Powder Technology 246 (2013) 187–192

Contents lists available at SciVerse ScienceDirect

Powder Technology

journal homepage: www.elsevier.com/locate/powtec

Flow and consolidation properties of neem gum coprocessed with two pharmaceutical excipients

Abayomi Tolulope Ogunjimi, Gbenga Alebiowu *

Department of Pharmaceutics, Obafemi Awolowo University, Ile-Ife, Nigeria

ARTICLE INFO

Article history:
Received 29 December 2012
Received in revised form 12 April 2013
Accepted 30 April 2013
Available online 9 May 2013

Keywords:
Neem gum
Coprocessing
Consolidation index
Irregularity
Equivalent circle diameter

ABSTRACT

Neem gum (NMG) was coprocessed with either rice starch (STC) or lactose (LTC) at different proportions to produce different novel excipients. The native and novel excipients were assessed using shape and size factors (aspect ratio, roundness, irregularity, equivalent circle diameter (ECD)), bulk density, angle of repose (AR), angle of internal friction (AI), flow rate (FR), consolidation index (C) and rate of consolidation (K) as evaluation parameters. The results were dependent on the particle shape, size and the amount of rice starch or lactose present in the coprocessed excipients. The study concluded that coprocessing neem gum with either rice starch or lactose would enhance the consolidation properties and still improve the flow of the novel excipients produced.

1. Introduction

Tablet manufacturing has changed significantly over the years because of the introduction of direct compression and high speed machines, with these two developments increasing the functionality demand on the excipients used in terms of flow and compression [1]. The uniform flow of powders is one of the most important considerations in solid dosage manufacture and also dictates the quality of the final product in terms of weight and content uniformity [2–5]. Powder flow, which is governed by physical rather than chemical properties, has been shown to depend on size, size distribution or shape of the powder particles [3,6–8]. Tableting operations therefore require excipients with the desired flow, physical and mechanical properties [9]. However, due to the introduction of direct compression processes and high speed machines, shortcomings of existing excipients, and lack of excipients that address specific patients, coprocessing is now being employed by formulators in creating excipients with intrinsic multifunctional properties.

Coprocessing is the science of particle engineering of individual excipients, combining two or more conventional excipients (usually with one or more primary functionality which compromises other functionalities) into a single multifunctional/advanced substance of high functionality with superior intrinsic performance — high compatibility, high intrinsic flow, good lubricating efficiency, improved blending properties and good binding properties. The performance of coprocessed excipients exceeds those of conventional ingredients [9,10]. Several coprocessed excipients formulated have been shown to have improved properties including good flowability, compressibility, and hardness that is independent of machine speed [11].

This study determined and evaluated the properties of processed neem gum obtained from the trunk of *Azadirachta indica* A. Juss (Meliaceae) and coprocessed excipients produced from the gum with lactose or rice starch at different ratios, and related these properties to their performance in terms of flow and consolidation.

2. Materials and methods

The materials used were rice starch BP, lactose BP (A.B. Knight and Co., London, United Kingdom), acetone, 99.8% ethanol (Sigma-Aldrich Laborchemikalien GMBH, D 30926 Seelze, Germany), and neem gum obtained from the incised trunk of *A. indica* tree at the Obafemi Awolowo University, Ile-Ife, Nigeria and processed using established methods [10,12].

2.1. Collection and processing of neem gum

The collected neem gum was hydrated in a sufficient amount of distilled water for 5 days with intermittent stirring, and extraneous materials were removed by filtering using a Buchner funnel under negative pressure. The gum from the filtered slurry was precipitated with 99.8% ethanol; the precipitated gum was filtered, washed several times with acetone and dried in a hot air oven at 30 °C for 96 h before milling and sieving with a mesh no. 60 (250 μm) and then stored in an amber colored bottle until needed.

* Corresponding author. Tel.: +234 8069384107.
E-mail addresses: gbengaalaba@gmail.com, galebiowu@rediffmail.com (G. Alebiowu).

0032-5910/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.powtec.2013.04.051

Table 1
Formulae and codes of coprocessed excipients.

Batch ratios	Composition (g)		Codes
	Neem gum	Lactose/rice starch	
3:1	175	25	NL1
1:1	100	100	NL2
1:3	25	175	NL3
3:1	175	25	NS1
1:1	100	100	NS2
1:3	25	175	NS3

2.2. Preparation of coprocessed excipients

Batches of 200 g each (Table 1) containing neem gum–lactose or neem gum–rice starch mixtures at different ratios i.e. 3:1, 1:1 and 1:3 were coprocessed respectively according to Ogunjimi and Alebiowu's [10] methods with slight modifications. The neem gum for each batch was dissolved in sufficient quantity of distilled water to form a viscous homogeneous solution. A sufficient amount of distilled water was added to the previously milled and sieved (mesh no. 60 (250 μm)) lactose or rice starch to form either a solution or slurry. The solution or slurry was added to the viscous solution of the neem gum by mixing in a Hobart planetary mixer (Hobart Canada Inc., Don Mills, ON, Canada). Mixing was carried out over a period of 15 min and the resulting homogeneous paste was dried at 40 °C for 72 h in a hot air oven. The dried mass was then milled and sieved with a mesh no. 60 (250 μm) and stored in an amber colored screw-capped bottle until needed.

2.3. Characterization methods

2.3.1. Determination of particle shape and size of the neem gum (NMG), rice starch (STC), lactose (LTC) and coprocessed excipients

The size and shape of NMG, STC, LTC and the coprocessed excipients were determined by optical microscopy (LEICA DM 750 research microscope with an integrated icc50 camera, LEICA Microsystems GmbH, Germany). The images (Figs. 1–3) were then transferred to a personal computer for analysis. Approximately 300 particles picked randomly in the optical field for each sample were analyzed using the Image Pro Premier software (Media Cybernetics, Bethesda, MD, USA) to determine the particle descriptors of major and minor axis length, perimeter and projected area from which shape factors of aspect ratio, roundness, irregularity and equivalent diameter were determined according to the following equations [13]. The parameters obtained were subjected to linear regression analysis to determine their relationships with the flow rate and angle of internal friction of the powders.

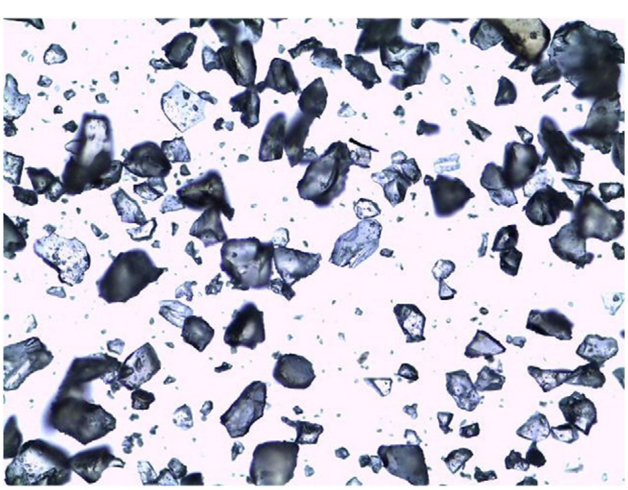

Fig. 1. Photomicrograph of neem gum powder (×100).

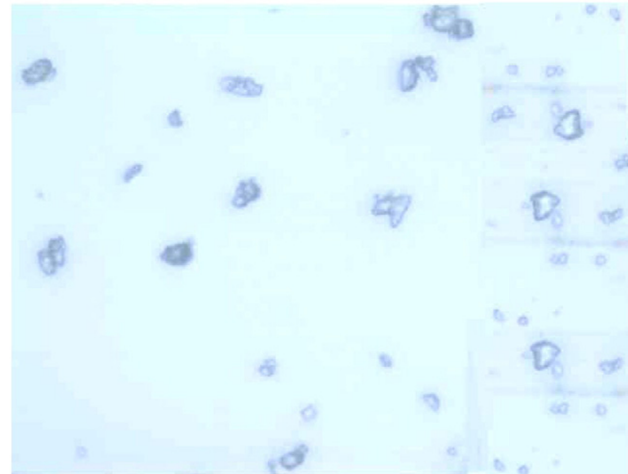

Fig. 2. Photomicrograph of lactose powder (×400).

$$\text{Aspect ratio} = \frac{b}{l} \quad (1)$$

$$\text{Roundness} = \frac{4 \times \pi \times A}{P^2} \quad (2)$$

$$\text{Irregularity} = \frac{P}{l} \quad (3)$$

$$\text{Equivalent circle diameter(ECD)} = 2 \times \sqrt{\frac{A}{\pi}} \quad (4)$$

where

b length of the minor axis (minimum Feret diameter)
l length of major diameter (maximum Feret diameter)
A projected area of the particle
P perimeter.

2.3.2. Determination of physical properties of NMG, STC, LTC and coprocessed excipients

Particle density of each of the powders was determined by using the liquid pycnometer method with acetone as the displacement

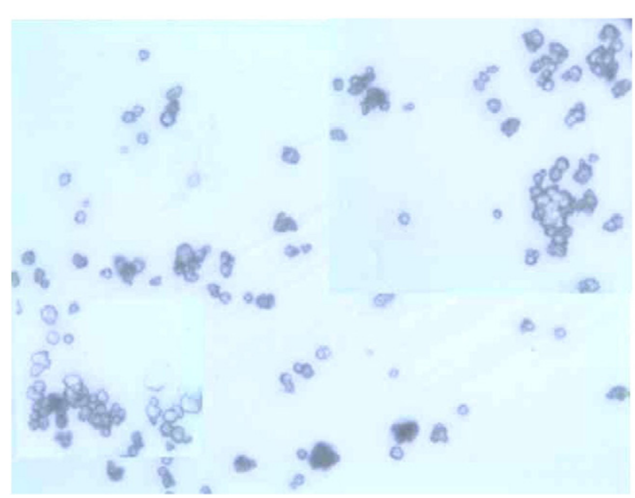

Fig. 3. Photomicrograph of rice starch granule (×400).