

Full Length Research Paper

The suspending properties of *Terminalia randii* gum in magnesium carbonate suspension

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Terminalia randii tree is widely planted in Nigeria as an exotic plant, and gum can be obtained from the incised trunk. The natural gum from *T. randii* is a hydrophilic carbohydrate polymer. The purpose of this work was to develop cheap and effective natural excipient that can be used as an alternative for the formulation of pharmaceutical suspensions. The suspending properties of *T. randii* gum (Combretaceae) was studied in magnesium carbonate suspension and compared with acacia, compound tragacanth and gelatin at a concentration range of 1 to 4% w/v. Sedimentation volume, rheology, redispersibility and flow rate of suspensions were used as evaluation parameters. The ranking of sedimentation volume, viscosity and ease of redispersibility of the suspensions were in the order of *T. randii* gum > compound tragacanth > gelatin > acacia with non-Newtonian flow. The flow rates of the suspensions were in the order of acacia > gelatin > compound tragacanth > *T. randii*. At concentrations above 2.5% w/v, the viscosity of suspensions containing *T. randii* reduced the ease of redispersibility. It can be concluded that the mucilage of *T. randii* gum can be used as an alternative suspending agent in suspension formulations. It could be exploited for use as a stabilizer and thickening agent in the food industry due to its high viscosity.

Key words: *Terminalia randii* gum, suspension, viscosity, sedimentation volume, ease of redispersibility.

INTRODUCTION

Pharmaceutical suspensions are coarse disperse systems that are thermodynamically unstable and require the addition of thickeners or suspending agents to make them stable by reducing the settling rate of the particles (Martin, 2001). Suspensions offer several advantages over other dosage forms. Some of the benefits include: improved chemical stability of certain drugs, higher rate of bioavailability than other dosage forms, onset and duration of drug action can be controlled, suspensions are usually applicable for drugs which are insoluble or poorly soluble and it can also be used to mask the unpleasant or bitter taste of some drug substances (Fahr

and Liu, 2007). Suspension drug delivery dosage forms are also extensively used in the pharmaceutical industry for different routes of administration such as oral, inhalation, topical and parenteral (Edman, 1994). Suspensions may be dilute (2 to 10% w/v solid), concentrated (50% w/v solid), flocculated or deflocculated (Aulton, 2002).

Synthetic materials seem to be taking over the place of naturally available excipients in the design of drug delivery systems (Kumar and Gupta, 2012). However, the use of natural polymers such as gums and starches as pharmaceutical excipients presents several advantages

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such as non-toxicity, low cost, high availability and biological compatibility (Bhardwaj et al., 2000). Natural gums are widely used in the pharmaceutical industries as suspending agents (Femi-Oyewo et al., 2004; Verma and Razda, 2003; Kumar et al., 2009), emulsifying agents (Odeku et al., 1997; Nasipuri et al., 1999), binders (Panda et al., 2008; Gangurde et al., 2012), disintegrants (Patel and Patel, 2011) and in the food industries as thickeners. *Terminalia randii* tree is widely grown in Nigeria as an exotic plant and wind breaker. The gum is obtained from the incised trunk of this tree and has been used as a binder (Bamiro et al., 2010) and as a controlled release agent in carvedilol formulations (Bamiro et al., 2012). In the present study, the suspending property of the gum is being investigated in magnesium carbonate formulation.

MATERIALS AND METHODS

The materials used are light magnesium carbonate, gelatin (Merck, Germany), acacia gum (Mytonjaundrs and Co. Ltd, Liverpool), compound tragacanth powder, benzoic acid, chloroform water and distilled water. *Terminalia* gum was collected from the incised trunk of *T. randii* tree at the premises of Olabisi Onabanjo University, Ogun State in South Western part of Nigeria. The extraction of the gum has been described elsewhere (Bamiro et al., 2010).

Suspension preparation

Light magnesium carbonate suspension (10% w/v) was prepared by trituration method. *T. randii* gum (1 to 4% w/v) served as the suspending agent and was compared with standard agents (acacia gum, compound tragacanth gum and gelatin). Benzoic acid (0.1% v/v) and chloroform water (50% v/v) served as preservatives and the dispersing vehicle (distilled water) was used to make up to volume.

Determination of suspension properties

The properties of the suspension were evaluated using the methods described:

Sedimentation volume

Triplicate samples of fifty (50) ml of suspension was stored in a 50 ml measuring cylinder and left undisturbed for one week at room temperature (33°C). The sedimentation volume of each suspension was taken at 1 h intervals for 7 h and every 24 h for 7 days. Readings were done in triplicates. Sedimentation volume was calculated using the formula:

$$F = V_u/V_o \quad (1)$$

Where: V_u is the ultimate volume of the sediment and V_o is the original volume of the suspension.

Flow rate

The time required for 10 mls of each suspension sample to flow through a 10 ml pipette (from a fixed height) was determined and determinations were done in triplicate. The flow rate was calculated using the formula:

$$\text{Flow rate } (\eta\alpha) = \frac{\text{Volume of pipette (ml)}}{\text{Flow time (s)}} \quad (2)$$

Viscosity

The Brookfield Synchro-lectric viscometer, model LVF (Brookfield Laboratories, Massachusetts) was used to carry out viscosity test on the suspensions using spindle size 3 at $25 \pm 2^\circ\text{C}$ at 30 revolutions per minute. All determinations were done in triplicate.

Particle size analysis

The method of Patel et al. (1986) was used to analyze the particle size. Ten (10) ml of each sample was transferred into 200 ml cylinder after shaking the suspension for 2 min. Distilled water (150 ml) was then added, mixed, and 10 ml aliquot was removed at a distance of 10 cm below the surface of the mixture at 1 to 30 min using 5 min interval. Each aliquot was transferred into an evaporating dish and dried in an oven at 105°C and the residue weighed. The particle diameter (d in cm) was then calculated using the Stokes equation.

$$d = \frac{18\eta h}{(\rho_s - \rho_o) g t} \quad (3)$$

Where h is the distance of fall of the particle (cm), t is the time (s), η is the viscosity of the dispersion medium (poise), $\rho_s - \rho_o$ is the density gradient between the dispersed particles and the liquid (g cm^{-3})

Redispersibility test

This was carried out by rotating the bottle containing the suspension at an angle 180° and the ease of re-dispersibility was noted (Saeedi et al., 2003).

Statistical analysis

All tests were conducted in triplicates and analyzed using Graph Pad InStat (Graphpad Software Inc., San Diego, USA). Unpaired student's t-test, analysis of variance and linear regression tests were utilized. The null hypothesis in each test was that there were no significant differences between or within the treatments. P values of < 0.05 (that is, 95% confidence interval) were considered significant.

RESULTS AND DISCUSSION

Sedimentation volume

The sedimentation volume (F) of the suspensions containing the different suspending agents is presented in Table 1. It was observed that the sedimentation volume of the suspensions increased with increase in concentration of suspending agent. This could be due to an increase in viscosity of the suspensions with increase

Table 1. Values of sedimentation volume of magnesium carbonate suspensions using different concentrations of suspending.

Suspending agent	Concentration (% w/v)	Sedimentation volume time (h)														
		0	1	2	3	4	5	6	7	24	48	72	96	120	144	168
<i>Terminalia randii</i> gum	0	1.00	0.60	0.55	0.54	0.52	0.50	0.50	0.50	0.48	0.46	0.46	0.46	0.46	0.46	0.46
	1	1.00	0.72	0.69	0.68	0.67	0.67	0.65	0.64	0.61	0.60	0.60	0.60	0.60	0.60	0.60
	2	1.00	0.80	0.78	0.76	0.76	0.75	0.74	0.73	0.70	0.69	0.68	0.68	0.68	0.68	0.68
	2.5	1.00	0.90	0.90	0.88	0.85	0.84	0.83	0.80	0.79	0.78	0.78	0.78	0.78	0.78	0.78
	3	1.00	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	3.5-4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tragacanth gum	1	1.00	0.70	0.68	0.64	0.62	0.61	0.59	0.58	0.56	0.55	0.55	0.55	0.55	0.55	0.55
	2	1.00	0.78	0.77	0.76	0.75	0.73	0.72	0.71	0.68	0.67	0.67	0.67	0.67	0.67	0.67
	2.5	1.00	0.81	0.80	0.79	0.78	0.76	0.75	0.73	0.71	0.70	0.70	0.70	0.70	0.70	0.70
	3	1.00	0.84	0.82	0.81	0.80	0.78	0.77	0.76	0.73	0.72	0.72	0.72	0.72	0.72	0.72
	3.5	1.00	0.86	0.85	0.83	0.82	0.80	0.80	0.78	0.75	0.74	0.74	0.74	0.74	0.74	0.74
	4	1.00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Gelatin	1	1.00	0.63	0.60	0.59	0.57	0.56	0.54	0.52	0.51	0.51	0.50	0.50	0.50	0.50	0.50
	2	1.00	0.72	0.70	0.68	0.66	0.64	0.62	0.60	0.57	0.56	0.56	0.56	0.56	0.56	0.56
	2.5	1.00	0.78	0.76	0.74	0.73	0.71	0.69	0.65	0.63	0.63	0.63	0.63	0.63	0.63	0.63
	3	1.00	0.80	0.78	0.77	0.75	0.74	0.73	0.70	0.68	0.67	0.67	0.67	0.67	0.67	0.67
	3.5	1.00	0.84	0.83	0.81	0.80	0.78	0.77	0.75	0.73	0.72	0.72	0.72	0.72	0.72	0.72
	4	1.00	0.85	0.83	0.82	0.81	0.80	0.79	0.77	0.75	0.74	0.74	0.74	0.74	0.74	0.74
Acacia	1	1.00	0.62	0.60	0.58	0.55	0.54	0.53	0.51	0.50	0.49	0.48	0.48	0.48	0.48	0.48
	2	1.00	0.70	0.68	0.64	0.62	0.59	0.57	0.56	0.53	0.51	0.49	0.49	0.49	0.49	0.49
	2.5	1.00	0.75	0.73	0.72	0.69	0.67	0.66	0.64	0.61	0.59	0.59	0.59	0.59	0.59	0.59
	3	1.00	0.78	0.77	0.74	0.70	0.68	0.67	0.65	0.61	0.60	0.60	0.60	0.60	0.60	0.60
	3.5	1.00	0.79	0.78	0.76	0.74	0.72	0.70	0.68	0.65	0.64	0.63	0.63	0.63	0.63	0.63
	4	1.00	0.80	0.79	0.77	0.75	0.73	0.71	0.69	0.67	0.67	0.67	0.67	0.67	0.67	0.67

n=3, P<0.05

in the concentrations of suspending agent which led to a decrease in the rate of settling of the particles. The dispersed particles sediment at a faster rate in suspensions containing 0.1 and 2% w/v of suspending agent and the initial sedimentation

sedimentation during the first 24 h are much faster than afterwards. All suspension samples prepared maintained steady sedimentation volume after 72 h with the different concentrations of suspending agent. Formulations containing *Terminalia* gum

at 3.5 to 4% w/v did not show a reduction in sedimentation volume throughout the period of observation. This was due to the high viscosity and the suspension was difficult to pour from the container. At 2.5% w/v, there was an initial

Table 2. The flow rate and viscosity of magnesium carbonate suspensions prepared using different types of suspending agents.

Suspending agents	Concentration of suspending agents (% w/v)	Flow rate (ml/s)	Viscosity at 25°C* (CentiPoise)
<i>Terminalia randii</i> gum*	0.00	0.51	50.00
	1.00	0.85	415.00
	2.00	0.69	600.00
	2.50	0.43	800.00
	3.00	0.29	920.00
	3.50-4.00	**	**
Tragacanth gum	1.00	1.01	40.00
	2.00	0.82	70.00
	2.50	0.70	74.00
	3.00	0.42	100.00
	3.50	0.35	110.00
	4.00	0.32	160.00
Gelatin	1.00	1.08	20.00
	2.00	1.05	40.00
	2.50	1.00	60.00
	3.00	0.93	80.00
	3.50	0.67	100.00
	4.00	0.65	120.00
Acacia gum	1.00	1.56	14.00
	2.00	1.51	30.00
	2.50	1.44	45.00
	3.00	1.40	50.00
	3.50	1.33	55.00
	4.00	1.26	65.00

**Too viscous to be determined, n = 3, *p < 0.001.

steady decline in sedimentation volume for all the suspending agents which gradually became constant with *Terminalia randii* gum having the highest (0.78). The trend of sedimentation volume for all the suspending agents at 2.5% w/v was: *Terminalia* > compound tragacanth > gelatin > acacia.

Flow rate

The results of flow rate are presented in Table 2. The flow rate of the suspensions was observed to decrease with increase in concentration of suspending agent. Formulation containing *Terminalia* gum at 3.5 to 4.0 % w/v concentration was too viscous and could not flow through the pipette. A good suspension is one that can easily flow through a container. This also indicates that the dosing of the suspension would not be uniform. The flow rates of the suspensions were in the order of acacia > gelatin >

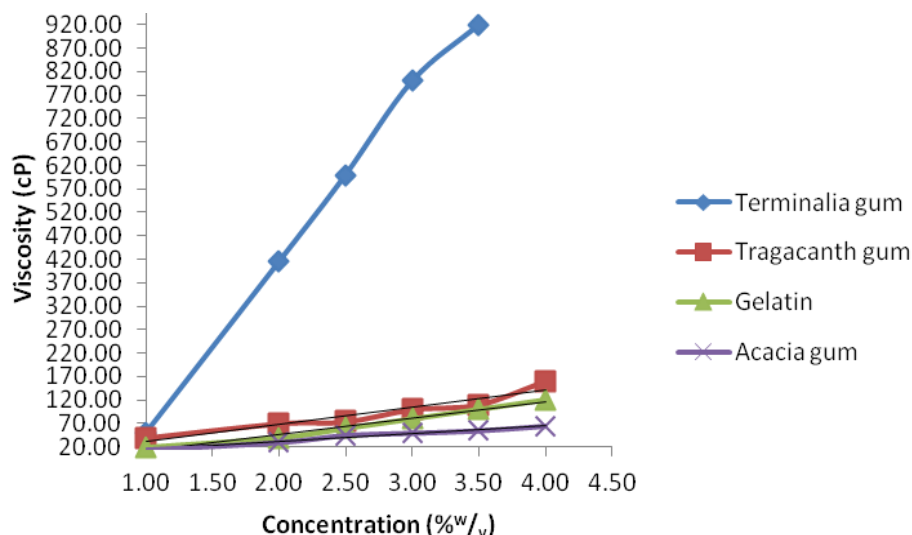
compound tragacanth > *T. randii*.

Viscosity

The viscosities (Table 2) of the suspensions containing the different suspending agents was observed to increase with increase in concentration of suspending agents (Figure 1) and the ranking of viscosity was in the order of *T. randii* gum > compound tragacanth > gelatin > acacia. Table 3 also shows the result of viscosity data analyzed using linear regressions and good correlations ($r^2 = 0.910$ to 0.996) between viscosity and concentrations were obtained from the suspending agents with a trend of *Terminalia* > compound tragacanth > gelatin > acacia. *Terminalia randii* gum also gave significantly higher ($p < 0.001$) viscosities than the other agents at all concentrations used. This shows that whenever a material with high viscosity is required, the gum will be readily

Table 3. The correlation of viscosities of suspending agents with concentration in magnesium carbonate suspension

Suspending agent	Correlation coefficients (r^2)
<i>Terminalia randii</i> gum	0.9961
Tragacanth gum	0.9096
Gelatin	0.9796
Acacia	0.9804

**Figure 1.** Effect of concentration of suspending agents on the viscosity of Magnesium carbonate suspensions.

gum will be readily useful and quantity needed might be low and this is of economic importance.

Particle size analysis

All the formulations obeyed Stoke's equation when subjected to particle size analysis (Data not shown). The ranking of particle size was terminalia < compound tragacanth < gelatin < acacia. This implies that the particle diameter of dispersed phase was directly proportional to the viscosity of the medium as imparted by the suspending agent. The proportion of smaller particle sizes were also inversely proportional to the sampling time implying that the longer the sampling time, the higher the proportion of smaller particles obtained. This is consistent with the expected behavior of dispersed solids in which the bigger particles fall faster than the smaller ones.

Redispersibility

Generally, the formulated suspensions have a non-Newtonian flow and a ranking of *T. randii* gum > compound

compound tragacanth > gelatin > acacia with respect to sedimentation volume, viscosity and ease of re-dispersibility. Optimum stability and ease of redispersion of magnesium carbonate suspension was obtained at a moderate concentration of 2.5% w/v for terminalia gum.

Conclusion

In view of these results, *T. randii* gum exhibited the best suspending properties when compared to all the other agents employed in the formulations and can be used as an alternative suspending agent in the formulation of pharmaceutical suspensions. Moreover, its high viscosity could be exploited for use as a stabilizer and thickening agent in the food industry.

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