Formulation and Evaluation of Film of Starches Obtained From Different Plant Sources

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Abstract

Polysaccharide films were developed using red lentil, water chestnut, and tamarind seed powder starches as the basic raw materials. The physical and mechanical properties of the films were investigated. High amylose starches exhibited excellent film forming capabilities and properties compared to low amylase starches. The starch films also exhibited excellent tensile strength values (0.334+0.05 to 0.502+0.05). Physical (viscosity) characterization of the vegetable starches showed that the high amylose starches formed better biopolymer films compared to the low amylose and high amylopectin starches. Polysaccharide films for pharmaceutical applications could be developed from plant starches with similar physical and mechanical properties to synthetic and gelatin products.

Keywords: Polysaccharide Film, Starch, Gelatin, Animal Base Film, Amylose

Introduction:

Synthetic polymeric food packaging materials developed in the last 50–60 years are durable and inert or resistant to microbial degradation. These synthetic polymeric materials are widely used in food packaging due to their various advantages such as high strength, stretchability, gas barrier properties, low cost, light weight and water resistance. Packaging materials account for about 30% of the weight of municipal solid waste, with garbage cans accounting for two-thirds of the volume because they are very bulky. Of the 30% packaging waste, 13% is plastics, which are practical, safe, stable and economical, but not biodegradable. Incineration is a common method of disposing of polyolefins, but it results in high carbon dioxide emissions. Since the 1970s, polar biopolymers such as polysaccharides and proteins have been studied as potential alternatives to synthetic polymers in the film and plastics industry due to environmental concerns. Several studies have investigated the properties of protein-, polysaccharide-, and lipid-based films, and these raw materials have been successfully processed into films or coatings. These edible/biodegradable films have reportedly been successfully used in a number of commercial applications: (a) gelatin for capsules, dietary supplements, pharmaceuticals, and flavor encapsulation; (b) corn zein for coatings, confectionery, dietary supplements, and drug tablets; (c) collagen for wrappers and casings for meat products; (d) starch coatings for drug tablets, confectionery, and dried fruits; (e) HPMC, MC and HPC coatings for dietary supplements and drug tablets; (f) fatty acid sucrose esters for coatings of fresh products; (g) wax, oil and shellac coatings for fresh products, confectionery, dietary supplements and drug tablets.[1]

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Method of Preparation Of Film:[2-5]

One or a combination of the following processes can be used to manufacture the film:

- Solvent casting
- Hot-melt extrusion
- Semisolid casting
- Solid dispersion extrusion
- Rolling

- **Evaluation parameter of film**[6]
- Thickness
- Dryness/tack test

Methods of Isolation and Separation of TSP

The coat of the tamarind seeds is removed and the white part of the seeds is obtained. The coarse powder of the tamarind seeds is ground and then soaked in distilled water for 24 hours. Extracting the gum from TSP, isolating TSP by gauze cloth. The pomace is removed from the gum and the same amount of absolute ethyl alcohol is added to the gum, a precipitate is formed which is separated by filtration. Isolation is carried out until the material is free of gum. The separated rubber is dried in a hot air oven at a temperature of 40ºC. Then the dried rubber is pulverized and stored in airtight containers at room temperature.[7]

- **FTIR:** Excipients and polymer interaction study by FTIR
- **Flow Properties of RL, WCS, TSP.**[8]
- **Hausner's Ratio**
- **Carr's Index**

This was calculated by applying the equation:

$$\frac{(\text{Tapped density} - \text{Bulk density}) \times 100}{\text{Tapped density}}$$

- **Angle of Repose (θ)**

- Tensile strength
- Young's modulus
- Tear resistance
- Folding endurance
- Organoleptic test
- Surface pH test
- Swelling property
- Transparency
- Assay/content uniformity
- Disintegration test
- In-vitro dissolution

The angle of repose was calculated using the following equation,

$$\tan\theta = h/r \qquad \theta = \tan^{-1} h/r$$

Where, θ is angle of repose, h is Height, r is the Radius.

- **Formulation Procedure of Film** [9]
- **Solvent Casting Method**

The films are preferably formulated by the solvent casting method, in which the water-soluble components are dissolved to form a clear viscous solution and the drug together with other excipients are dissolved in a suitable solvent, then both solutions are mixed and stirred, and finally poured into the stream membrane and dried.

Water-soluble ingredients are dissolved in water, and the drug and other excipients are dissolved in a suitable solvent to form

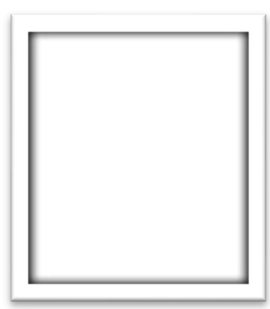

Figure 1. Frame Back Membrane (Glass)

Table 1. Material Used for Film Preparation with Their Use in Preparation

S N.	Material Used for Film	Use
1	Red Lentil Powder (RL)	Polymer
2	Waterchestnut Powder (WCS)	Polymer
3	Tamarind Seed Powder (TSP)	Polymer
4	HEC	Polymer
5	Titanium Dioxide	Opacifier
6	Polyethylene Glycol	Plasticizer
7	Benzalkonium Chloride	Surfactant
8	Tween 80	Surfactant

- **Evaluation Parameters for Polysaccharide film** [10-12]
- **Visual Inspection** (Shape, size, Colour & Texture)

Check Shape, Size, Colour & Texture of the final Film prepare by visual inspection

- **Thickness of Film**
- **Folding Endurance**
- **Tensile Strength**

Tensile strength = Breaking force/Area

- **Starch content**
- **Disintegration Test**
- **pH of Films**

Result and Discussion:

Identification of Starches by FT-IR and DSC:

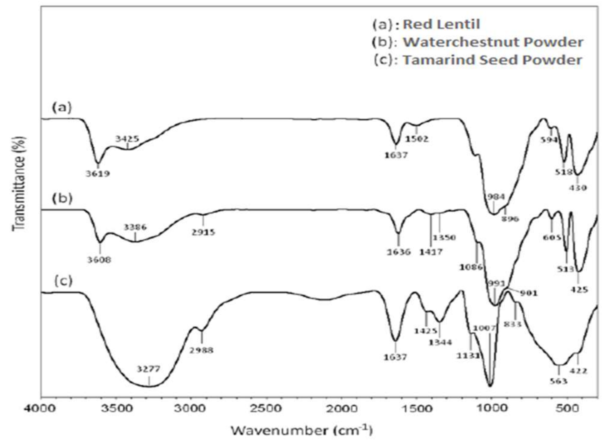

Figure 2. FT-IR spectrum of RL, WSC, TSP

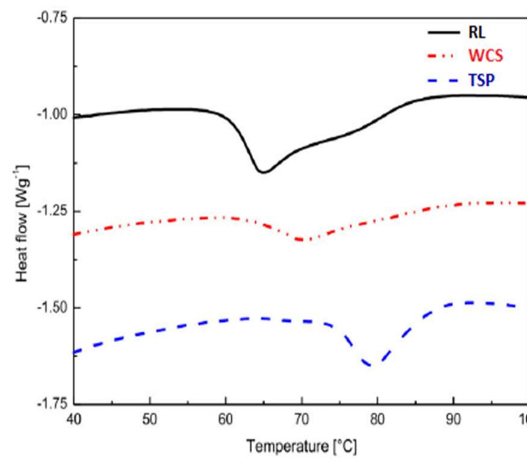

Figure 3. DSC spectrum of RL, WSC, TSP

Discussion:

FTIR and DSC studies have been performed to detect starch. In the present study, the IR study of starches was performed and the resulting spectrum is shown in Figure 2-3

Table 2. Flow Properties of Starch Powders Obtain From RL, WSC, TSP

Starches	Hausner's Ratio	Carr's Index	Angle of Repose (θ)
RL	1.15±0.5	12.71±0.11	45^0±1
WCS	1.15±0.5	12.96±0.11	28^0±1
TSP	1.06±0.5	5.45±0.11	37^0±1

n=3 (Mean ± SD)

Discussion:

The flow properties of the formulated starch powder were generally good. The flow properties according to Carr's Index and Hausner's Ratio were calculated using the results in (Table 2). The flow properties using the angle of repose were obtained by calculating from the results in (Table 2)

- **Preparation of Film:**

Table 3. Formulation Detail of Films Of TSP, WCS And RL Starches

Ingredient mg	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
RL	100	150	200	---	---	---	---	---	---	---
WCS	---	---	---	100	150	200	---	---	---	---
TSP	---	---	---	---	---	---	100	150	200	200
HEC	---	---	---	---	---	---	---	---	---	200
Titanium dioxide	1	1.50	2	1	1.50	2	1	1.50	2	4
Tween 80	1	1	1	1	1	1	1	1	1	1
Polyethylene Glycol (PEG400)	5	7.50	10	5	7.50	10	5	7.50	10	20
Benzalkonium Chloride	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.40
Water	q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s

Discussion:

The formulation of red lentil (F1 to F3) was prepared and due to the lack of stickiness and the results of other parameters (see Table 4-5), the next formulation of water chestnut (F4 to F6) was prepared and the same results were also found (see Table 4-5), so turning to tamarind seed powder. In F7 there was also a result, but in F8 and F9 no satisfactory result was obtained, so the next batch was prepared by adding HEC (F10) in the F9 formulation and good results were found

- **Evaluation of Polysaccharide Film**

Table 4. Evaluation Parameter of Film

Formulation	Tack Test	Appearance	Weight Mean (mg)	Folding Endurance Mean	Thickness Mean (mm)
F1	Non-Tacky	Transparent reddish brown	19±1.5	30±2	1±0.1
F2	Non-Tacky	Transparent reddish brown	25±1.5	28±2	0.6±0.1

F3	Non-Tacky	Transparent reddish brown	28±1.5	26±2	0.9±0.1
F4	Non-Tacky	Transparent yellowish brown	22±1.5	31±2	0.8±0.1
F5	Non-Tacky	Transparent yellowish brown	18±1.5	24±2	0.6±0.1
F6	Non-Tacky	Transparent yellowish brown	29±1.5	32±2	1.2±0.1
F7	Non-Tacky	Transparent yellowish brown	18±1.5	27±2	1±0.1
F8	Tacky	Transparent yellowish brown	22±1.5	25±2	0.8±0.1
F9	Tacky	Transparent yellowish brown	30±1.5	36±2	0.8±0.1
F10	Tacky	Transparent yellowish brown	33±1.5	40±2	0.7±0.1

n=3 (Mean ± SD)

Table 5. Evaluation Parameter of Film

Formulation	Tensile Strength	D.T Mean (min)	Starch Content (%)	Moisture Permeation Test(mm/Hg)
F1	0.381±0.05	32±0.5	95.00	0.09±0.01
F2	0.346±0.05	35±0.5	97.00	0.15±0.01
F3	0.358±0.05	39±0.5	99.45	0.19±0.01
F4	0.421±0.05	28±0.5	96.34	0.16±0.01
F5	0.451±0.05	32±0.5	97.43	0.21±0.01
F6	0.334±0.05	38±0.5	99.96	0.27±0.01
F7	0.417±0.05	30±0.5	98.65	0.18±0.01
F8	0.488±0.05	34±0.5	99.54	0.25±0.01
F9	0.502±0.05	35±0.5	99.75	0.31±0.01
F10	0.498±0.05	38±0.5	99.80	0.34±0.01

n=3 (Mean ± SD)

Discussion:

Batches F1 to F7 show non-tackiness and F8 to F10 show tackiness. F1 to F3 show transparent reddish-brown appearance and F4 to F10 show transparent yellowish-brown appearance. The weight, folding strength, thickness, tensile strength, disintegration time, starch content and moisture permeability test were observed (the results are shown in Table 4-5) and via evaluation, F9 and F10 are considered as the optimum batch for capsule shell production.

Conclusion:

Polysaccharide films were developed using starches from different plant sources and their physical and mechanical properties were evaluated of the samples tested, tamarind seed starch exhibited relatively good mechanical and physical properties compared with starch from red lentils and water chestnuts. Tamarind seed starch was also used to develop hard capsules for the pharmaceutical industry.

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