Physicochemical and rheological characterization of Cissus populnea gum extracted by different solvents

Olutayo A. Adeleye[1], Mbang N. Femi-Oyewo[1], Michael A. Odeniyi[2]

[1]Department of pharmaceutics and pharmaceutical technology, Olabisi Onabanjo University, Sagamu campus, Ogun State, Nigeria.

[2]Department of pharmaceutics and industrial pharmacy, University of Ibadan, Ibadan, Oyo State, Nigeria.

Corresponding Author: Olutayo Adeleye
Email: olutayoadeleye@yahoo.com Phone: +2348033784449

ABSTRACT

Background: The use of synthetic excipients has been associated with mucosal irritation and high cost; hence the use of natural excipients and their semi synthetic derivatives in drug delivery continues to be an area of active research.

Objectives: To determine the effect of extraction solvents on the physicochemical and rheological properties of Cissus gum and its suitability as a pharmaceutical excipient.

Material and Methods: Cissus gum was obtained from incised stem of Cissus populnea Guill and Perr. Gum samples extracted with acetone (CA) and water (CW) were analyzed. Phytochemical screening, elemental, particle shape and size analysis, X-ray powder diffraction (XPRD), density measurements, moisture content and sorption capacity, swelling index, rheological and flow properties were used to characterize the gums.

Results: Both extracts had pleasant odor. The yield for both extracts of the gum was high, with the water extract being significantly higher. The swelling index, moisture content and moisture sorption capacity of the gum was high. The viscosity of the two extracts of Cissus gum increased with increase in concentration at room temperature.

Conclusion: Both extracts of Cissus gum possessed fundamental characteristics that would make them suitable as pharmaceutical excipients in the formulation of solid, semi-solid and liquid dosage forms and also in sustained release formulations.

Key words: Cissus populnea gum, pharmaceutical excipient, extraction, acetone extract, water extract

La caractérisation physicochimique et rhéologique de la gomme de Cissus Populnea gum extraites par des plusieurs solvants

Auteur correspondant: Olutayo Adeleye
Email: olutayoadeleye@yahoo.com Téléphone: +2348033784449

RESUME

Contexte: L'usage des excipients synthétiques a été associé avec l'irritation des muqueuses et les prix élevés; d'où l'usage d'excipients naturels et leurs dérivés semi-synthétiques dans la livraison de produits pharmaceutique continue d'être un domaine de recherche active.

Objectifs: Pour déterminer l'effet des solvants d'extraction sur les propriétés physicochimiques et rhéologiques de la gomme de Cissus et sa pertinence en tant qu'excipient pharmaceutique.

Matériel and Méthodes: La gomme de Cissus a été obtenue à partir de la tige incisée du Cissus populnea Guill et Perr. Des échantillons de gomme extraits avec l'acétone (CA) et l'eau (CW) ont été analysés. Le test phytochimique, élémentaire, l'analyse de la forme et la taille de la particule, la diffraction de poudres radioscopiques (XPRD), les mesures de densité, le contenu en humidité et la capacité de sorption, l'indice de gonflement, les propriétés rhéologiques et d'écoulement ont été utilisés pour caractériser les gommes.

Résultats: Les extraits avaient une odeur agréable. Le rendement des deux extraits de la gomme était élevé, avec l'extrait d'eau étant considérablement plus élevé. L'indice de gonflement, le contenu d'humidité et la capacité de sorption de l'humidité étaient élevés. La viscosité des deux extraits de la gomme de Cissus a augmenté avec l'augmentation dans concentration à température ambiante.

Conclusion: Les deux extraits de la gomme de Cissus possédaient des caractéristiques fondamentales qui pourraient les rendre adéquats en tant qu'excipients pharmaceutiques dans la formulation de formes de dosage solide, semi-solide et liquide et aussi dans des formulations à libération prolongée.

Mots-clés: Gomme de Cissus populnea, excipient pharmaceutique, extraction, extrait d'acétone, extrait d'eau

INTRODUCTION

Pharmaceutical excipients are components other than the active pharmaceutical ingredient(s) which have been appropriately evaluated for safety and intentionally added to the formulation of a dosage form in order to achieve certain desired characteristics which make the dosage form suitable for administration to the patients. [1]

Excipients play a wide variety of functional roles which are crucial in the design of drug delivery systems, determining its quality and performance.

Pharmaceutical excipients control the physicochemical properties as well as release profiles and availability of drugs from their formulated products. [2] They must be non-toxic, free of any unacceptable microbial load and must be compatible with active pharmaceutical ingredients. [3]

Research into plant based pharmaceutical excipients is on the increase since plant products have been found to serve as an alternative to synthetic products because of its biocompatibility, non-toxicity, biodegradability, environmental-friendly nature and low prices compared to synthetic products. [1, 4]

Natural gums have been employed as disintegrants, [5] emulsifying agents, [6] suspending agents, [7] binders [8] and sustained release formulations. [9] Excipient characterization is a pre-formulation study which is an essential step in establishing its suitability in dosage form design. It is a quantitative analysis which gives an insight into excipient behavior and the key to successful formulation and processing is identifying and controlling the parameters that define performance for any given application. Such parameters include optimization of flowability and compressibility. Some of the parameters usually characterized include particle packing, particle size, particles shape and surface area, density, porosity, flowabilty and compressibility.

Cissus populnea Guill and Perr is a tropical plant belonging to the family Vitaceae. The plant is a tall woody climber of up to eight meters high, it is semicircular and grows mainly in tropical regions of Africa, Asia, Australia, Central and South America, and North Mexico. [10] It has a natural tendency of retaining water, thus it remains fresh almost throughout the season. It is gel forming and the gum is hydrocolloid and forms mucilage.

Cissus populnea is associated with a myriad of medicinal uses in different parts of the world. Its extracts have been credited with antibacterial properties, [11] as an antitrypanosomal plant and a source of gum powder [12] and as a component of an herbal anti-sickling Nigerian formula. [13] In Benin Republic, it is used for its diuretic properties [14] while in Ghana it is used as a post-harvest ethnobotanical protectant. [15] In the western part of Nigeria it is used to improve genital erection in male and to improve spermatogenesis. [10]

Some drug formulation studies have been done on this plant by some researchers in Nigeria. Ibrahim *et al.* [16] investigated the mucilage obtained as a pharmaceutical expicient in tablet formulation. Abioye *et al.* [17, 18, 19] studied the emulsifying properties of *Cissus populnea* gum, *invitro* release kinetics of salicylic acid from *Cissus populnea* gel and the stability effects of *Cissus populnea* gum in Oil-in-water extemporaneous emulsions while Adeleye *et al.* [20] evaluated the binding property of the gum in paracetamol tablet. However, there exists little or no information on the physicochemical characteristics of *Cissus populnea* gum. This study is aimed at determining the physicochemical properties of the gum and its potential as a polymeric excipient in pharmaceutical formulations.

MATERIALS AND METHODS Materials

The materials used in the investigation were Cissus gum extracted in Pharmaceutics Laboratory, University of Ibadan, Nigeria. All other solvents and chemicals used were of analytical-reagent grade.

Procedure Extraction of Cissus gum

Fresh stems of *Cissus populnea* were collected from a wild forest in Eruwa, Oyo State of Nigeria in the month of August and authenticated with voucher specimen no. FHI: 10878 at the Forest Research Institute of Nigeria, Ibadan, Nigeria. The stem was subjected to two different methods of extraction to obtain the gum.

Preparation of Acetone-extracted Cissus gum

The gum was extracted by weighing 1kg of sliced stem of *Cissus polpunea* and soaking it in 2 liters of distilled water for 24 hours, followed by filtration of the viscous solution with muslin bag and precipitation of the extracted gum with acetone at a ratio of 2:1 of acetone to viscous solution of *Cissus polpunea*. The precipitate was dried at 50^{o}C for 24 hours and pulverized in an Osterizer blender, (Model 857 Williamette Industries, Bowing Green Kentucky USA) to produce gum powder. The powder obtained was stored in an airtight bottle.

Preparation of Water-extracted Cissus gum

The gum was extracted by weighing 1kg of sliced stem of *Cissus polpunea* and soaking it in 2 liters of distilled water for 24 hours, followed by filtration of the viscous solution with muslin bag. The filtered viscous solution was dried at 80^oC for 24 hours and pulverized in an Osterizer blender, (Model 857 Williamette Industries, Bowing Green Kentucky USA) to produce gum powder. The powder obtained was stored in an airtight bottle.

Phytochemical screening of Cissus gum

Phytochemical screening tests were performed on the Cissus gum to determine the presence or absence of starch, sugar, saponin and some other secondary metabolites such as alkaloids, glycosides, tannins, quinines etc., according to the methods described by Trease and Evans.[21]

Physicochemical Properties of the Cissus gum

Moisture content

The moisture content of the Cissus gum was determined by weighing accurately 5 g each of the Cissus gum in a tarred evaporated dish on a mettler AB54 Electronic balance (Mettler, A.G., Switzerland). This was then dried in a Gallenkamp size two oven BS at 105 ^oC for 5 hours and the final weight noted.[22] The percentage weight loss was calculated Equation (1). Percentage moisture content = Weight of moisture/ Weight of sample x 100% [1]

Determinations were made in triplicate and the mean taken.

Moisture sorption capacity of Cissus gum extract

Two (2) g of Cissus gum powder was weighed and evenly distributed over the surface of a 70 mm tarred petri dish and placed in a large desiccator containing distilled water in its reservoir (RH = 100%). The desiccator was stored at room temperature at various time intervals over a period of five days. The weight gained by the exposed sample was recorded and the amount of water sorbed was calculated from the weight difference.[23]

Viscosity of gum

Aqueous dispersion containing different concentrations (1% $^w/_v$, 2% $^w/_v$, 3% $^w/_v$, 4% $^w/_v$ and 5% $^w/_v$) of Cissus gum were made to hydrate for 2 hours.[22] The viscosities were determined at room temperature using a Brookfield viscometer (Model - DV - 11 + Pro, Brookfield Eng. Labs Inc., MidddleBoro, MA, USA)

Swelling Capacity

The swelling capacity was determined by weighing accurately 1g each of the Cissus gum powder separately into a 25-ml glass-stoppered graduated measuring cylinder and the volume occupied, V_o, was noted. About 20ml of distilled water was added and the cylinder closed. This was shaken vigorously every 10 minutes for 1 hour and then allowed to stand for 6 hours at room temperature.[24] The volume, V , occupied by the sample $_s$ including any adhering mucilage was noted and the swelling capacity was calculated using Equation (2). The test was performed in triplicate and the mean taken. Swelling capacity = Vs / V_o x 100 [2]

Particle size and size distribution

The particle size distribution of the Cissus gum was determined by sieve analysis using standard sieves arranged in descending order of aperture sizes in the following order; 1.0mm, 0.710mm, 0.500mm, 0.355m, 0.250mm and the collection pan (receiver).

A 20g each of acetone extract and water extract of Cissus gum were separately poured on the uppermost sieve and the cover was placed firmly in position and the stack of sieves shaken electrically on a sieve shaker for about 15 minutes. The weight of material retained on each sieve (oversize) was determined.

Bulk and tap densities

The bulk and tapped density of each of the Cissus gum was determined by modified method of Oyi *et al*.[2] Twenty five (25) gram of each of the Cissus gum was weighed gradually poured at an angle of 45^0 through a funnel into a 100ml graduated glass measuring cylinder and the volume V, occupied by each of the gum without tapping was noted. The unsettled apparent volume was determined from the height (h) of the powder bed and the internal radius, r, of the cylinder using Equation (3). V = r^2h [3]

The bulk density was calculated using the following Equation: P = m/v [4]

Where m is the weight of sample in the cylinder in grams and v is the bulk volume (cm^3). This was carried out in triplicate and the final bulk density was the mean determination of the three values.

Tapped density was determined by manually tapping 25 g of Cissus gum in a graduated measuring cylinder on a wooden surface at height of 7 inches until no further change in volume was observed.

Particle density

The particle densities of the Cissus gum were determined by the pycnometer method using liquid immersion technique with xylene as the displacement liquid.[25] A 50ml pycnometer bottle was weighed when empty (W) with the stopper. This was filled with xylene to the brim till it overflows and excess was wiped off, and the weight with the stopper was noted as (W_1). The difference between this weight and the first was recorded as (W_2). A 2 g quantity of the Cissus gum was weighed (W_3) and quantitatively transferred into the pycnometer bottle and filled with the solvent to the brim. The excess solvent was wiped off and the bottle weighed again with the stopper (W_4). The particle density, P , was calculated from the following Equation:

$_tP = W_{t\,2}.W_3/50\ (W_3 - W_4 + W_2 + W)$ [5]

Angle of repose

The angle of repose was determined by using the method adapted by Iwuagwu and Onyekwelli.[26] The cissus gum powders were allowed to fall freely through a funnel onto a plain white sheet of paper, placed on a flat surface until the apex of the cone formed by the powder just touched the tip of the funnel clamped to a retort stand with its tip 2 cm above the paper. The diameter of the base of the power cone was obtained and the angle of repose was calculated using the following Equation:

$\tan \theta = h / r$ [6]

where h is the height of the heap of powder, r is the radius of the cone and θ is the angle made by the heap with the base.

Hausner's ratio and Carr's Index

The Hausner's ratio was calculated as the ratio of tapped density to the bulk density (Equation 7).

Hausner ratio = Tapped density/ Bulk density [7]

The compressibility index of the gum was determined according to the Carr's compressibility index percentage (Equation 8).

Carr's Index = Tapped density - Bulk density / Tapped density X 100 [8]

Elemental analyses of Cissus gum

X-ray fluorescence analysis of the elemental constituent was done by introducing 500mg each of the Cissus gum into the Link Analytical XR300 (Wallis Worthing, Europe) instrument according to University of Ibadan Central Laboratory protocol. The results of the elemental constituents were displayed on the screen.

X-ray powder diffraction

Each gum sample (1.2 g) was tightly packed in a sample holder with path length of 10 mm attached to the powder diffractometer (*XPERT-PRO PW3064/60*, Stoe and Cie GmbH, Darmstadt, Germany). The diffractometer goniometer, pre-set at 40 kV and 30 mA was started at a 2ϑ (Bragg angle) of 5.0042°. The gum powders were exposed to a spinning beam of the powder diffractometer for a step-time period of 6.35s until the 2ϑ end position of approximately 100° was reached. The pattern was recorded with a copper anode X-ray tube (Cu $K_{\alpha 1}$ and K_β radiation). Plots of intensity against 2ϑ were recorded as the scanning progressed.

Microscopy

The gums were spread over a glass slide placed under a light microscope (Model BH – 2, Olympus Optical Co.). Micrographs of the shapes of the gums were taken.

RESULTS

The physicochemical properties of acetone and water extract of *Cissus populnea* gum are presented in Table 1. The percentage gum yield of water extract was 68.20%w/w while the percentage gum yield of acetone extract is 35.50 %w/w. The colour of the gum ranges between brown and dark brown. The mean particle diameter of both gums is the same. The angles of repose of both extracts were above 50 . Both extract of Cissus ° gum had Carr's index above 21% and Hausner's ratio values above 1.25. Water extract of the gum had more moisture content (10.73%w/w) than the acetone extract (9.72%w/w). The water extract also had higher moisture sorption capacity (54.6%w/w) than the acetone extract (42.0%w/w) ($p<0.05$).

The particle size distribution of Cissus gum obtained by sieve analysis is presented in Figure 1 as the plots of cumulative weight (%) oversize versus sieve size.

Table 1: Physicochemical properties of acetone and water extract of Cissus gum (mean ± sd, n = 3)

Properties	CA	CW
Gum yield (%)	35.50	68.20
Colour	Brown	Dark-brown
Odour	Pleasant	Pleasant
Mean particle diameter (μm)	430	430
Moisture content (%w/w)	9.72± 0.03	10.73± 0.01
Moisture sorption capacity (%w/w)	42.0± 0.04	54.6± 0.07
Angle of repose (^{0})	59.20± 0.73	56.78± 0.51
Bulk density (g/cm ^{3})	0.3647± 0.02	0.3220± 0.14
Tapped density (g/cm ^{3})	0.5110± 0.40	0.4987± 0.32
Particle density (g/cm ^{3})	1.910± 0.33	2.096± 0.21
Hausner's ratio	1.4012	1.5488
% compressibility	28.63	34.43

CA, acetone extract of cissus gum, CW, water extract of cissus gum

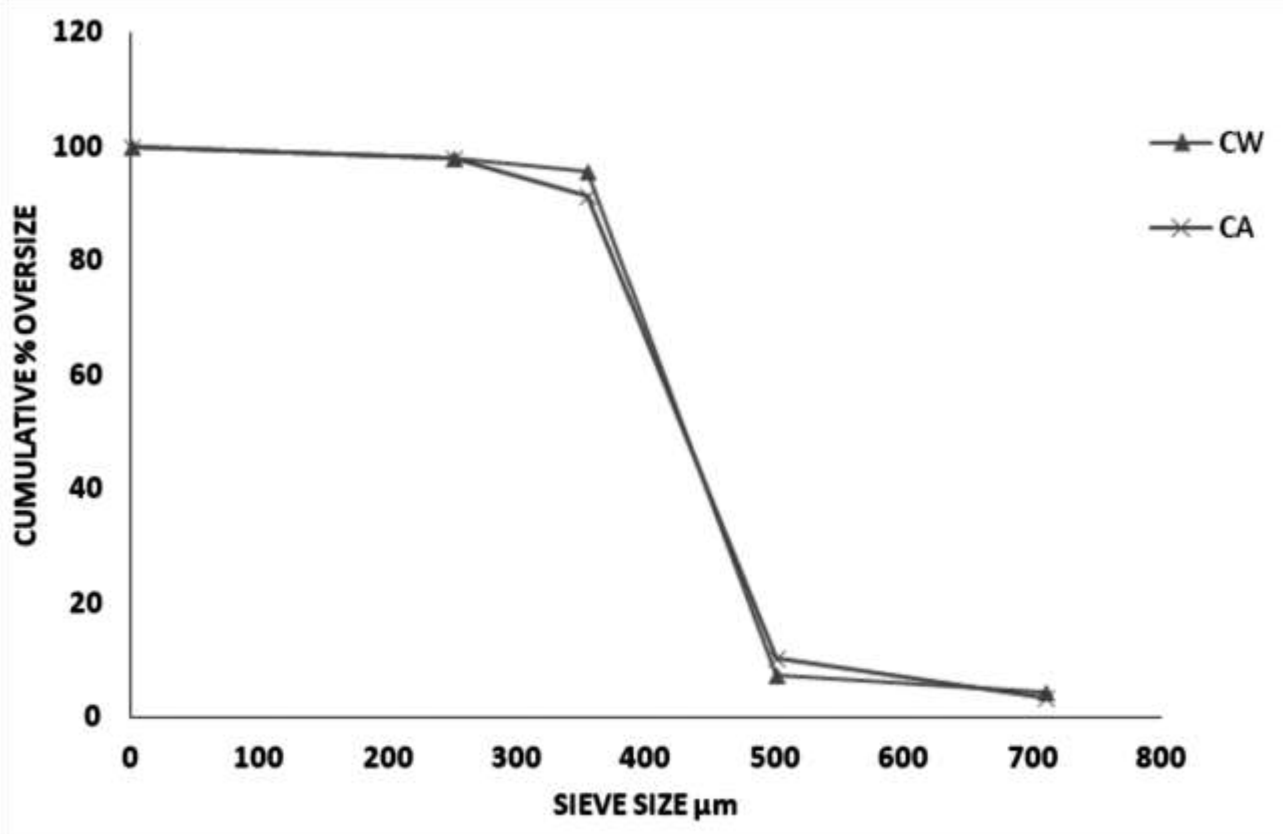


Figure 1: Particle size distribution of Cissus gum

The phytochemical screening of the gums presented in Table 2 revealed little difference in the constituents of both extract but the water extract had more percentage of elements as presented in Table 3.

Table 2: Phytochemical screening of Cissus gum extracts

Phytochemicals	CA	CW
Reducing sugar	-	-
Anthraquinone	-	-
Saponins	+	+
Cardiac glycosides	+	++
Alkaloids	+	++
Tannins	-	+
Starch	-	-
Mucilage	+	+

+ indicates presence, while – indicates absence of substance
C A, acetone extract of cissus gum, CW, water extract of cissus gum

Table 3: Elemental constituents of *Cissus gum*

	% Element	
Elements	**CA**	**CW**

Aluminum		
	-	-
Arsenic	-	
	0.06	0.21
Bromine	0.76	
Calcium	36.42	0.85
	6.02	
Carbon	0.28	53.04
Hydrogen	-	9.58
Iron	-	0.47
Lead		-
Magnesium	0.76	-
Manganese	0.05	0.85
	-	
Mercury	0.98	0.47
Nickel	47.16	-
Nitrogen	0.12	0.73
Oxygen	5.32	45.31
Phosphorus		0.49
Potassium		5.35
Selenium Silicon 0.78		-
Sodium	0.09	0.82
Titanium		0.10
Zinc		-
0.32		0.59

CA, acetone extract of Cissus gum, CW, water extract of Cissus gum

The X-ray powder diffraction spectral of both extract of Cissus gum is shown in Figure 2 while Figures 3 and 4 show the micrographs of water extract and acetone extract of the gum respectively.

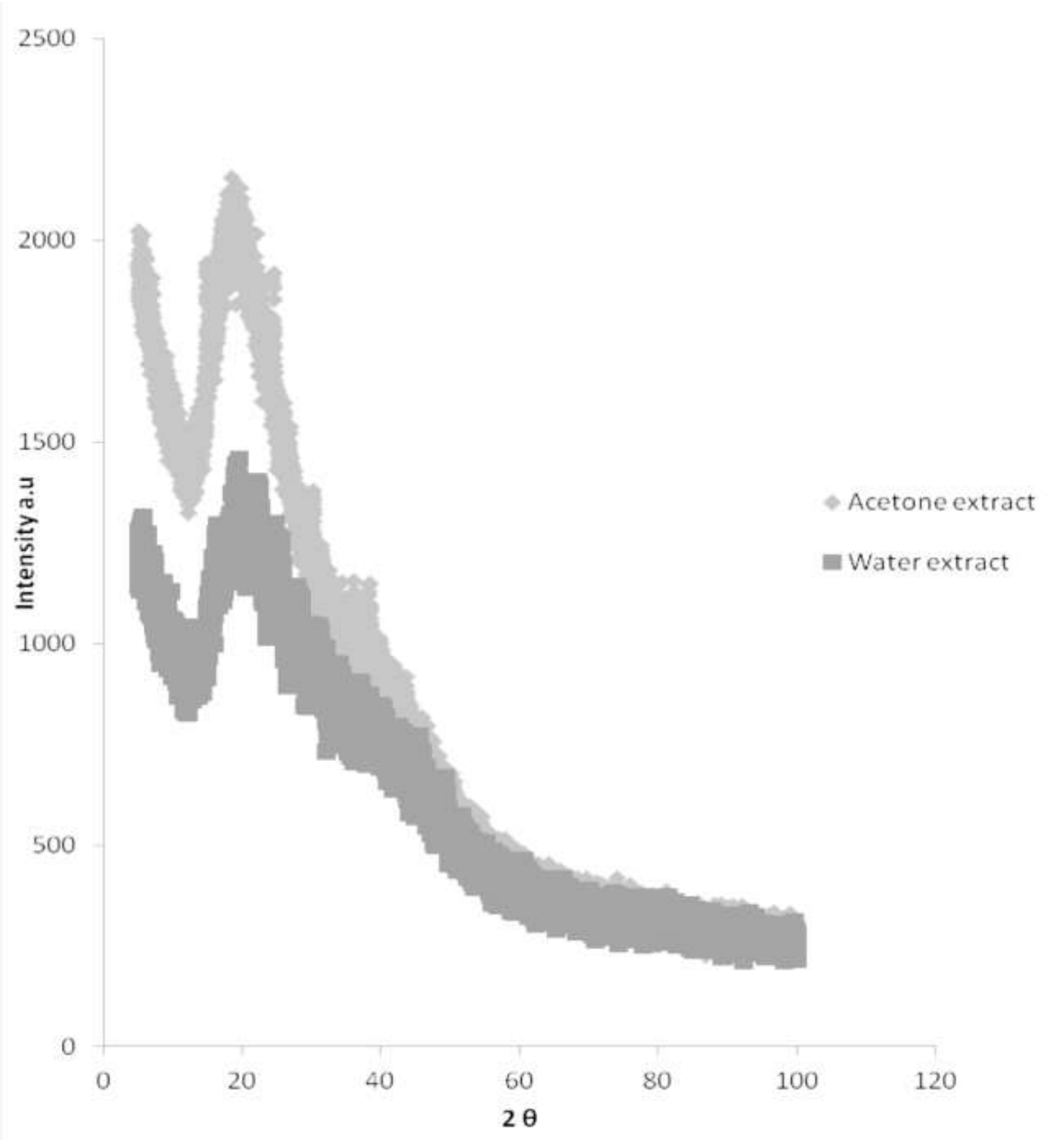

2500
2000
1500
1000
500
0
Intensity a.u
0
20
40
60
80
100
120
2 θ
Acetone extract
Water extract

Figure 2: X-ray power diffraction spectrum of acetone and water extracted Cissus gum

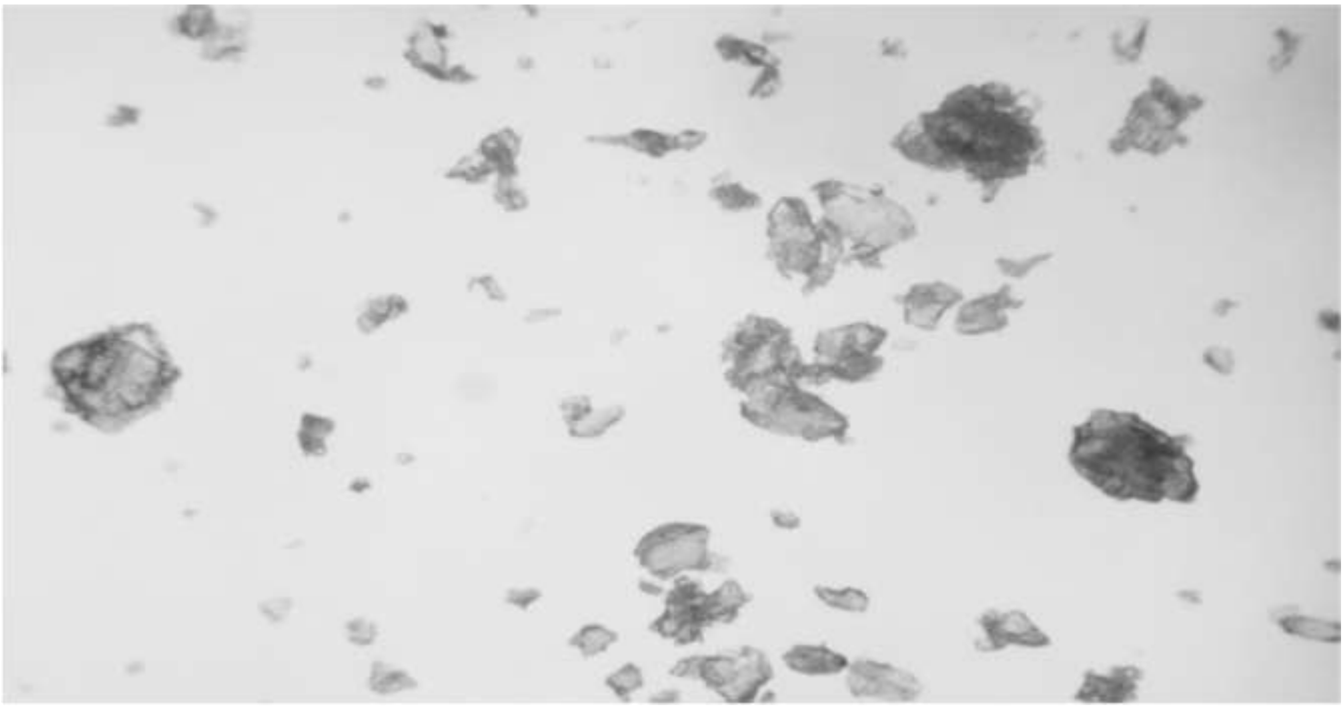


Figure 3: Micrograph of water extract of Cissus gum

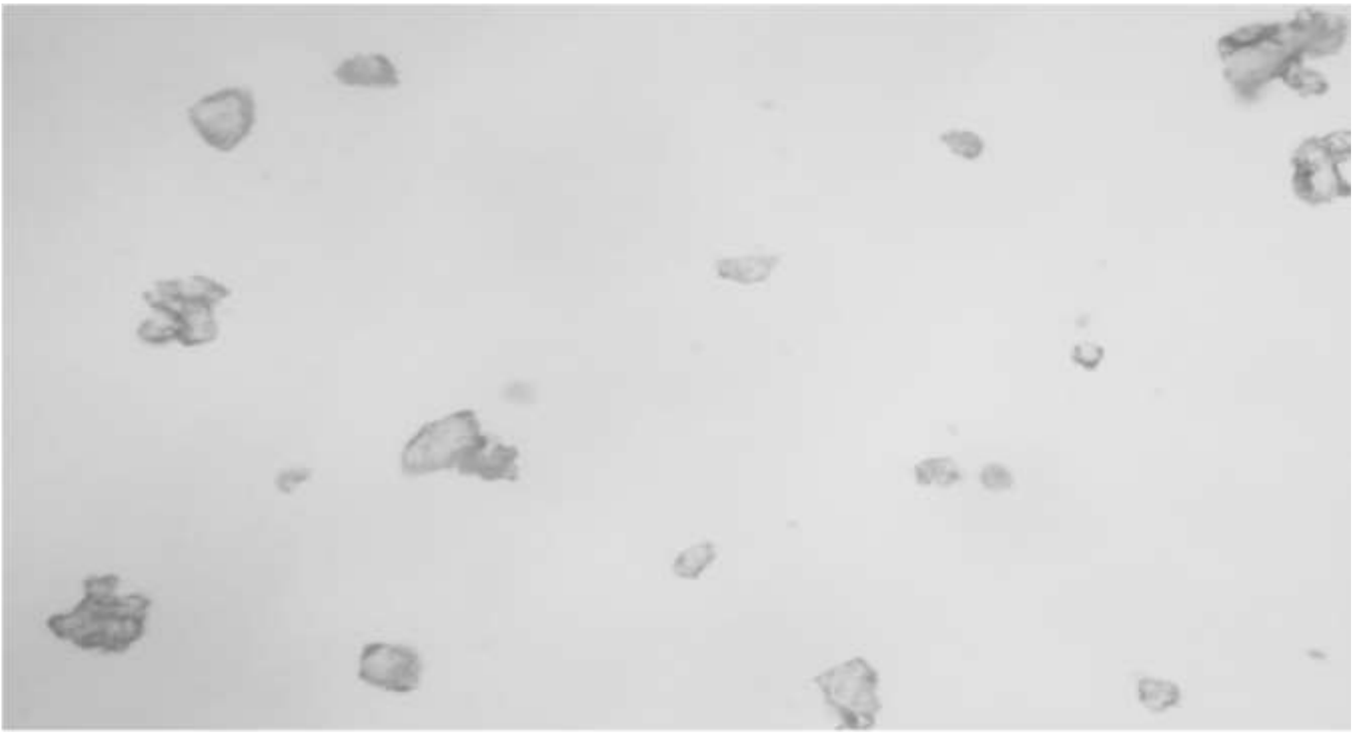


Figure 4: Micrograph of acetone extract of Cissus gum

Swelling rate increased with time for both extract as presented in Table 4 and the viscosity of the two extracts of Cissus gum increased with increase in concentration at room temperature as shown in Table 5 and in Figures 5 and 6.

Table 4: Swelling index (%) of Cissus gum at different time intervals (mean ± sd, n = 3)

Gum/hours	1	2	3	4	5	6	8	24
CA	310± 0.02	333± 0.05	353± 0.03	369± 0.00	383± 0.02	396± 0.01	404± 0.06	408± 0.01
CW	298± 0.03	319± 0.01	331± 0.01	340± 0.04	349± 0.02	355± 0.03	359± 0.02	361± 0.01

Table 5: Viscosity of the Cissus gum after different times of storage and shear speed

		50rpm		100rpm	
0hr	1%	0.0	0.0	0.0	0.0
	2%	20.0	0.0	20.0	10.0
	3%	240.0	40.0	170.0	50.0
	4%	360.0	160.0	280.0	130.0
	5%	380.0	140.0	270.0	100.0
24hrs	1%	20.0	10.0	10.0	0.0
	2%	160.0	40.0	110.0	30.0
	3%	620.0	260.0	410.0	200.0
	4%	1,500.0	700.0	950.0	510.0
	5%	1,860.0	1,240.0	1080.0	930.0
48hrs	1%	60.0	20.0	40.0	10.0
	2%	260.0	120.0	1 90.0	90.0
	3%	800.0	540.0	540.0	380.0
	4%	1,560.0	1,000.0	990.0	580.0
	5%	2,440.0	1,560.0	1,560.0	1,080.0
72hrs	1%	80.0	40.0	60.0	30.0
	2%	300.0	160.0	220.0	140.0
	3%	840.0	560.0	580.0	420.0

Hrs/Conc	CA (cP)	CW (cP)	CA (cP)	CW (cP)
4%	1,720.0	1,140.0	1,020.0	650.0
5%	2,640.0	1,780.0	1,600.0	1,220.0

Figure 5: Effect of concentration on the viscosity profile of the Cissus gum at 0hr

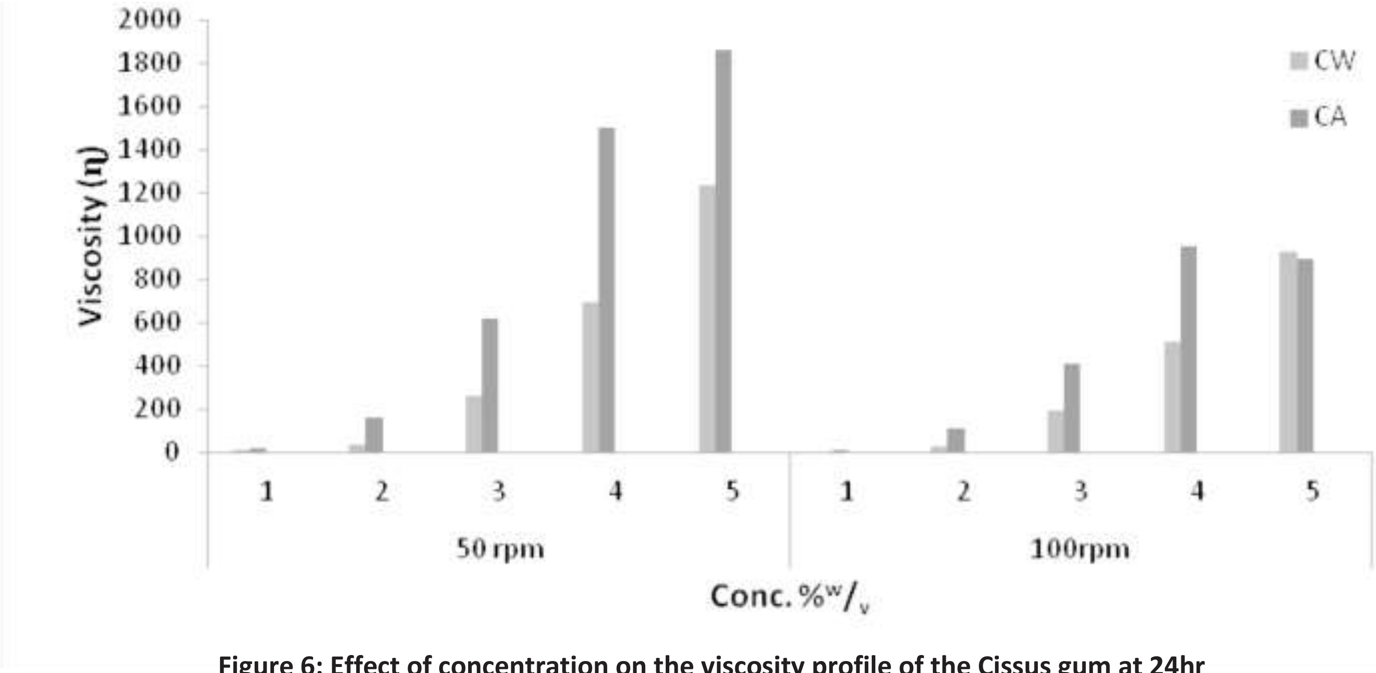
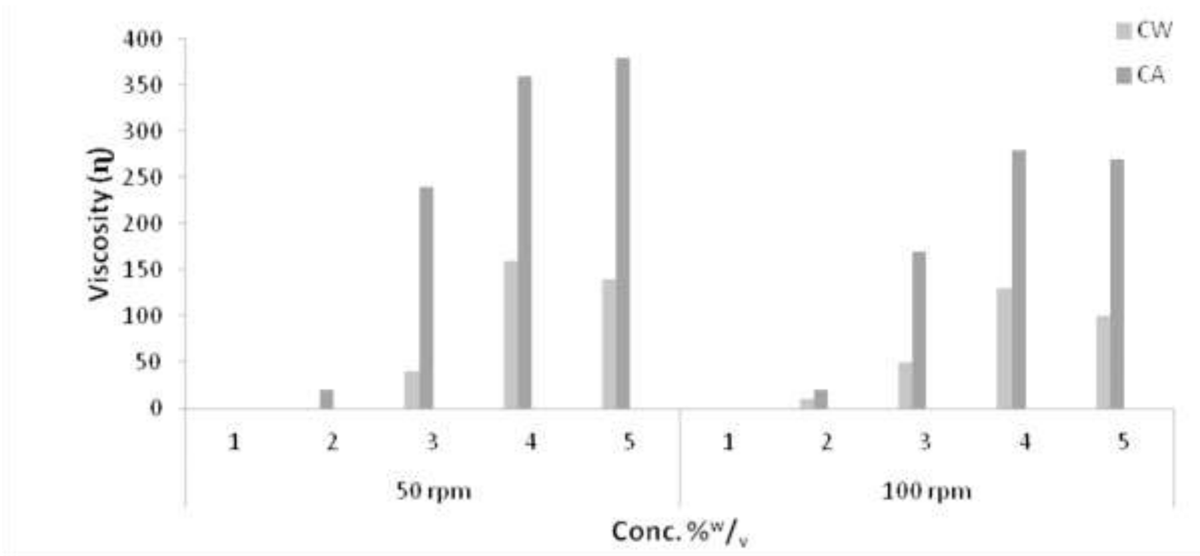


Figure 6: Effect of concentration on the viscosity profile of the Cissus gum at 24hr



DISCUSSION

This study is specific for the gum extract of *Cissus polpunea* and also limited to the water and acetone extract. The yield for both gums is considered high enough for natural products [21] and thus desirable for use as an excipient in pharmaceutical industries. However, the gum yield was found to be significantly higher using water than acetone. This makes the process of extraction to be cheaper using water rather than the more expensive acetone. Similar studies could be conducted in the extraction of other natural polymers in order to reduce cost and possibly increase yield.

The viscous solution obtained from the incised stem of *Cissus polpunea* is colourless while after precipitation and drying, both extract of the gum had a colour ranging from brown to dark brown. The phytochemical screening revealed little difference in the constituents of both extract. This indicates that the solvent used in the extraction processes has no effect on constituents. Both the water and acetone extracts contained saponins, alkaloids, mucilage and cardiac glycosides.

Both extracts did not give blue-black to iodine indicating absence of starch. They are devoid of anthraquinones and reducing sugars. Tannin is present in water extract of Cissus gum and absent in acetone extract of the gum. Acetone extract has less secondary metabolites making it purer than the aqueous extract. Generally, the percentage of elements contained in the water extract was higher than acetone extract. This is an indication that water extract contained more constituents. According to USP, 2006,[27] there is a limit on the amount of lead and other heavy metals that may be present in pharmaceutical product. The presence of these metals in formulations can lead to the formation of stable covalent or co-ordinate complexes with body protein and can also act as a catalyst to induce autooxidative reactions. Heavy metals such as lead, arsenic and nickel were absent, as presence of these metals and aluminum in pharmaceutical raw materials would be undesirable because they are hazardous to health.[28] The X-ray powder diffraction spectral of both water and acetone extracts of Cissus gum shows a single broad peak without any other characteristic peaks which indicates that Cissus gum is amorphous in nature. The micrograph of both extracts shows that the shape gum is polygonal. It has been shown that the compaction characteristics of powders are affected by the particle shape of the powders.[23] Since the particle shape of Cissus gum is polygonal, it shows that it has a higher tendency to fragment during compaction thus better compatibility.

The values of the mean particle diameter of both gum extracts are the same. The mean particle size of materials may give an insight into the deformation characteristics of that material. Fell and Newton,[29] noted that the smaller the mean particle size, the greater is the ability of the materials to deform plastically through the process of microsquashing. A decrease in particle size will result in an increase in specific surface area and available inter-particulate bonding area thus making powders to be cohesive and less flowing. The particle size and size distribution affects properties such as flowability and compaction,[30, 31] viscosity,[32] emulsifying and as suspending properties.[33] Both had a mean particle diameter of 430 µm which shows that they coarse powders. This indicates that they are less cohesive and will have to undergo fragmentation for plastic deformation to take place during compaction process.

Flowability is typically determined by powder properties which include density.[34] Ayorinde, *et al.*[31] reported that high particle density favours free flow of such material. There is no significant difference between the particle densities of both extracts. The angles of repose of both extracts were above 50°. This is an indication that Cissus gum does not have a good flow. The angle of repose is usually affected by particle shape, particle size and size distribution. FemiOyewo *et al.*[35] reported that the higher the particle size, the lower the angle of repose.

The percentage compressibility (Carr's index) is a qualitative descriptive assessment of the compressibility and flowability of a powder while Hausner ratio is indicative of interparticle friction. As the values of these two parameters increase, the flow of the powder decreases.

Both extract of Cissus gum had Carr's index above 21% and Hausner's ratio values above 1.25 suggesting poor flow.

The amount of moisture present in a powder may affect the frictional properties of the compact formed. The formation of moisture film may reduce friction at the die wall by acting as a lubricant thus decreasing tablet adhesion to the die wall. CW when used in tablet formulation will ease tablet ejection better than when CA is used.

Moisture sorption capacity is the reflection of the relative physical stability of tablets made from the polymers when stored under humid conditions. The high value of the moisture sorption capacity of Cissus gum is an indication that they are sensitive to atmospheric moisture which suggests that may undermine the stability of hydrolysable constituents of a solid dosage form if used as excipient in that formulation. Cissus gum should be stored in air tight containers since they are susceptible to moisture sorption at atmospheric condition.

The rate of swelling for the both extract of Cissus gum was rapid within the first hour after which it slows down. This occurs because at first, hydration of polymer at the surface takes place fast so the swelling is more but when the diffusional path length is increased, water penetration slows down which slows rate of swelling of the polymer. The gel layer thickness depends on water penetration, polymer chain disentanglement and mass transfer in water. Acetone extract had higher water retention capacity than the water extract. Akhila and Emilia,[36] and Odeniyi *et al.*[37] have shown that the capacity of materials to capture water molecules influence parameters such as mechanical properties and surface mobility. The high swelling index of Cissus gum is an indication that it may be used as a sustained release excipient in a matrix tablet system.

The viscosity of the two extracts of Cissus gum increased with increase in concentration at room temperature. This is expected as increasing concentration results in more viscous mucilage. This is of particular interest in the formulation of suspensions and semi-solid dosage forms, where resistance to shear of agitation may impair easy pouring from the container. [38] Hence, optimum concentration of the gum is expected to be determined. Acetone extract of Cissus gum had higher viscosity than the water extract; this is attributable to the higher water retention capacity of the acetone extract, which is imparting a corresponding higher viscosity.

The viscosity of the gum at room temperature also increased as the length of storage time was increased. The viscosity was observed to change with change and shear speed. At a higher shear speed, viscosity decreased due to increase in shear force caused by high speed of the spindle which reduces internal friction leading to thinning i.e. increase in fluidity of the material. This is an indication that Cissus gum would undergo a pseudoplastic behavior, during storage (at low shear speed), it will have a high viscosity and during shaking or pouring (at high shear speed), it will have a low viscosity.

CONCLUSION

Cissus gum has been extracted from the incised stem of *Cissuspopulnea Guii and Perr*. The yield for both extracts of the gum was high and heavy metals were absent which makes it desirable for use as an excipient in pharmaceutical industries. The high swelling index of Cissus gum suggests that it may be used as a sustained release excipient in a matrix tablet system.

Both extracts of Cissus gum possessed fundamental characteristics that would make them suitable as pharmaceutical excipients in the formulation of solid, semi-solid and liquid dosage forms and also in sustained release formulations.

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REFERENCES

1. Patel DM, Prajapat DG, Patel NM (2007). Seed mucilage from Ocimumamericanum as disintegrant in tablets: seperation and evaluation. *Indian Journal of Pharmaceutical Science* 69: 431-434.

2. Oyi AR, Shittu AO, Mahmud HS (2007). Physicochemical Characterization of Acacia Sieberiania gum. *Indian Journal of Novel Drug Delivery* 2 (3): 99-102.

3. Anekant JO, Yashwant FR, Saiyai KJ (2007). Properties of biodegradable national polysaccharides for the specific drug delivery to the colon. *Journal of Pharmaceutical Science* (1): 86 - 128.

4. Meimei LB, Yang FJ, Wang KO, Zhimin EH (2007). Synthesis, characterization and evaluation of phosphated cross linked konjacglucomannan hydrogels for colon targeted drug delivery. *Drug Delivery* 14: 397-402.

5. Somboonpanyakul PD, Wang QP, Cui WS, Barbut SO, Jantawat AP (2006). Malva nut gum (Part I): extraction and physicochemical characterization. *Carbohydrate Polymers* 64: 247-253.

6. Nasipuri RN, Igwilo CI, Brown SA, Kunle OO (1997). Mucilage from Abelmoschusexculentus fruits - a potential pharmaceutical raw material. Part II - emulsifying properties. *Journal of Pharmaceutical Research and Development* 2: 27-34.

7. Nasipuri RN, Igwilo CI, Brown SA, Kunle OO (1999). Mucilage from Abelmoschusexculentus fruits - a potential pharmaceutical raw material. Part III - suspending properties. *Journal of Pharmaceutical Research and Development* 2: 121-130.

8. Sinha VR, Kumria R (2002). Binders for colon specific drug delivery, an in-vitro evaluation. *International Journal of Pharmacy* 24: 923-31.

9. Onunkwo GC, Udeala OK (2003). Some physical properties of theophylline monohydrate sustained release tablets formulated with

Abelmoschusesculentus gum as a hydrophilic matrix. *Global Journal of Medical Science* 2: 145-152.

10. Ojekale AB, Lawal OA, Lasisi AK, Adeleke TI (2006). Phytochemistry and spermatogenic potentials of extract of *Cissus populnea* (Guill and Perr) stem bark. *TSW Holistic Health Medicines* 1 (2): 176 – 182.

11. Kone WM, Atindehou KK, Terreaux C, Hosetettman K, Traore D, Dosso M (2004). Traditional medicine in north Cote-d'Ivoire: screening of 50 medicinal plantsforantibacterialactivity. *Ethnopharmacology Bulletin* 93 (1): 43 – 49.

12. Atawodi S., Ameh DA, Ibrahim S, Andrew JN, Nzelibe HC, Onyike EO, Anigo KM, Abu EA, James DB, Njoku GC, Sallau AB (2002). Indigenous knowledge system for treatment of Trypanosomiasis in Kaduna state of Nigeria. *Journal of Ethnopharmacology* 79 (2): 279-282. 13. Moody JO, Ojo OO, Omotade OO, Adeyemo AA, Olumese PE, Ogundipe OO (2003). Anti sickling potential of a Nigerian herbal formula (Ajawaron HF) and the major plant component (*Cissuspopulnea*L. CPK). *Phytotherapy Research* 17 (10): 1173-1176.

14. Souza S, Houngnon P (1985). *Cissus populnea Guill. & Perr.* (Vitaceae) en République Populaire du Bénin. Bulletin of History of Nature 4 (2): 457-468.

15. Belmain SR, Golo P, Andan HF, Atarigiya H, Chare FA, Carr P (2000). Toxicity and repellency of ethnobotanicals used in Ghana as post harvest protectants, in Abstracts of presentations on selected topics at the XIVth International Plant Protection Congress (IPPC). Phytoparasitica 28 (1): 87-90.

16. Ibrahim MA, Dawes VH and Bangudu AB (2002). Evaluation of cissus populnea polymer as a matrix former for controlled drug release. Journal of Phytomedicine and Therapy 5 (2): 23-32.

17. Abioye AD, Odusote MO, Ifudu ND and Silva BO (2000). Evaluation of Cissus populnea gum as a potential emulsifying agent. Journal of Pharmaceutical Science and Pharmacy Practice 6 (1): 49-53.

18. Abioye AD, Odusote MO, Ifudu ND and Silva BO (2001). Invitro Release Kinetics of salicylic acid from Cissus populnea gel. Journal of Pharmacy Practice 7 (12): 40-43.

19. Abioye AD, Odusote MO, Ifudu ND and Silva BO (2000). A physicochemical basis for the stability effects of Cissus populnea gum in oil-in-water extemporaneous emulsions. *Journal of Pharmaceutical Science and Pharmacy Practice* 6 (1): 17-22.

20. Adeleye AO, Odeniyi MA and Jaiyeoba KT (2011). Evaluation of cissus gum as binder in a paracetamol tablet formulation. Farmacia 59 (1): 85-96.

21. Trease A, Evans WC (1989). Pharmacognosy (13th Ed.) Balliene Tindiall, London pp. 62-74.

22. Malviya R (2011). Extraction and characterization of selected mucilage as pharmaceutical excipients. Polymer in Medicine 41 (3): 39-44.

23. Ohwoauworhua FO, Kunle OO, Ofoefule SI (2004). Extraction and characterization of microcrystalline cellulose derived from luffa cylindrical plant. African Journal of Pharmaceutical Research and Development 1 (3): 1-6.

24. Odeniyi MA, Ayorinde JO (2012). Material and rheological properties of yam starch/polymer blend hydrogels. International Journal of Pharmacology and Pharmaceutical Technology 1 (2): 23–28.

properties: Effect of surfactant incorporation. Pharmazie 48: 120-123.

31. Ayorinde JO, Itiola OA, Odeniyi MA (2013). Effects of excipients and formulation types on compressional properties of diclofenac. Acta Poloniae – Drug Research 70 (3): 557-566.

32. Marcelo DA, Steven VE, José MA (2004). Effect of the particle size distribution on the low shear viscosity of high-solid-content latexes. Journal of Polymer Science Part A: Polymer Chemistry 42 (16): 3936–3946.

33. Femi-Oyewo MN Adedokun MO, Olusoga TO (2004). Evaluation of the suspending properties of Albiziazygia gum on sulphadimidine suspension. Tropical Journal of Pharmaceutical Research 3 (1): 279 -284.

34. Zhang GG, Law D, Schmitt EA, Qui Y (2004). Phase transformation considerations during water

25. Odeniyi MA, Onu RN, Adetunji OA (2011). Evaluation of bioadhesive properties of natural and modified banana starches. East and Central African Journal of Pharmaceutical Science 14 (2): 34–42.
26. Iwuagwu MA, Onyekweli AO (2002). Preliminary investigation into the use of pleutorus tuber regium powder as a tablet disintegrants. Tropical Journal of Pharmaceutical Research 1: 29-37.
27. United State Pharmacopeai and National formulary (2006). Webcom Ltd, Toronto, Asian Edition.
3259-3261.
28. Howard SA (2002). Variables influencing drug release from layered matrix system comprising hydroxypropyl methylcellulose. American Association of Pharmaceutical Scientists 9 (2): 668-674.
29. Fell JT, Newton JM (1971). Effect of particle size and speed of compaction on density changes in tablets of crystalline and spray dried lactose. Journal of Pharmaceutical Science 60 (12): 1866-1869.
30. Femi-Oyewo MN, Adefeso A (1993). Influence of granule size on paracetamol granule and tablet mixtures on the nature of the crystalline drug phase, I. Theopyhlline. International Journal of Pharmacy 135: 151-160.
35. Femi-Oyewo MN, Elujoba AA, Alebiowu G (1992). Formulation Studies on Daturametel Linn powder I: Effect of powder size on granule and compact properties. *Journal of Pharmaceutical Science and Pharmacy Practice* 2 (2): 50-55.
36. Akhila RT, Emila A (2006). Enzymatic modification of cassava starch by bacterial lipase. Bioprocess and Biosystems Engineering 29: 65-69.
37. Odeniyi MA, Babalola AO, Ayorinde JO (2013). Evaluation of Cedrela gum as a binder and bioadhesive component in ibuprofen tablet formulations. Brazilian Journal of Pharmaceutical Science 49 (1): 95-105.
38. Sinko PJ (2011). Threshold size for optimal passive pulmonary targeting and retention of rigid microparticles in rats. *Journal of Controlled Release* 143 (1): 31-37.