International Journal of Food Science and Nutrition
www.foodsciencejournal.com
ISSN: 2455-4898
Received: 12-08-2022, Accepted: 29-08-2022, Published: 15-09-2022
Volume 7, Issue 3, 2022, Page No. 184-187

Production of biodegradable film using potato starch and corn starch with increased resistance to tear property by incorporation of xanthan gum

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Abstract
The aim of this study was to develop biodegradable films derived from plants and to understand the effect of xanthan gum as a thickening agent which provides not only stickiness among starch particles, binding property but also increase in strength of the film. This method uses the starch material from plant sources as base by additives and xanthan gum the film is produced through heat treatment. As the raw materials are of plant sources and easily available it is easily degraded by microbes. This study helped to understand the physical, structural, morphological and biodegradation properties of the film. The method uses the commercially available xanthan gum powder which is incorporated into to the starch obtained from potato and corn. The treatment results in extraction of thin film through flat molds. The obtained film was tested for its pH, thickness and extensibility by alveograph. The awareness over non-biodegradable petrochemical based plastics has been increasing and giving various opportunities to explore the fields for producing biodegradable and plant derived products. Because of the availability, film forming ability, low cost production, easy disposal properties starch is selected for obtaining films from plant-based sources.

Keywords: starch based films, biodegradable films, xanthan gum, tensile strength

Introduction
Xanthan gum is a high molecular weight extracellular polysaccharide produced by the bacterium *Xanthomonas campestris* and is one of the most important commercial microbial hydrocolloids used in the food industry as thickening agent and stabilizer. It is composed by a linear β-1, 4-linked D-glucose chain substituted on every second glucose unit by a charged trisaccharide side chain with glucuronic acid residue between two mannose units. The inner mannose residue is normally acetylated at C (6), which is located at the external part of the helical conformation of the polysaccharide. About half of the terminal mannoses are linked to pyruvyl residues. The blending of starch with small amounts of the above polysaccharide could represent a simple method that has the potential of improving the starch film properties while keeping the competitive cost of the material. Xanthan gum is produced by the fermentation of glucose and sucrose. The medium is well-aerated and stirred, and the xanthan polymer is produced extracellularly into the medium. The polymer is precipitated from the medium by the addition of isopropyl alcohol, and the precipitate is dried and milled to give a powder that is readily soluble in water or brine. It is composed of pentasaccharide repeat units, comprising glucose, mannose, and glucuronic acid in the molar ratio 2:2:1.

Materials used for production of biofilm from Potato and Corn Starch
Requirements
- Potato Starch
- Corn Starch
- Xanthan gum
- 250ml Conical Flask
- Measuring Cylinder
- Beaker
- Bunsen Burner
- Glass Rod
- Moulds
- Hot Air Oven
- Muslin Cloth
- Pestle and Mortar

Chemical Requirements
- 0.1N NaOH solution
- 0.1M HCL solution

- Distilled Water
- Glycerine
- 4% acetic acid and Colouring pigments.

Production of biodegradable film from potato starch

Extraction of Potato Starch is done by peeling potato and grinding by using pestle and mortar, pureed using distilled water and filtered with the help of muslin cloth. The starch was allowed to settle down for 10 minutes and then the supernatant was decanted. 100ml distilled water was added to rinse the starch. The water was decanted, this leaves clean wet starch. The starch was dried in an oven to obtain white powder. To this 10g of Starch powder 100ml distilled water was added along with 12ml of HCL (0.1M), 8ml of Glycerol and 0.1N NAOH, the mixture was heated for 15 minutes. Add 10gm/ 100 g of mixture of commercially available xanthan gum powder and stir well and continuously before forming lumps. Orange coloring pigment was added during heating. Mixture was poured in mold and spread into thin film by pressing on mold and was baked in hot air oven for 30 minutes at 130˚c.Then it was placed in dry area.

Production of biodegradable film from corn starch:

Extraction of Corn Starch: Soak the corn on large bowl for up to 3 days, changing the water every 12 to 18 hours. Thoroughly wash the corn with some cold water. In a blender, blend the corn until extremely smooth and filter by using muslin cloth and the starch was dried in an oven. Pour 100ml of water to 20g of corn starch. Add 10ml of Glycerin. Add 10gm/ 100 g of mixture of commercially available xanthan gum powder and stir well and continuously before forming lumps. Add 5ml of 4%acetic acid. Add few drops of Orange coloring pigment.Warm the mixture in the beaker gently. Stir the mixture while heating. Pour it onto the mould and spread into thin film by pressing on mold. Put aside let it cool and keep in hot air oven at 130˚c.Remove out of oven and place in dry area.

Test for biodegradable film decomposition

Materials: Plastic films, Digital weighing scale, water, soil.

Procedure

The decomposition of biofilm was observed after 15 days this is determined by using the digital weighing scale to measure the weight of plastic film of two different sources. The constant is the type of soil used

Then the plastic films were placed in a garden soil and left for 15 days. Temperature was 30˚c and RH was 56%. After 15 days the films are removed from the soil and cleaned under tap water and weight was recorded by using digital weighing scale.

Table 1

PLASTIC FILMS	START WEIGHT in gms	FINISH WEIGHT in gms	PERCENTAGE OF DECOPOSITION
POTATO	1.671g	0.087g	85.47%
CORN	1.671g	Completely degraded	100%
PLASTIC	1.671g	1.671g	0%

Qualitative tests for starch in potato and corn

Materials: Test tubes, test tube stand, dropper, distilled water, food stuff, slides and coverslips.

Chemicals required: Iodine solution, α-napthal, conc. H_2SO_4, Glycerine.

Table 2

Experiment	Observation	Inference
Molisch's test: Solution of substance in water + α-napthal + conc.H_2SO_4 is added along the sides of the test tube.	A violet ring is formed at the junction of the two layers.	Carbohydrate is present.
Iodine test: Freshly prepared starch + 1 to 2 drops of iodine solution.	A deep blue colour develops.	The given polysaccharide is starch.
Crush the material wash and add a drop of glycerine, place the cover glass on material observe under microscope.	Concentric, eccentric or compound grains are present.	Presence of starch is confirmed.

Test to determine the thickness of biodegradable film

The thickness of bioplastic can be determined by using Screw Gauge.

Table 3

SAMPLE	QUANTITATIVE DESCRIPTION	THICKNESS IN mm
POTATO BASED BIOPLASTIC	Green colour, hard, thin plastic film.	0.11mm
CORN BASED BIOPLASTIC	Green colour, transparent film, soft and flexible.	0.29mm

Test for pH

pH of Potato starch based biofilm is 9

pH of Corn starch based biofilm is 9

Test to determine break or blow the film

The alveograph test measures and record the force required to blow and break the film. Its values represent,

P value: the force required to blow the film. It is indicated by the maximum height of the curve and is expressed in mm

L value: it is the extensibility of the dough before the film breaks. It is indicated by the length of the curve and is expressed in mm.

P/L ratio: it is the ratio between dough strength and extensibility.

W value: it is the area under the curve. It is the combination of P value and L value.

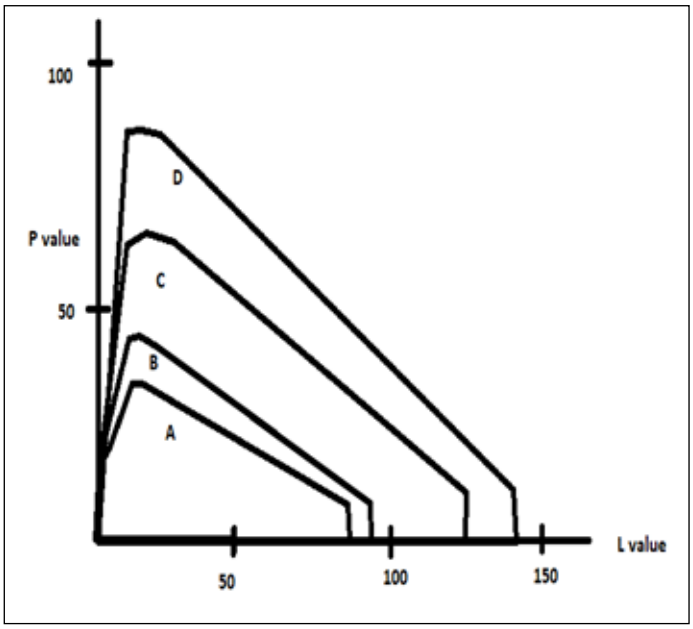

Fig 1

The points noted here are,

- A is the corn starch biofilm graph before adding xanthan gum.
- B is the potato starch biofilm graph before adding xanthan gum.
- C is the corn starch biofilm graph after adding xanthan gum.
- D is the potato starch biofilm graph after adding xanthan gum.

Table 4

	A	B	C	D
P value	36 mm	40 mm	61 mm	86 mm
L value	82 mm	94 mm	124 mm	142 mm

Results

- From the obtained data we can find that addition of xanthan gum in the starch film gives comprising and sufficient results to enhance the tensile properties of the film.
- Both A and B have shown less L value as extensibility and P value to blow the film pr make tear in it.

- After adding xanthan gum the P and L value has been increased to acceptable level to support the strength and structural efficiency of the film.
- Hence with addition of starch which is of plant source we can increase the structural properties of film which can be used as a substitute for chemically derived films.

Conclusion

The biofilms were efficiently derived from the plant sources and were found to be acceptable to be used as the alternative for the chemically derived films. But the strength factor in relation to the chemically obtained films is the area need to be given importance and innovation. As the films are food grade material they can easily replace the commercially available plastic films. The research shows that there is need of more standardization and specification in these films to make use them and production with good strength additives. The starch based films obtained are usually transparent, odourless and do not impart additional deteriorating effects to the containment in them. Due to its high solubility, degradation, hydrophilic property to moisture various procedures to overcome these properties can be approached with incorporation of additives, chemical modification in starch.

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