Formation Of Biodegradable Film from Linum Usitatissimum to Deplete the Consumption of Plastic

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ABSTRACT

Flaxseed is the nutrient rich seed abundantly found in Asia. It is also rich in polysaccharide, which present flax seed as the form of gum. The flaxseed gum is used in much food processing to provide thickening and stabilizing to the product. The guar gum is Guar gum is derived from the seeds of the drought tolerant plant Cyamopsis tetragonoloba, a member of Leguminosae family, is also used as the stabilizer and emulsifier. The biodegradable films are formed all over the world to reduce the waste of plastics and to keep the environment save. Flaxseed gum and guar concentrations are combining to form the biodegradable film in which the effect of glycerol that is a plasticizer is studied. Plasticizer has the ability to increase the plasticity and rigidity of the gum which directly affect the physical attributes of the film. We studied the concentrations of 1%, 2%, 2.5% and 3% glycerol with the ratio of 1:1 (20:20) in the film mixture. It has been noticed that 2% and 2.5% gives the best effect on the film whereas, comparing both of them, the concentration of 2% gives excellent effect on the film as increasing the concentration of the film weaken the film elasticity, and rigidity and allow more water escape from the film as the 2% concentration have best effect as the film of this concentration have less opacity, high transparency, rigid and more smooth texture of the film had been obtained.

Keywords: flaxseed, guar gum, plasticizer, film

INTRODUCTION

Right now, biodegradable plastic grabs the attention of environmentalists for the betterment of earth. Biodegradable film was initiated in 18th century. Biodegradable film can be prepared from natural polymers and synthetic also. Biodegradable plastic use for food packaging, containers for example cutlery and crockery), bag and straw. Flexibility, printability, durability, barrier to heat and transparency are the physical properties of bioplastic film (Rao et. *al*., 2010).

Flax (Linum usitatissimume) are the fiber and food crop. Flax seed are the great source of dietary fiber and omega 3 fatty acids, adding alpha-linolenic acid. Flax seed have phytoestrogens which are called ligands. They are similar to the hormone eater. Flax seeds also contain phytoestrogens called lignans, which are similar to the hormone estrogen. Fiber is found in the seed coat of flaxseed. It feels to us less hunger than other. when taken it before eating. It can also help to control cholesterol absorption from the body. Flax seeds are commonly used for diabetes, obesity, swelling of kidney in people with lupus, constipation and high cholesterol. It also used in many other situations but there is no specific evidence of their use. There are also different effects of flaxseed (Adil et. *al.*, 2020).

Flaxseed is one of the oldest crops since the starting of civilization. Flaxseed is two types one is Brown and other one is Golden they both are equally nutritious. Flax seeds contain 534 calories per 3.5 ounces (100 grams) related to 55 calories for each tablespoon (10 grams) of whole seeds. A usual ground flax seed of 1 tablespoon

contain 7 grams only 1 tablespoon of flaxseed is containing highly protein, fiber and omega 3 fatty acids. And they also contain vitamins and minerals (Tee *et. al*., 2016).

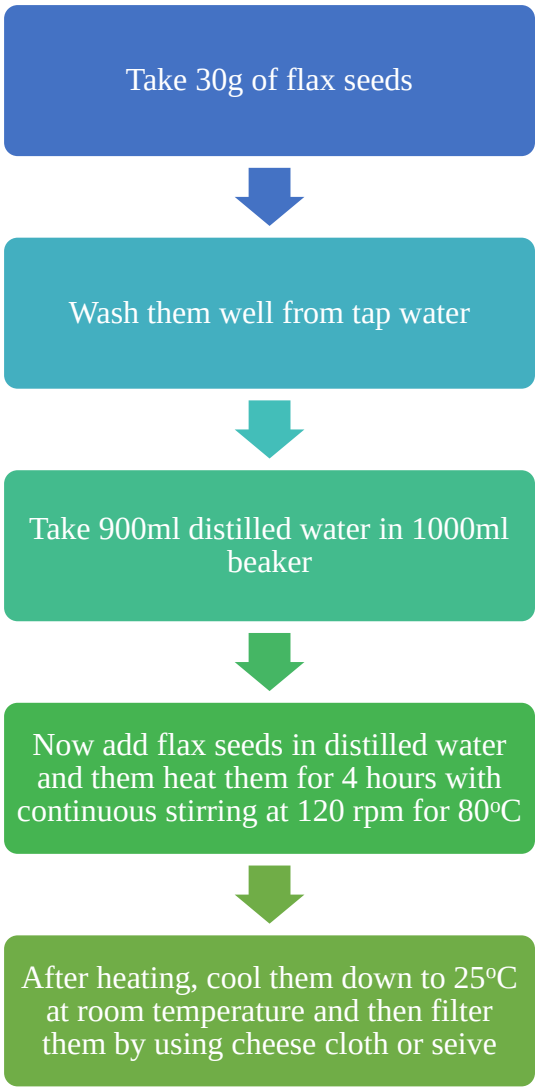
Because of interaction with the gums of flaxseed the protein is influenced by blood glucose. It also stimulates insulin secretion which results in decreasing the glycemic response. To reduce colons luminal ammonia, the relationship of flaxseed protein and soluble lignans has strong protein binding qualities. or milk protein allergies. In BCAA and Fischer ratio the flaxseed proteins and its individual fraction are high as compared to soybeans. Some of the flaxseed proteins have high ratio with BCAA and Fisher ratio as 25h per 100 g proteins and 4.7 fisher's ratio protein. They give desirable level which required in diet formulations for patients with liver like diseases. Cholesteraemic and atherogenic are determinants of the lysine/ arginine they are good protein and low in flaxseed protein. The flaxseed protein are great source of arginine, glutamine and histidine. Amino acids are good for humans' body. The content of cysteines and methionine in flaxseed enhance the body's antioxidant conditions, and reduces the threat, when DNA Stabilizing the cell division. Flaxseed help to reduce weight, fight cancer and control blood pressure as well (Tee et. al., 2017).

Guar gum is a gel-forming galactomannan derived by shattering the endosperm of Cyanosis tetragonolobuss, a leguminous plant mostly grown in India and Pakistan, and has been used in human and animal food for centuries. The outer husk (16-18 percent), the germ (43-46 percent), and the endosperm (34-40 percent) are all layers of the guar kernel. Protein makes up the majority of the germ seed, while galactomannan makes up the majority of the endosperm. Guar gum is made up of galactomannans, which are polysaccharides by a linear chain of 14-D-mannopyranosyll units and 16-D-galactopyranosyll residue as side chains. The galactose and mannose groups represent the seed endosperm of galactomannan portions (Tang *et. al.*, 2018). Next to the mannan backbone, the side groups are substituted at regular intervals. While experiments using enzymatic degradation of guar, spectroscopic methods, and computer simulations showed a more random distribution of galactose side groups. The galactosyl units in guar galactomannan are arranged in pairs and triplets at random. It has been reported that ratios of mannose to galactose units are 2:1. The ratios will be in the range of 1.6:1 to 1.8 in various studies. Different varieties of guar Galactomannans have the same galactose/mannose combination. Guar's greater branching contributes to its simpler hydration properties and hydrogen bonding activity (Arfat et al., 2016).

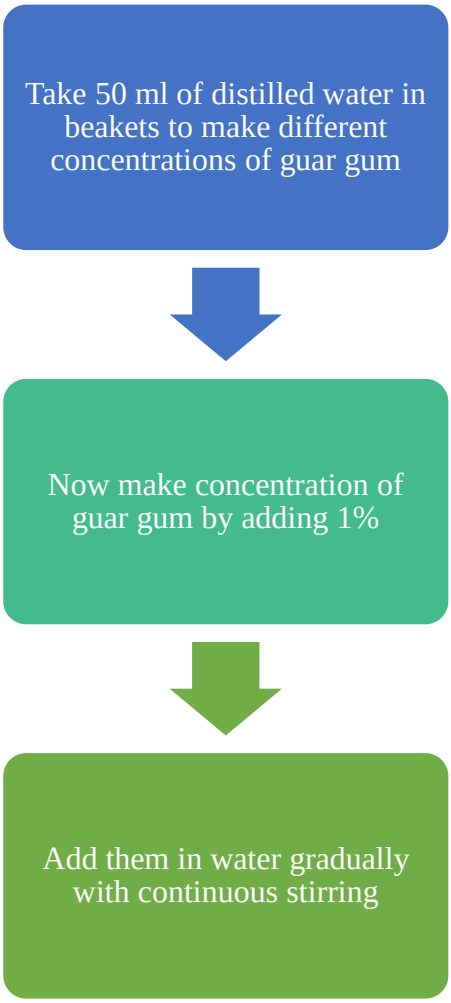
Guar gum contains moisture, protein, acid-insoluble residue, ether extractable fat, and ash, among other pollutants. The gel-forming characteristics of guar gum lower the cholesterol and glucose levels. It also helps in weight loss and prevention from obesity. Because of the gel-forming properties, soluble fiber slow stomach emptying and enhanced satiation is attained. The supplementation of guar gum in the diet may reduce appetite, hunger, and desire to eat. Guar gum's cholesterol-lowering action is due to the rise in bile acid excretion in the feces and decrease in enterohepatic bile acid, which boosts the formation of bile acids from cholesterol and lowers hepatic free cholesterol levels. The effects of hypo triacyl glycerolize are caused by a decrease in dietary lipid absorption and decreased fatty acid synthase activity in the liver. According to a dosage of 2500mg/day, the toxicity analysis is partly hydrolyzed the guar gum which is not harmful. The consumption of guar gum in sufficient amounts as dietary fiber, helps in maintaining bowel reliability, a substantial reduction in totality & LDL cholesterol, diabetic control, increase mineral absorption, as well as the prevention of digestive disorders such as constipation (Mudgil, 2014).

MATERIAL AND METHODS

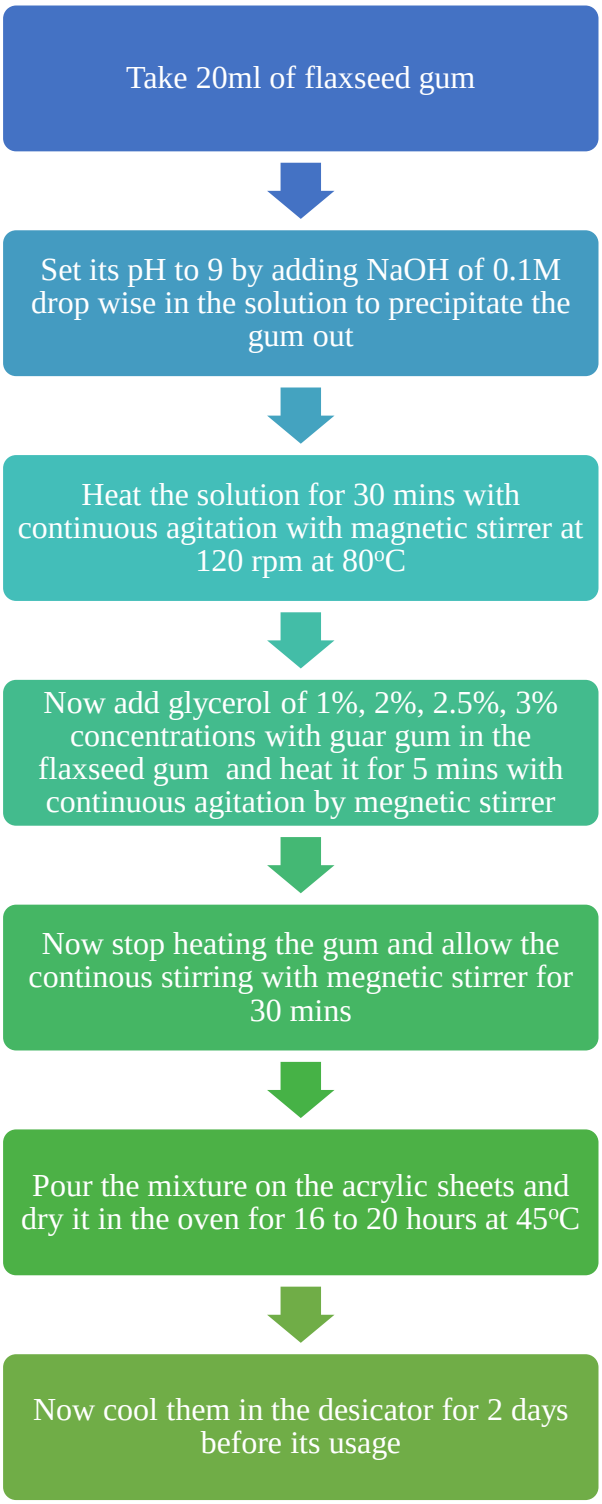
Flaxseed Gum Extraction Method



Guar Gum Formation Method



Film Formation Method



First Phase: Collection and initial testing of Raw materials

The research will be conducted at Jinnah University for Women in the department ofFood Science and Technology. Flaxseed and guar gum will be purchased from the local market.

Second Phase: Analysis of Raw material

The proximate analysis of the product will be carried out.

Moisture content:

The moisture content will be determined in an oven through drying method (at 105°C) according to the procedure described inAACC (2000) Method No. 44-15A.

Total Ash content:

The ash content will be determined in a muffle furnace that is based onAOAC method tagged as 942.05.

Protein content:

The protein content will be determined by Kjeldahl method (N _6.25 for nitrogen to protein conversion) tagged as AOAC 979.09.

Antioxidant analysis:

DPPH free radical method was determined according to the method previously reported by Brand-Williams et al. (1995) based on application of DPPH decolorization assay (Sigma-Aldrich, Steinheim, Germany)

Total flavonoid content

The aluminum chloride colorimetric method was used for the determination of the total flavonoid content of the sample.

Total Phenolic Content:

The content of total phenolic compounds (TPC) was determined by theFolin–Ciocalteu method, which is based on colorimetric oxidation/reduction reaction of phenols (Blainski et al., 2013).

Physical characteristics of flaxseed:

Physical characteristics, such as length, width, thickness, thousand kernel weight, bulk density, tapped density, true density, angle of repose, Carr's index, Hausner's ratio and porosity of the flaxseed were determined using the AOAC Method

Third phase: Testing of the film

Thickness Determination of the Film:

The thickness of the casted mass was measured using a digital micrometer (0.01 mm sensitivity) by placing it randomly among five positions across the film, and the mean value was calculated for each sample.

Tear test:

Tear test was performed to note the strength.

Solubility test:

The solubility index was measured with water and acid solubility of the films through slight amendment in the existing setup, as suggested by Zhang et al.

Sealing test:

In order to determine seal strength, the samples were cut into 2.54 cm × 5.00 cm strips. Later, two strips were joined together and sealed by an impulse heat sealer at a temperature of 110 ± 10 °C and a sealing time of 1–2 s. The unsealed ends of the strips were attached between the two jaws of the texture analyzer, where the distance between the jaws was set 5 cm apart and the crosshead speed was 2 mms^{-1}. The tests were repeated

with other film samples.

RESULTS AND DISCUSSION

The sample has been prepared of the concentration of 1:1 of guar gum and flax seed whereas the concentration effect of the glycerol has been changed i.e.: 1%, 2%, 2.5% and 3%. In which the best result is given by 2% and 2.5% as increasing the concentration of glycerol is decreasing the plasticizing effect in the film.

1:1 (2% glycerol): more firm, smooth glossy texture, without any moisture. Strong, hard, rigid film is formed.

1:1 (2.5% glycerol): moist, less rigid, weak films are formed.

As in ratio 1:1 with 1% glycerol, no film had been formed where as in 1:1 with 3% glycerol is observed that there are some visible coarse particles is present in the film due some suspended particles of the film.

For the formation of biodegradable film, raw materials used were flaxseeds, guar gum and glycerol. The purpose of using flaxseeds for film production was it naturally has mucilage present in it which was extracted by mixing and heating continuously for a few hours until the mucilage completely extracted and uniformly dissolved in water. The natural pH of flax mucilage is in between 6-8 which is slightly acidic and not suitable as basic pH required for the film production up to 9-10. For that 0.1M NaOH solution was added drop wise until desirable pH obtained. the reason behind adding NaOH into the flax mucilage was to precipitate it as if not it might cause hurdles during film formation. After precipitating the mucilage with NaOH, glycerol solutions were added of different concentrations of 1%, 2%, 2.5% and 3% in already prepared mixture of flax mucilage and guar gum of ratio of 1:1. According to the results obtained, the best films were formed at the concentration of 2% glycerol solution with firm, smooth, glossy texture without any moisture with better resistance capabilities as compared to film formed at concentration 2.5% glycerol solution which was moist, weak and low resistance capabilities. On the other hand, films with concentration 1% and 3% glycerol solutions were not formed as some coarse and suspended particles was observed in the film with no proper structure desirable for a film. On film formed with concentration 2% glycerol solution, some tests were applied to check how the film was doing and capable against the environment.

Thickness Determination of the Film

Film with concentration of 2% glycerol solution was less thick than the film with concentration 2.5% glycerol solution with the thickness of 0.13 and 0.28 respectively.

Tear Test/Biodegradability of Film

Film with concentration of 2% glycerol solution was rigid and hard to tear than the film with concentration 2.5% glycerol solution which can easily tear.

Drip Test/Burn Test

According to the results, both the films of concentrations 2% and 2.5% glycerol solutions are considered as thermosets as they both char and burn completely.

Solubility Test

After dipping them both the films of concentrations 2% and 2.5% glycerol solutions for 24 hours, they were neither dissolved in water nor any organic solvents including acetone, ethanol and toluene.

Sealing Ability of Film

Film with concentration of 2% glycerol solution required less time to seal as compared to the film with concentration 2.5% glycerol solution i.e. 3 seconds and 5 seconds respectively.

CONCLUSION

The immense usage of plastic escalates the land and sea pollution foster the development of biodegradable plastic to abate the utilization of normal plastic use in food packaging i.e. confectionery item wrappers and baked product wrappers. We produced the biodegradable plastic from flaxseed gum combining with the guar gum and plasticizers of different concentrations 1%, 2%, 2.5% and 3% added in the trails to study the effect of plasticizers on the strength of biodegradable plastic. Glycerol is used as biodegradable plasticizer.

The result concluded that the trial with 2% concentration of glycerol provide excellent effect on the elasticity and firmness of film and it also allow more transparency which make the inside food items. According to UNDP (United Nations development Programme) in 2021 Pakistan alone produced 3.3 million tons' plastic waste which might be serious issue. To subside this issue vast amount of food industries day by day moving towards biodegradable plastic.

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