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PREFORMULATION STUDY ON THE GUM OF *MORINGA OLEIFERA*

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Preformulation study on the gum of Moringa oleifera was carried out. Various parameters like colour, odour, taste, pH and physical characteristics such as density, angle of repose, hygroscopicity, swelling index, loss on drying, total ash, insoluble matter and solubility were determined using the standard pharmacopoeial procedure. The gum was found to be hygroscopic and organoleptically acceptable. The pH was found to be 5.77 which is ideal for topical use. The gum solution exhibits non Newtonian, pseudoplastic rheological behaviour. It was found to be stable to heat, humidity, light and compatible with verapamil and propranolol hydrochloride. The gum has the potential to be used in different pharmaceutical formulations and food preparations.

Keywords: Preformulation, *Moringa oleifera*, Rheology, pH, Solubility

INTRODUCTION

Preformulation study is necessary to formulate dosage forms. This implies that some of the physical chemistry has to be known and this requires determination of physicochemical properties. The approach was so logical, that it became part of official requirements of pharmacopoeias (Wells 2002). The goals of preformulation study (Wells 2002; Niebergall 1985) are to establish physicochemical parameters, compatibility with drugs and safety.

Moringa oleifera is a small genus of quick growing tree distributed in India. The stem of the tree exudes a gum which is initially white in colour but changes to reddish brown or brownish black on exposure to sunlight. It is sparingly soluble in water but swells in contact with water giving a highly viscous solution. It is a polyuronide consisting of arabinose, galactose and glucoronic acid in the proportion of 10:7:2; rhamnose is present in traces (Council of Scientific and Industrial Research 1998). There are reports about the application of *M. oleifera* gum as gelling agent (Panda *et al.* 2006), suspending agent (Panda *et al.* 2007), film former (Panda *et al.* 2008a), binder and release retardant in tablet (Panda *et al.* 2008b). The gum has got a high lethal dose (LD_{50}) in mice indicating its safety. Considering these utilities the preformulation study was undertaken (Panda *et al.* 2007).

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METHODS

Isolation of the Gum

The gum was isolated as per the reported method (Panda *et al*. 2006). All materials used were of analytical grade.

Physical Characteristics

The organoleptic characteristics such as colour, odour and taste were observed. Density was determined using the settling apparatus (British Pharmacopoeia 1988). The angle of repose was determined using the fixed funnel method (Martin, Bustamante and Chun 1994; Eugene and Timothy 1991) and hygroscopicity was determined using the method described by Wadke, Serajuddin and Jacobson (1989). Loss on drying, total ash, insoluble matter, pH and solubility were determined using the standard pharmacopoeial procedure (Indian Pharmacopoeia 1985).

Swelling Index

1 g of gum was mixed with 96% ethanol (sufficient to moisten the gum) followed by the addition of 25 mL of distilled water in a graduated cylinder, shaken every 10 minutes by hand for 1 hour, and allowed to stand for 4 hours. The volume occupied by the swollen gum was determined. Swelling index was expressed as volume in mL occupied by 1 g of the drug after swelling.

Rheological Study

A 1% solution of the *M. oleifera* gum in water was prepared by sprinkling weighed quantities of the gums into distilled water, corresponding to 3/4th of the final volume of solution, while being stirred using an overhead stirrer. The stirring was continued for 1 hour after the addition was completed. The solutions were kept aside for 24 hours to allow the gums to hydrate and swell completely to its equilibrium value. The volume was made up with distilled water to produce a 1% w/v solution and stirred for an additional 20 minutes to achieve a uniform solution.

Gum solutions having concentrations of 0.8%, 0.6%, 0.4% and 0.2% w/v were prepared by suitably diluting the 1% w/v solution. Diluted solutions were stirred for 20 minutes to achieve a uniform product. The system was stabilised to attain equilibrium viscosity for 10 hours before determination of viscosity was made.

The viscosity of the prepared gum solutions were measured with a Brookfield Synchro-Lectric viscometer (Model RVT, Brookfield Engineering Laboratories Inc., Middleboro, MA, USA) at 25°C in the range 10 to 100 rpm. All the solutions were translucent and appeared like colloidal dispersion.

The 1% w/v of the gum solution was stored for 1 hour at 40°C, 60°C and 80°C and their apparent viscosity was determined at 100 rpm.

Solid State Stability

Stability of the gum to heat, humidity and light was studied (Wadke, Serajuddin and Jacobson 1989). Gum was placed in stoppered glass bottles and stored at 3 different conditions that is 50°C in hot air oven, 40°C and 75% relative humidity in humidity chambers and exposed to light with 400 foot-candles of illumination at ambient humidity for 2 weeks. Any visual change was noted.

Compatibility Study

The compatibility study (Eugene and Timothy 1991; Wadke, Serajuddin and Jacobson 1989) was carried out with verapamil hydrochloride and propranolol hydrochloride using diffusive reflectance spectroscopy [Fourier transform infrared spectrophotometry (FTIR) 8400S, Shimadzu, Kyoto). Infrared spectrum (FTIR 8400S, Shimadzu, Kyoto) was taken by scanning the sample in potassium bromide physical mixture. The samples of pure drug, gum and gum/drug mixture were scanned individually.

RESULTS

The angle of repose was found to be 33°, indicating the poor flowability of the powder. Other physical characteristics like loss on drying and swelling index are shown in Table 1.

Table 1: Gum of *M. oleifera* preformulation observations.

Parameter	Observation
Colour	Brownish black
Odour	Characteristic
Taste	Mucilaginous
Poured density (g/mL)	0.71
Tapped density (g/mL)	1.23
Angle of repose	33°
Hygroscopicity	17%
Swelling index (mL/g)	19.7
Loss on drying	11% w/w
Total ash	2.6% w/w
Insoluble matter	0.03% w/w
pH	5.77
Solubility	Sparingly soluble in water forming a viscous solution, practically insoluble in acetone, alcohol and ether
Heat	No visual changes
Humidity	Aggregation of gum into lumps
Light	No visual changes

Figure 1 shows that the gum solutions exhibited non-Newtonian, pseudoplastic rheological behaviour at all concentrations. At low concentration, solutions showed less pseudoplastic behaviour. The viscosity of gum solutions at 0.8% and below changed slightly with increasing shear. The gum solutions did not exhibit any significant thixotropy (Wells 2002; Caerter 1986). The viscosity of the different concentrations of the gum solution (Fig. 2) decreased with increase in temperature.

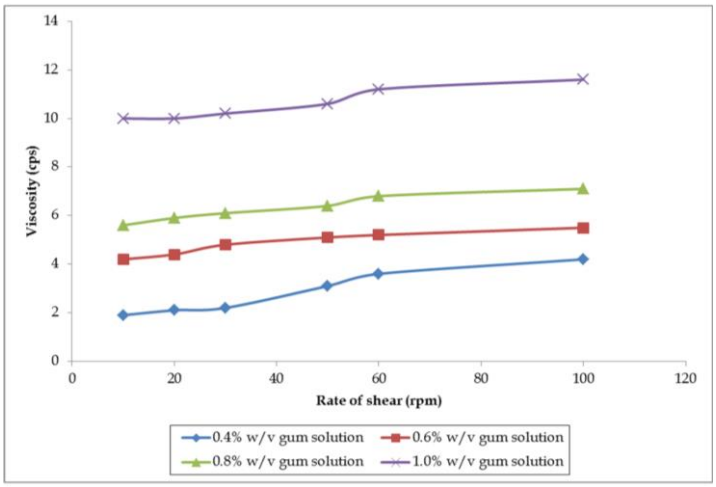

Fig. 1: Viscosity of gum solution at different shear rates.

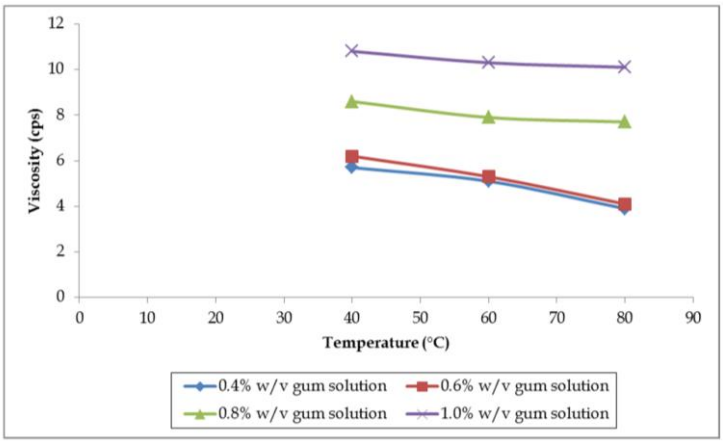

Fig. 2: Viscosity of gum solution at different temperature.

Compatibility Study

The FTIR spectrum (Fig. 3a) of the gum of *M. oleifera,* produced sharp peaks between 3650–3590 cm^{-1} is due to stretching vibration of –OH group. The peak between 2936–2916 cm^{-1} is due to the C-H stretching of arabinose, while the peak between 1730–1740 cm^{-1} is owing to the presence of aldehyde group of mannose. There are peaks between 1700–1725 cm^{-1}, 3560–3500 cm^{-1} and 1440–1395 cm^{-1} indicating the C=O stretching, OH stretching and C=O stretching and OH deformation, respectively, of the glucoronic acid.

The FTIR spectrum of propranolol hydrochloride (Fig. 3b), revealed the presence of peaks at 2965.1 cm^{-1} due to the presence of a secondary amine group. The peaks at 3283.7 cm^{-1} was due to the hydroxyl group (secondary). The aryl alkyl ether displayed a stretching band at 1268 cm^{-1} and the peak at 797.9 cm^{-1} was due to substituted naphthalene (Fig. 3c).

FTIR spectrum (Fig. 3d) of verapamil hydrochloride is characterised by the absorption of NH group at 3467 cm^{-1}. In spectra of verapamil hydrochloride with gum (Fig. 3e), this band was shifted towards lower frequencies at 3282 and 3280 cm^{-1}, respectively.

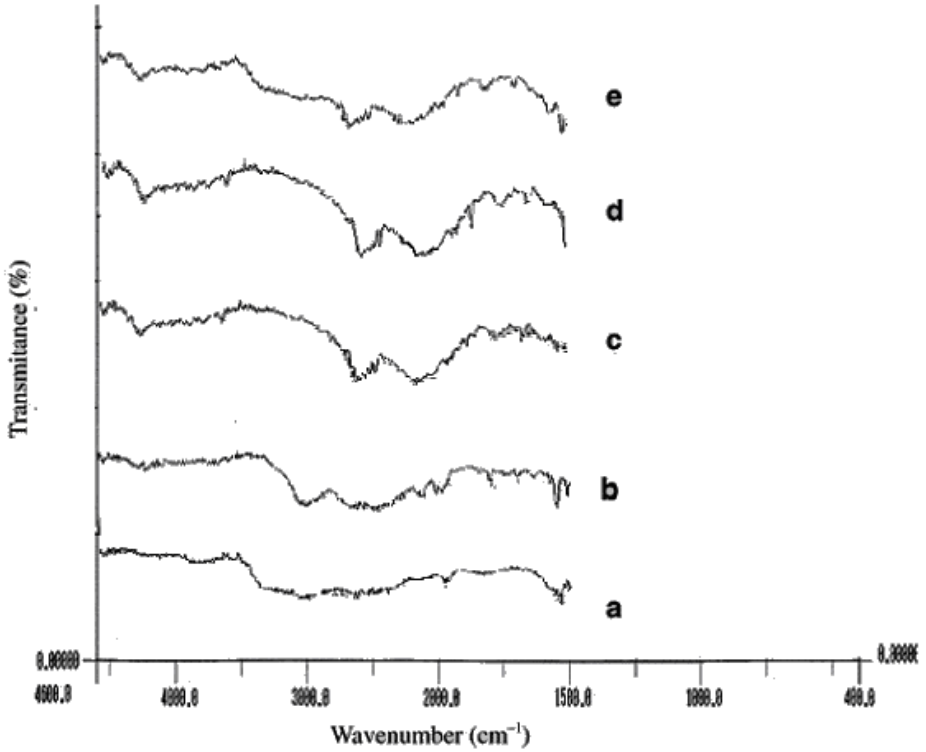

Fig. 3: FTIR spectroscopy of: (a) gum of *M. oleifera*, (b) propranolol HCl, (c) mixture of gum and propranolol HCl, (d) verapamil HCl and (e) mixture of gum and verapamil HCl.

DISCUSSION

The poured density and tapped density of the gum powder are measures to indicate the uniformity of the bulk chemical. They help in selecting proper size of the container, packing material and mixing apparatus in the production of tablets and capsules. They also indicate the compressibility of the powders. The poor flowability of the powder may be due to the presence of large quantity of moisture and the small size of the powder. The surface property may also be responsible for this effect as particles having smooth surface have better flowability than those with rough surface. The powder is hygroscopic, hence care is required during storage and the presence of moisture may be harmful to the moisture-sensitive drugs. The high swelling index indicates the potential of the gum to act as a disintegrant in tablet formulation as well as a release retardant (Koresemeyer *et al*. 1983). The rheological property of the gum may be attributed to thermodynamic properties such as temperature, molecular weight and structure.

The FTIR spectra (Fig. 3c) of propranolol hydrochloride/gum mixture showed a broadening of peaks at 3283 cm^{-1} frequency due to extensive hydrogen bonding. Major frequencies of functional groups of pure drug remain intact in drug and gum mixture hence, there is no major interaction between the drug and gum used in the study. In the FTIR spectrum of verpamil hydrochloride and gum, the shift in the band could be due to some sort of interactions between the drug and polymer. These interactions might be due to the intermolecular hydrogen bonding or complexation.

CONCLUSION

The organoleptic properties of the gum of *M. oleifera* are quite acceptable. Favourable results were found with rheological and compatibility studies. It appears that the gum has the potential to be used as an excipient in different pharmaceutical formulations.

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Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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