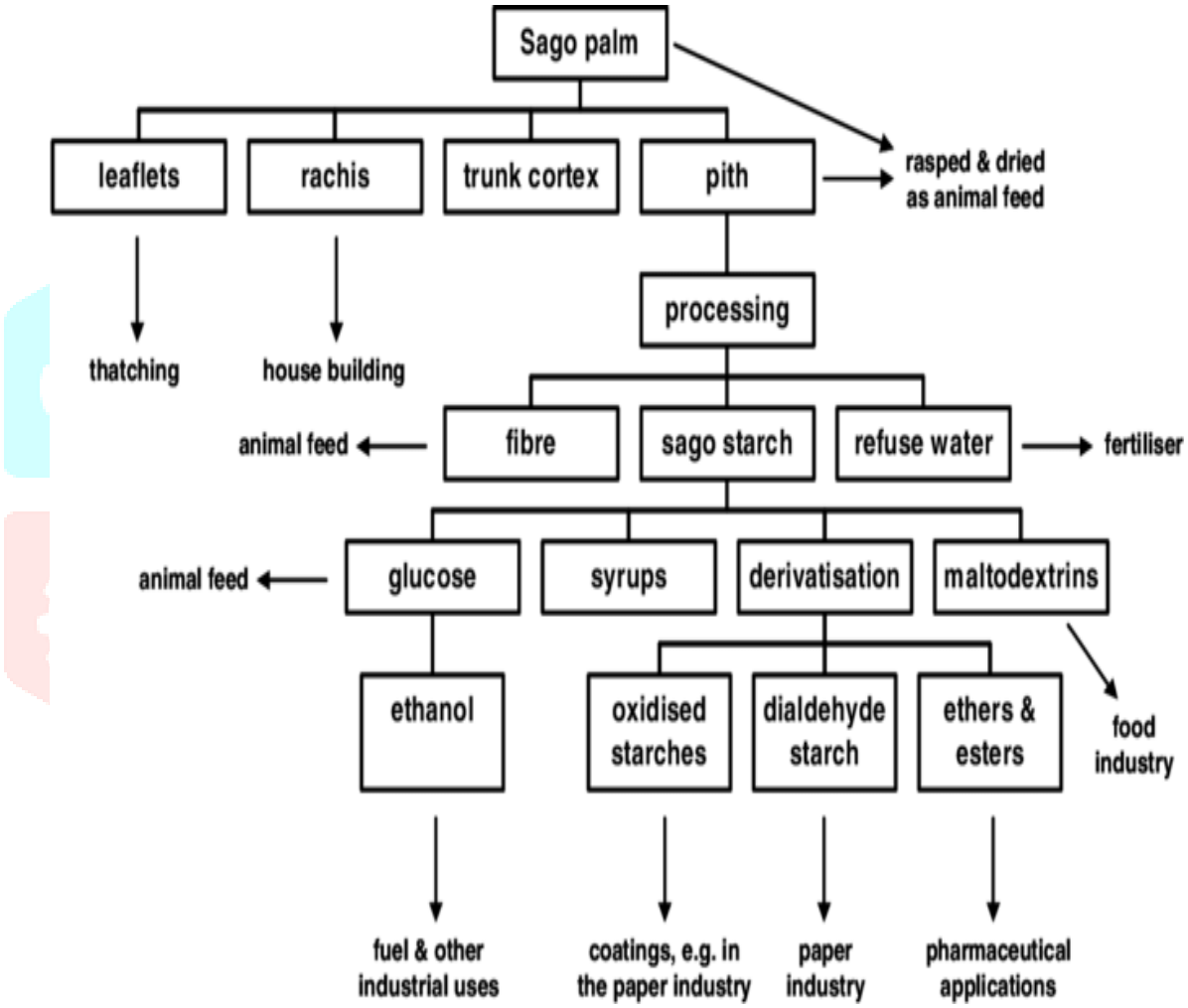
There are newer possibilities for the design of low-cost and compact, on-site waste treatment systems with very short retention periods. A hybrid reactor which combines the advantages of both fixed-film and up-flow anaerobic sludge blanket systems for the treatment of sago waste water for reduction of Chemical Oxygen Demand (COD) was operated at organic loading rates varying from 10,4 to 24.6 kg COD/m'd (Banu, Kaliappan, & Dieter. 2006). After 120 days of start-up, an appreciable decrease in COD and efficient removal of solids were evident. The COD removal varied from 91% to 83%, while the removal of total solids was in the range of 56-63% and that of volatile solids varied from 67% to 72%. This was considered a step in the right direction for the treatment of waste water

in the prevention of pollution. An indigenous strain of Rhodopseudomonas palustris strain BI isolated from rice-noodle factory waste water was grown in 50% sago effluent in an attempt to utilize the sago starch processing waste water to produce biomass (Vickineswary et al., 1997). A high biomass concentration of 2.5 g/L with a pigment content of about 1.1 mg caroten oid per g cell mass was achieved after 96 h of growth in anaerobic-light culture system together with a 77% reduction in the COD of the sago effluent. This was considered essential. to be of value since carotenoids are nutraceuticals having a huge market worldwide.

Waste water arising from the production of sago starch has a very high carbon to nitrogen ratio (105:0.12), but it has been made more suitable for fermentation by anaerobic fermentation in an up flow packed bed digestor (Phang et al., 2000). The digested effluent with an average CNP ratio of 24.0.14:1 supports growth of Spirulina platensis (Arthrospira). The highest crude protein, carbohydrate and lipid content of the biomass were 68% 23%, and 11%, respectively. The reduction in COD, ammoniacal- nitrogen and phosphate levels of the digested effluent reached levels of 98.0%, 99.9%, and99.4%, respectively.

APPLICATION OF SAGO STARCH

Sago Is almost pure starch, a type of carbohydrate it only contains small amounts of protein ,fat and fibre and lack of many vitamins and minerals .below the nutritional information per 3.5 pounds of Sago contains : 332 ,proteins less than one gram ,fat less than 1 gram, carbs 83 grams fiber less than one gram, zinc 11% of RDI(reference daily intake).



❖ Sago is used as antioxidant :

antioxidant are molecule that neutralize Potentially harmful molecules known as free radicalswhich is responsible for cancer & heart disease.

Sago is used in composite film Formulations for increased biodegradability.is also used as an alternative

gelling agent in the jam industry.

Sago is commercially used in making noodles and white bread. Sago also used as thickner forother dishes

In India ,it is used in a variety of dishes such as desserts boiled with sweetened milk on occasionof religious fasts

- Textile production:

Sago is used to treat fibre, making it easier to machine. this process called Sizing and helps to bind the fibre , Give it a predictable slip for running on metal , standardise the level of hydration of the fibre and give the textile more body

- Tablet formulation:

in the formulation of tablet the sago starch is used as binder . It gives a good binding quality .the tablet formulated with sago starch as binder having hardness with a decrease in friability, and increase in disintegration time.

- As packaging material :

Sago esters prepared by pre-treatment of sago starch with excess of formic acid followed by acetylation with acid chloride results in formation of modified sago Starch

this is overcome the physiochemical Problems associated with native starch.

- culture medium:

in culture medium the Sago is usedas gelling agent. for agar the sago Starch is a cheap alternative. Sago starch provided of firm surface throughout the entire culture period and fostered optimum plantlet growth in terms of shoot height , number of nodes per plant , number of leaves and fresh mass. No softening the Sago gelled medium occurred over prolonged storage .the study show that Sago starch could be used as a substitute to agar in culture medium to substantially reduce medium cost.

- Glucose production:

Penicillium brunneum isolated from sago processing site produces amylase which digests the starch granules to glucose. Treatment of sago starch by subjecting to temperature gelatinization temperature at low pH results in enhanced ability of enzyme to digest sago starch granules .

- Cyclodextrin production:

Cyclodextrin glycosyltransferase (CGTase) synthesizes cyclodextrin, It is widely used in food, pharmaceutical, agricultural and cosmetic industries. Cyclodextrin is produced by Bacillus circulans CGTase at an optimum temperature and pH of 55 60°C and 4.5 to 5 respectively.

- Production of UV curable coatings:

Grafted copolymer of sago starch is prepared by grafting Glycidyl methacrylate (GMA) on sago starch using ceric ammonium nitrate as initiator in aqueous medium. These grafted copolymers of starch are incorporated into UV curable films. This increases the flexibility of the cured films.

❖ **PHYSICO CHEMICALPROPERTIES OF SAGO STARCH:**

S.NO	PROPERTIES	SAGO STARCH
1)	Bulk density ($g/cm^{3)}$	0.57142
2)	Tapped density (g/cm^3)	0.76923
3)	Angle of repose (º)	32.39
4)	Carr's index	25.7513
5)	Paste clarity (%)	8.47
6)	% solubility	0.56
7)	Yield stress (pascal)	57.493
8)	Viscosity (pascal)	34.16
9)	Swelling power	26.10
10)	% loss on drying	2.2
11)	Diameter of the starch grain (µm)	16.4-30
12)	Temperature (ºC)	2-5
13)	Gelatinisation	68-73
14)	Total microbial load	PASS
15)	Limit test (chloride)	PASS

CONCLUSION

The review article is primarily focus on different types of application of Sago starch and its application it is an excellent starch research with a myriad of possible application in the food polymer pharmaceutical and textile industries. The sago starch, because of its availability, easy processing biodegradability and physiochemical properties can be successfully used in pharmaceutical industry. Its application is now not only limited to binder, disintegrant and diluent but it can also be cross linked and modified for delivering novel drug delivery system and also as a packaging material. Cyclodextrin, a fermentation product from starch has been used not only as a complexion agent but also for solubility enhancement of poorly water soluble drugs. Thus we can conclude that sago starch can be used in place of many synthetic polymers as well as can be alterative of starches from expensive sources.

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