

Original Article**ISSN 0975-8216****PHARMACEUTICAL CHARACTERIZATION OF SOME NATURAL EXCIPIENT AS POTENTIAL MUCOADHESIVES AGENT****SINGH SUDARSHAN ^{1*}, SINGH SANGEETA ², BOTHARA S.B. ³, PATEL ROSHAN ⁴****Affiliated to:**

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ABSTRACT

Natural gums and mucilages have been extensively explored as pharmaceutical excipients. These gums are biocompatible, cheap and easily available. Mucoadhesives are agents which adhere to the mucous membrane due to specific properties and release the drug at the site of action in controlled manner. Since the biodegradability of the synthetic polymers are at some instance hesitant, in this exploration, an oral mucoadhesive polymer has been developed which is extracted from the seeds of *Caesalpinia pulcherrima* Swartz Obs. (Fabaceae) and *Leucaena leucocephala* (Lam.) de wit. (Fabaceae) by physical methods such measurements of viscosity, viscoelasticity, surface tension, tensile strength and adhesive force. The other parameters such as solubility, hydration capacity, microbial content, viscosity, pH, preliminary phytochemical screening, physicochemical properties, elemental analysis and acute toxicity of seed mucilage were also evaluated. The result shows that mucoadhesive properties of both seeds are comparable to synthetic polymers such as hydroxyl propyl methyl cellulose (HPMC) and sodium alginate but greater than hydroxyl propyl cellulose (HPC) and chitosan under the experimental conditions used in this study. Briefly, it could be concluded that the seed mucilage of *Caesalpinia pulcherrima* Swartz Obs. and *Leucaena leucocephala* (Lam.) de wit. can be used as a pharmaceutical excipient in oral mucoadhesive drug delivery systems; it has the potential to also replace some synthetic mucoadhesive polymers upon further modifications.

Keywords: *C. pulcherrima*, *L. leucocephala*, Natural mucoadhesive polymer.

INTRODUCTION

Oral drug delivery system has been known for decades as the most widely utilized route for drug administration among all the routes. Natural gums and their derivatives are used

widely in pharmaceutical dosage forms as biodegradable polymeric materials to deliver bioactive agents and have been hampered by the synthetic materials. These natural polysaccharides do hold advantages over the

synthetic polymers, generally because they are nontoxic, less expensive, and freely available. Natural gums can also be modified to have tailor-made materials for drug delivery systems and thus can compete with the synthetic biodegradable excipients available in the market. Natural gums are among the most popular hydrophilic polymers because of their cost-effectiveness and regulatory acceptance¹. Natural polysaccharides are extensively used for the development of solid dosage forms. These polymers of monosaccharides (sugars) are inexpensive and available in a variety of structures with a variety of properties. They are highly stable, safe, non-toxic, and hydrophilic and gel forming in nature. Pectins, chitosan, starch, guar gum, amylase and karaya gum are a few polysaccharides commonly used in controlled release dosage forms. Non-starch, linear polysaccharides remain intact in the physiological environment of the stomach and the small intestine, but are degraded by the bacterial inhabitants of the human colon which make them potentially useful in targeted delivery systems to the colon². Polymers have been successfully employed in the formulation of solid, liquid and semi-solid dosage forms and are specifically useful in the design of modified release drug delivery systems. Both synthetic and natural polymers have been investigated extensively for this purpose³ but the use of natural polymers for pharmaceutical applications is attractive because they are economical, readily available, non-toxic, and capable of chemical modifications, potentially biodegradable and with few exceptions, also biocompatible.

Because of their wide diversity in structure and physical properties natural polysaccharides have found a wide range of applications in the food, pharmaceutical and other industries⁴. Some of these applications include their use as emulsifiers, stabilizers, binders, gelling agents, coagulants, lubricants, film formers, thickening and suspending agents. These biopolymers are rapidly emerging as a new and industrially important source of polymeric materials which are gradually becoming economically competitive with natural gums produced from marine algae and other plants.

Caesalpinia pulcherrima Swartz Obs. and *Leucaena leucocephala* (Lam.) de wit. Commonly known as paradise flower and kadam, are available locally belonging to the family Fabaceae and has not been explored as pharmaceutical excipients. The seeds of *Caesalpinia pulcherrima* Swartz Obs. and *Leucaena leucocephala* (Lam.) de wit. Swells and form gelatinous mass when it comes in contact with water due to its hydrophilic nature. Hence the present work was attempted to evaluate mucoadhesive properties of seed mucilage of *Caesalpinia pulcherrima* Swartz Obs. and *Leucaena leucocephala* (Lam.) de wit.

MATERIALS AND METHODS

Materials

Caesalpinia pulcherrima and *Leucaena leucocephala* seeds were procured from the forest of KORBA, Chhattisgarh, India and authenticated from Botanical survey of India (Jaipur) Rajasthan. All other ingredients were of

analytical grade and purchased from Loba chemie Pvt Ltd, Mumbai.

Methods

Isolation of natural mucoadhesive agent from *C. pulcherrima* and *L. leucocephala* Defatted seed

C. pulcherrima and *L. leucocephala* seeds Kernel's powder (20g) were defatted by soxhlet extraction using petroleum ether as a solvent at temperature 60-70°C this was repeatedly extracted using hot water till the complete mucilage was extracted. The mucilaginous solution was then filtered through eight folds of muslin cloth. The mucilage was then precipitated by adding sufficient acetone (three times the volume of filtrate). The precipitate was washed with absolute diethyl ether and petroleum ether and dried in microwave oven (100% radiation energy) till it was completely dried. The obtained powder was then sieved through sieve #80 and stored in desiccators until used for further studies⁵.

Preliminary Phytochemical Screening of Isolated Mucilage

The phytochemical properties such as presence of carbohydrate, protein, flavanoids, sterols, alkaloids, tannins, saponins, phenol, and terpenoids were determined⁶.

Physicochemical properties of dried mucilage

C. pulcherrima (MCP) and *L. leucocephala* (MLL) were studied for physicochemical properties such as for melting point (melting point test apparatus), solubility, pH and viscosity

of dried mucilage were determined at three relevant temperatures (37°C, 45°C and 60°C) using Ostwald viscometer. The loss on drying, moisture content, hydration capacity, total ash content, acid insoluble ash and water soluble ash, swelling index were determined according to Ayurvedic Pharmacopoeia of India (A.P.I) (7). Bulk density, angle of repose, compressibility index, Housner's ratio and moisture content were determined according to Indian Pharmacopoeia (I.P.)⁸.

Microbiological properties

Microbial content determination

1 gm of MCP and MLL each were separately dispersed in 9ml of purified distilled water. Serial dilutions were made and viability assessed using pour plate method. For detection of fungal growth in sample, sodouraud dextrose agar medium was used. The plates were incubated at 27°C for 72 hours^{9,10}. Casein digest agar medium was used. The plates were incubated at 37°C for 24 hours¹¹.

Acute toxicity study

The method was performed according to the OECD test guide line for testing of chemical TG 423. Healthy wistar female rats fasted over night, but allowed access to water *ad libitum*. Animals were randomly divided in to five groups (n=3). The control group received water only. Group I-IV were orally treated with MCP and MLL at dose of 50, 300, 2000, 5000 mg/kg respectively and the animals were observed at 15, 30, 60, 120 and 240 minutes with no intake of food and water and thereafter over a period of

24hrs¹². The rats were further observed for 14 days with food and water intake animals were monitored shown in Table 1.

Table 1: Body weight of female rats in acute toxicity of the MCP and MLL

Group	Body weight (gm)					
	MCP			MLL		
	Days 0	Days 7	Days 14	Days 0	Days 7	Days 14
Control	222 ± 1.4	230 ± 1.9	242 ± 1.6	220 ± 1.3	218 ± 1.5	231 ± 1.3
Group I	214 ± 1.5	228 ± 1.7	249 ± 2.1	216 ± 1.4	212 ± 1.0	234 ± 1.5
Group II	223 ± 1.6	234 ± 1.9	247 ± 1.2	219 ± 1.9	219 ± 1.6	230 ± 1.2
Group III	219 ± 1.1	236 ± 2.1	251 ± 1.1	222 ± 1.8	220 ± 1.3	229 ± 1.4
Group IV	218 ± 1.7	231 ± 1.4	246 ± 1.4	221 ± 1.1	221 ± 1.9	233 ± 1.9

Values are expressed as mean ±S.D. (n = 3)
A significant difference from control, p < 0.05

Swelling index of the natural mucoadhesive agent

Natural mucoadhesive agent (200mg), previously reduced to the required fineness by sieve #80 was introduced in to Petri-dish and then 10ml of distilled water was added and the mixture was shaken thoroughly every 10min for the it was allowed to stand for 3hr at room temperature. In between at an interval of every 1hr the remaining water in Petri-dish was discarded and the weight increase of mucoadhesive agent was noted at the same interval of 1hr until that 3hr ends. The weight increase shows the sticky hydrogel nature of the plant seed material. The same procedure was repeated for 3 times and mean value was calculated. In the same manner the studies was

repeated with solution pH 1.2 and in 7.4 instead of distilled water^{13,14,15}.

$$\text{Swelling index} = [(W_2 - W_1) / W_1]$$

Were, W_1 = weight of natural mucoadhesive agent before swelling

W_2 = weight of natural mucoadhesive agent after swelling

Elemental analysis

CHNS analysis present in the isolated natural mucoadhesive agent was reported from C and M Lab, central Ashwamedh Engineers & consultants Co-operative Society (Ltd), Nasik (Maharashtra)¹⁶.

Mucoadhesive characterization of MCP and MLL with existing polymer

The mucoadhesive characterization of synthetic, semi synthetic or natural gum involves two various evaluation techniques with different methods. To conform the mucoadhesive character of the selected natural mucoadhesive agent (MCP and MLL) it was compared to other existing mucoadhesive polymers hydroxyl propyl methyl cellulose (HPMC), hydroxyl propyl cellulose (HPC), Chitosan and sodium alginate (SA)¹⁷.

Shear Stress Measurement

The shear stress measure the force that cause a mucoadhesive to slide with respect to the mucus layer in directional parallel to their place of contact of adhesion. The test was performed by using different concentration of mucoadhesive agent solution likes 1%, 2%, 3% w/v using HPMC, SA, Chitosan, MCP and MLL was

prepared. A specified amount of prepared solution was spread on 3 glass plate. Another clean slide was placed over the first plate and made to spread the polymer solution uniformly in between two glass plates by placing 100g weight on the glass plates. It was allowed undistributed for 15, 30 and 60 min then one side of glass plate was fixed in a hook and the other was collected to a twin passing over a pulley and at the end of pan was attached, Illustrated in figure 1. After the said times 15, 30 and 60min weight was placed in an increasing manner till the plates attached with polymer got detached. The weight which just detaches, were noted and the average values were tabulated as per methods official method^{18,19}.

Wihelmy's method

To characterize the mucoadhesive strength, wihelmy's method was used for that a small glass plate (2×5 cm) was coated by dipping into a 1%w/v solution of test materials HPMC, SA, Chitosan, MCP and MLL (mucoadhesive agent). The mucus gel was taken from goat intestine kept in a suitable container and the temperature was maintained at 30°C. Nylon thread was attached at one end of the glass plate. Provision was given to raise the weight at the other end. At specified intervals 5, 10, 15 and 30min, water required to pull out the glass plate from the mucus represents the force required the force required to break the mucus–polymer contact against adhesion^{20,21,22,23}, Illustrated in figure 2. Six plates were tested for each material and the average weights required were calculated.

Falling sphere method

To characterize the mucoadhesive strength, the falling sphere method was used for that a clean burette was taken and filled with 10% mucus solution and fixed in a stainless steel tube. Mustard grain which retained on sieve size # 12 were taken and dipped in polymer solutions (HPMC, SA, Chitosan, MCP and MLL) of various concentrations (0.5, 1.0 and 3.0% w/v) and then each grain were slowly placed at the top of the mucus layer. Time taken by the grain to fall 50 divisions in the burette was noted and values were tabulated^{24,25}, Illustrated in figure 3.

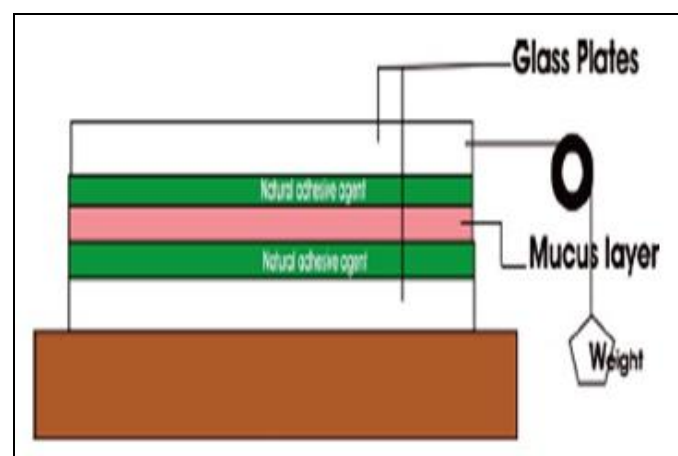


Fig. 1. Shear Stress Measurement.

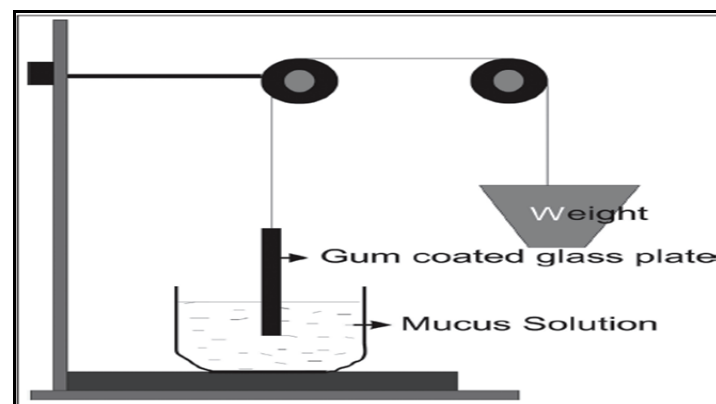
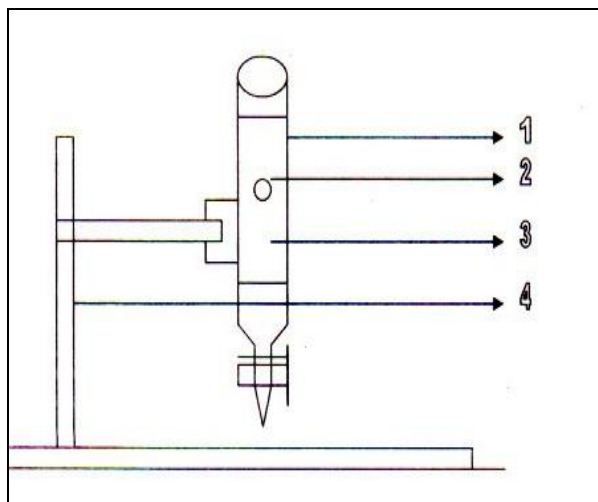


Fig. 2. Wihelmy's method.



Were, 1-Glass burette (50 ml), 2- mustard grains of uniform size, 3-Homogenized mixture of 10% mucus solution, 4-burette stand.

Fig. 3. Falling sphere method.

Detachment force measurement

To characterize the mucoadhesive strength, the detachment force method was used for that the intestine of goat was collected from slaughter house and transported to laboratory in tyrode solution (g/liter); sodium chloride 8; potassium chloride 0.2; calcium chloride 2H₂O 0.134; sodium bicarbonate 1.0; sodium dihydrogen phosphate 0.05; and glucose H₂O 1.0. During this experiment the intestine in specified area and place it on one glass slide and tie it. The glass slide with the intestine was affixed on one side floor below the modified physical balance. Mucoadhesive tablet prepared by using HPMC, SA, Chitosan, MCP and MLL, was pasted on another glass slide and it balanced in the assembled physical balance with a beaker in other side which is used to hold the water. Now the balance was calibrated^{19,26}, Illustrated in figure 4.

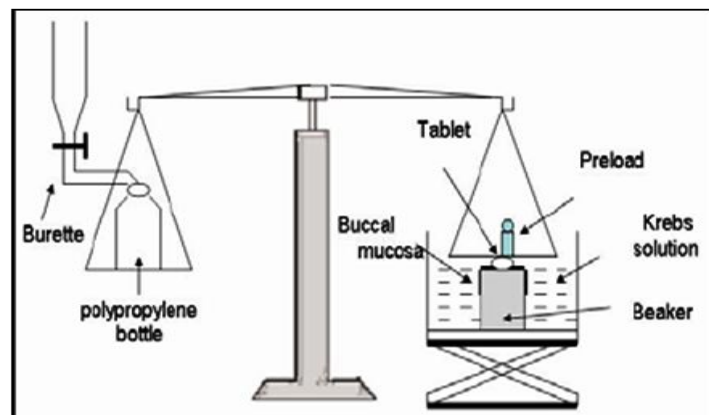


Fig. 4: Detachment force measurement.

Recording of adherence

To characterize the mucoadhesive strength, the recording of adherence method was used for that mucoadhesive tablet prepared by using HPMC, SA, Chitosan, MCP and MLL, was left on the intestine segment slide and stick by lightly pressing the intestine segment with forceps, the assembly should be kept undistributed for a fixed time interval 5, 10, 15 and 30min. then water was added slowly in drop wise to beaker aside. The amount of water required to pull out the tablet from intestinal segment represent the force required to pull the tablet against the adhesion²⁷, Illustrated in figure 5. The above same procedure is repeated from the comparative study the force in Newton's is calculated by equation,

$$F=0.00981W/2$$

Were W is the amount of water.

In vivo bioadhesive study

Preparation of Barium Sulphate Tablet (mucoadhesive Tablet)

100mg tablet was prepared in ratio of 1:1 with barium sulphate and isolated mucoadhesive

agent by addition of 5% w/v gelatin solution to make dough mass and this mass was passed through sieve #10. Thus obtained granules were passed through the sieve # 18 to remove fines. Tablets were prepared by Rimik mini press-II machine after addition of all excipient and additives.

To study the bioadhesive character and the mean residence time of natural polymer in the stomach, barium sulphate loaded tablet was used. Two healthy male rabbits weighing 2.5 kg were selected and administered orally with the tablet. X-ray photograph was taken intervals shown in Figure. (Animal ethical committee no: HNSIPER/IAEC/M.PHARM/PH.CEUTICS/09/2010)¹⁵.

RESULTS AND DISCUSSION

Preliminary Phytochemical and Physicochemical characterization

C. pulcherrima and *L. leucocephala* seed yielded 12.0% and 10.0% w/v respectively of natural mucoadhesive. The isolated mucoadhesive agent was tested for identification of hydrocolloid positive result was obtained. The purity of the selected mucoadhesive agent was determined by carrying out test for presence of different phyto-constituent and the result shown in Table 2. The result showed the presence of carbohydrates, flavonoids, amino acid and tannins in both the plant mucilage.

The pH, swelling index, viscosity, solubility (as per IP) and melting point tests for the selected natural mucoadhesive agent are shown in Table 3 and 4. The pH was found to be neutral indicating that the selected natural

mucoadhesive agent may not irritate the epithelium and mucus membrane of oral route and was found to be suitable for oral dosage forms.

The water absorption of the polymers was inversely related to the pH of the medium. The viscosity studies 1.0% w/v solution of isolated natural mucoadhesive agent shows decrease in viscosity with increase of temperature and melting point range is also reported. The isolated natural mucoadhesive agent was soluble only in warm water. The elemental analysis study shows that the isolated natural mucoadhesive agent consists of certain percentage of carbon, nitrogen, sulphur and hydrogen which Presence of S along with N in MCP and MLL possibly suggests the presence of S-containing protein amino acids, also conforms the formation of bond (primary strong covalent bonds, weak secondary hydrogen bond and Vander Waal's forces) of mucilage with mucosa in a short duration of time. The results are shown in Table 5.

Table 2: Determination of Purity of Selected Natural Mucoadhesive Agent

Test	MCP	MLL
Alkaloids	+	+
Carbohydrates	+	+
Flavonoids	+	-
Steroids	-	-
Amino acids	+	+
Terpins	-	-
Saponins	+	-
Oil & Fats	-	+
Tannins & Phenol	+	+
Protein	+	+

+ Present, - Absent

Table 3: Solubility Studies of Isolated Natural Mucoadhesive Agent

Solvent used	MCP	MLL
Cool water (8°C-25°C)	+	+
Warm water (30°C-40°C)	-	-
Di methyl sulfoxide	-	-
Ethanol	-	-
Methanol	-	-
Cyclohexane	-	-
Dichloromethane	-	-
Chloroform	-	-
Carbon tetrachloride	-	-
Acetonitrile	-	-
Benzene	-	-
Ether	-	-
Ethyl acetate	-	-

+ Present, - Absent

Table 4: Technological Characterization of Physicochemical property of Selected Natural Mucoadhesive Agent

Parameter	MCP	MLL
pH (1% w/v)	6.5 ± 0.5	6.6 ± 0.5
Swelling index (after 3 hr)		
At water	18.09 ± 0.34	11.24 ± 0.43
pH-1.2	13.33 ± 0.28	8.92 ± 0.42
pH-7.4	12.12 ± 0.29	0.19
Melting Point	209.5°C	109°C
Viscosity (1% w/v)		
At, 37°C	1.1158 Poise	1.1148 Poise
45°C	0.9139 Poise	0.123 Poise
60°C	0.5090 Poise	0.4094 Poise
Total ash content (%)	7.72 ± 0.13	7.70 ± 0.11
Acid insoluble ash (%)	0.57 ± 0.05	0.51 ± 0.03
Water soluble ash (%)	6.532 ± 0.08	6.823 ± 0.02
Loss on drying (%)	12.49	11.08
Microbial count	Bacteria: 4cfu/g Fungi: 3cfu/g	Bacteria: 6cfu/g Fungi: 4cfu/g
Moisture content (%)	18.07 ± 1.271	19.0 ± 1.575
Hydration Capacity	18.5 ± 0.261	13.0 ± 0.325
Bulk density (gm/ml)	0.66 ± 0.024	0.40 ± 0.050
Tapped density (gm/ml)	0.769 ± 0.061	0.50 ± 0.055
Carr's Index (%)	13.39 ± 0.691	20.0 ± 0.850
Hausner's Ratio	1.15 ± 0.082	1.25 ± 0.045
Angle of Repose	29.74 ± 1.30	23.0 ± 1.25

Table 5: Technological Characterization of Elemental Analysis

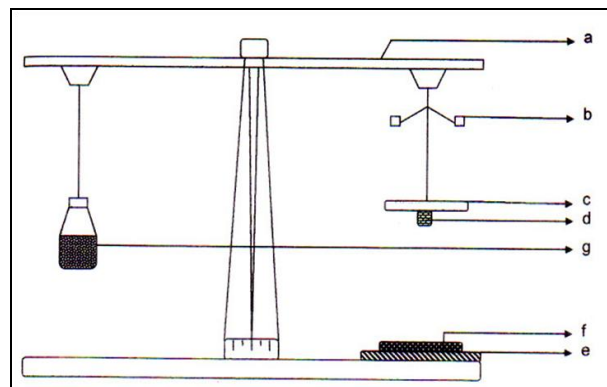
Polymer	Weight (mg)	C/N ratio	Content (%)	
MCP	4.6810	34.86	N	1.127
			C	39.28
			S	0.550
			H	6.468
MLL	4.6230	11.23	N	3.345
			C	37.58
			S	0.961
			H	6.080

Acute toxicity study

Acute toxicity studies were conducted according to OECD guidelines no.423. The results shows that there are neither behavioral changes nor change in body weight which show no toxicity induced from mucilage (MCP and MLL).

Physical evaluation (In vitro)

In case of shear stress measurement and Falling sphere analysis the natural agent from seeds of



Were a-modified physical balance, b-weights, c-upper glass slide, d-tablet, e-lower glass slide, f-goat intestine, g-beaker which hold water

Fig. 5. Recording of adherence analysis.

C. pulcherrima and *L. leucocephala* showed more adhesiveness than HPC and HPMC but less than the sodium alginate and Chitosan from the comparable of adhesiveness. Result is tabulated in Table 6, 7 and Figure 6, 7, 8 and 9. The initial measurement values for shear stress, (time 15 minutes) normalized and the values at 30 and 60 minutes reported as increase in ratio compared to time 15.

Table 6: Technological Characterization of Shearing Stress Measurement

polymer	Concentration (%w/v)	Weight required to detach glass plate (g) at the time interval (n=3)		
		15 min	30 min	60 min
HPC	1	1.0	1.14	1.43
	2	1.0	1.12	1.37
	3	1.0	1.13	1.32
HPMC	1	1.0	1.46	2.08
	2	1.0	1.38	1.78
	3	1.0	1.35	1.66
SA	1	1.0	1.13	1.42
	2	1.0	1.08	1.32
	3	1.0	1.04	1.27
Chitosan	1	1.0	1.45	1.96
	2	1.0	1.31	1.78
	3	1.0	1.25	1.38
MCP	1	1.0	1.15	1.43
	2	1.0	1.09	1.35
	3	1.0	1.16	1.37
MLL	1	1.0	1.47	2.05
	2	1.0	1.36	1.76
	3	1.0	1.39	1.75

Table 7: Technological Characterization of Falling sphere analysis

Polymer	Concentration of polymer (% w/v)	Average time taken (Second) (n=3)
HPC	0.5	09.20
	1.0	09.50
	3.0	10.20
HPMC	0.5	09.40
	1.0	09.70
	3.0	10.23
SA	0.5	10.23
	1.0	10.42
	3.0	10.55
Chitosan	0.5	10.10
	1.0	10.50
	3.0	10.70
MCP	0.5	09.57
	1.0	10.22
	3.0	10.50
MLL	0.5	09.60
	1.0	09.80
	3.0	10.30

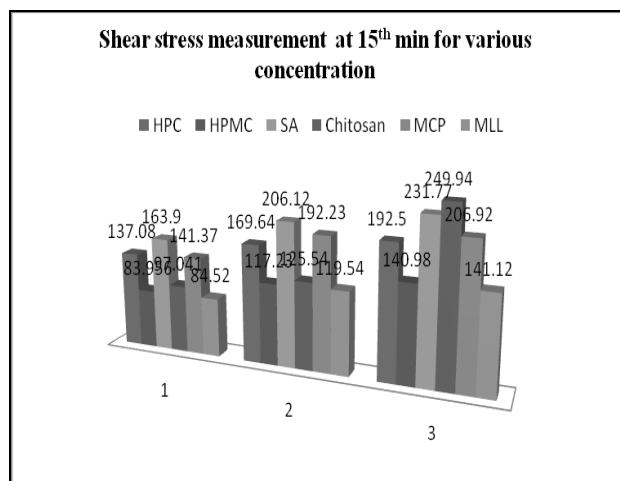


Fig. 6. Shear Stress Measurements at 15th Mint.

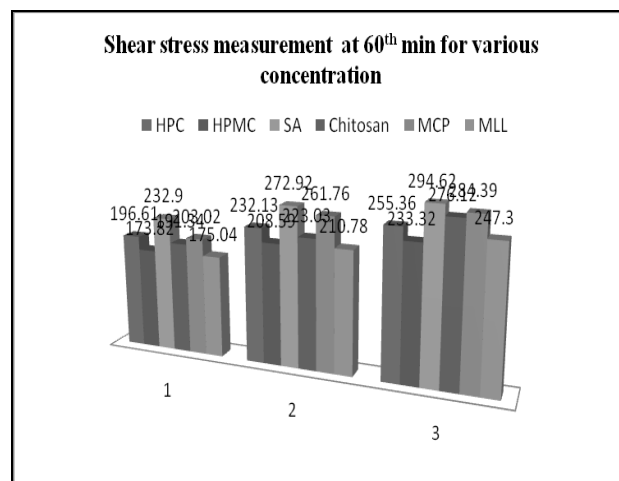


Fig. 8. Shear Stress Measurements at 60th Mint.

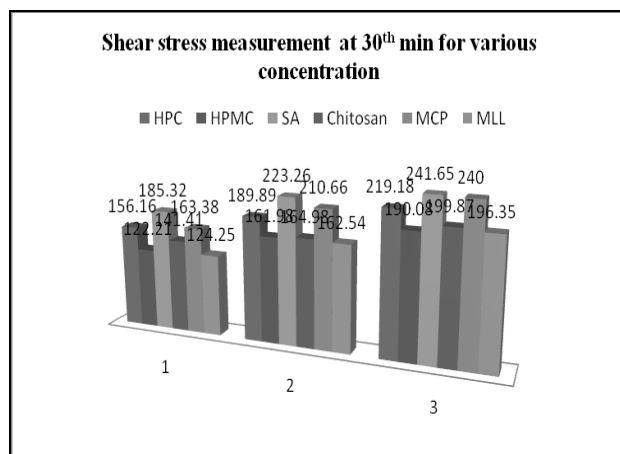


Fig. 7. Shear Stress Measurements at 30th Mint.

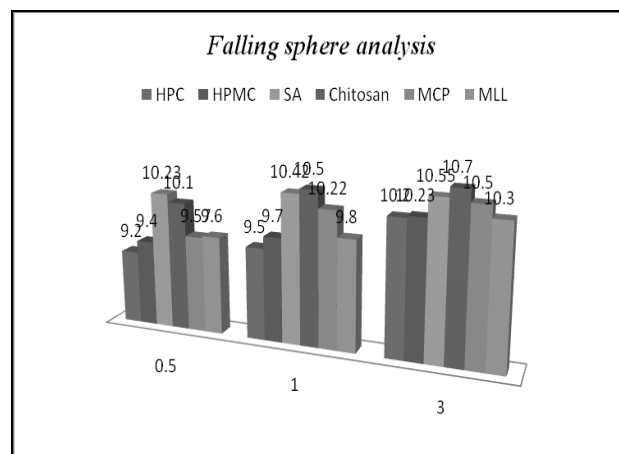


Fig. 9. Falling sphere analysis of polymer at various concentrations.

Table 8. Technological Characterization of mucoadhesive strength by wihelmy's method, Detachment force measurement and Recording adherence

Polymer	Time (min)	Wihelmy's method (g)	Detachment force measurement (g)	Recording adherence method (g)
HPC	05	0.60	18.6 ± 0.9	10.5 ± 1.5
	10	0.90	34.0 ± 0.8	19.5 ± 3.5
	15	1.15	50.6 ± 1.6	26.5 ± 1.5
	30	1.30	55.2 ± 1.1	29.5 ± 1.5
HPMC	05	0.63	26.0 ± 1.1	17.4 ± 1.5
	10	0.88	52.4 ± 1.0	20.1 ± 3.5
	15	1.17	65.4 ± 1.6	25.7 ± 1.5
	30	1.40	71.0 ± 1.2	30.6 ± 1.5
SA	05	0.85	30.2 ± 1.0	57.7 ± 4.0
	10	1.30	58.6 ± 0.8	100.8 ± 1.0
	15	1.45	72.9 ± 1.0	113.5 ± 2.5
	30	1.60	80.4 ± 0.1	139.4 ± 1.0
Chitosan	05	0.84	20.1 ± 0.6	57.4 ± 4.0
	10	1.35	31.01 ± 0.3	98.9 ± 1.0
	15	1.48	53.02 ± 0.6	111.4 ± 2.5
	30	1.70	59.0 ± 0.9	138.3 ± 1.0
MCP	05	0.70	42.1 ± 0.7	23.5 ± 1.5
	10	1.10	71.2 ± 0.8	73.5 ± 1.3
	15	1.25	88.4 ± 1.2	96.6 ± 3.5
	30	1.50	94.6 ± 1.6	108.3 ± 1.5
MLL	05	0.72	45.2 ± 0.2	24.4 ± 1.5
	10	1.13	76.3 ± 0.7	73.4 ± 1.3
	15	1.24	90.1 ± 0.6	94.6 ± 1.5
	30	1.60	98.4 ± 0.8	108.0 ± 0.3

Standard deviation= mean of six values (n=6)

The surveillance reveals that the natural and synthetic substances subjected for physical evaluation possess the adhesive characteristics. Among which the natural mucoadhesive agent from seeds of *C. pulcherrima* and *L. leucocephala* possess substantial mucoadhesiveness in the demonstrated Wilhely's method, detachment force and recording adherence method. It has been found that 1.5gm and 1.60gm, MCP and MLL respectively of weight was required to detach 1%w/v coated plate from the mucus gel. Among the synthetic polymer HPC is deprived in adhesive character with 1.6gm to detach the

plate. While comparing this polymer for mucoadhesive character the coated mucoadhesive agent shows a medium adhesiveness towards the mucus gel. Results are tabulated in Table 8 and in figure 10, 11 and 12.

In vivo bioadhesive study

In vivo bioadhesive study shows that the mucoadhesive tablet which was prepared by mucilage obtained from *C. pulcherrima* and *L. leucocephala* shows a better adherence in stomach for more than 8 hours results are illustrated in Figure 13 and 14.

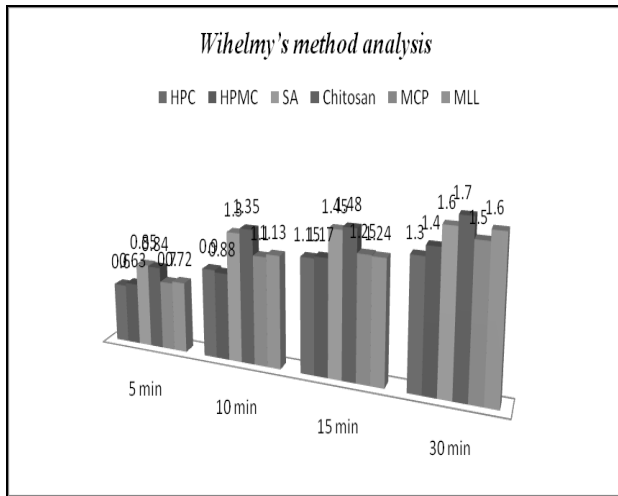


Fig. 10. Detachment force Measurements of polymer at various time interval.

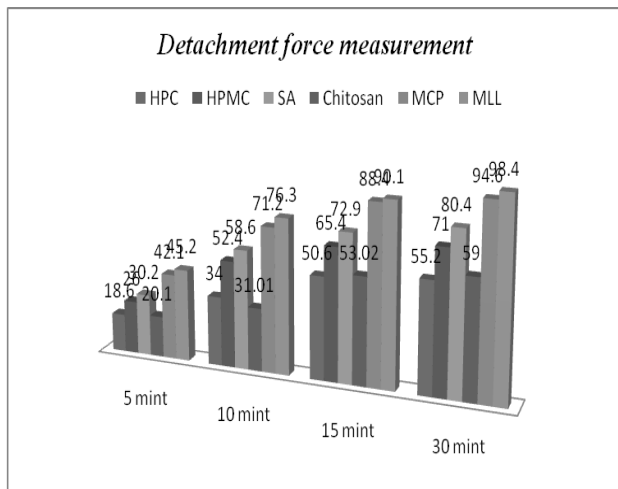


Fig. 11. Detachment force measurement at various time interval.

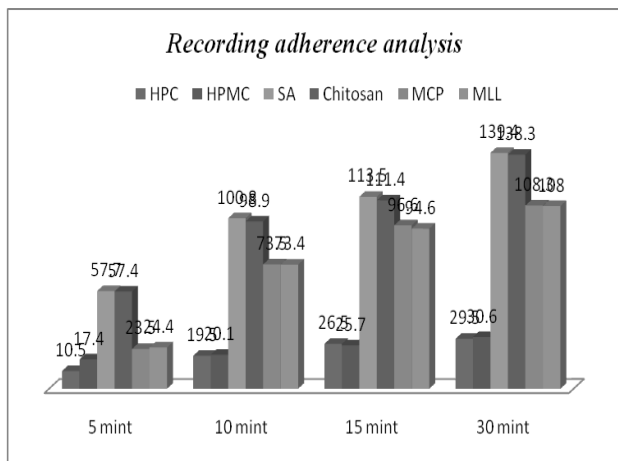


Fig. 12. Mean weight required to detach tablet at various time interval in mint.

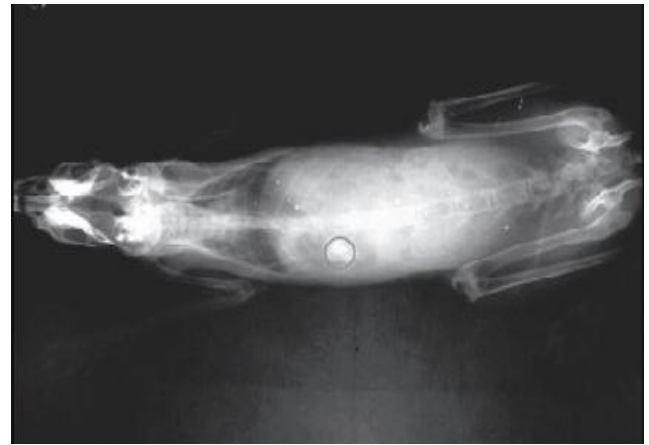


Fig. 13. Bio adhesive study for MCP at Eight Hour



Fig. 14. Bio adhesive study for MLL at Eight Hour

CONCLUSION

The polymers are playing an important role in field of controlled or sustained release drug delivery system. The selected natural mucoadhesive agent from seed of *C. pulcherrima* and *L. leucocephala* was successfully tested against their adhesive characteristic in the available physical studies like shear stress method, wihelmy's method, falling spheres method and detachment force measurement along with some synthetic polymer such as HPC, HPMC, Sodium alginate and Chitosan. The results were comparable to that of

same synthetic polymer. The *in vivo* study of plain isolated natural mucoadhesive agent (in tablet form) seeds of *C. pulcherrima* and *L. leucocephala* at albino rabbits also shows a good response in mucoadhesive characterization analysis.

The mucilage obtained from seeds *C. pulcherrima* and *L. leucocephala* was having mucoadhesive character and if any modifications are done in chemical structure then it may possess an enhanced adhesiveness, which may replaces the synthetic non-ideal mucoadhesive polymer.

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