Vol. 7 no. 1, pp. 1-4 (March 2010)

http://ajol.info/index.php/jpb

Journal of
PHARMACY AND
BIORESOURCES

Granule properties of paracetamol made with *Bombax ceiba* gum

Jennifer D. Audu-Peter*, Wuniah Bako and James K. Vandi

Department of Pharmaceutics and Pharmaceutical Technology, University of Jos, PMB 2084 Jos. Nigeria.

Received 30th December 2009; Accepted 11th February 2010

Abstract

Bombax ceiba gum was extracted from the calyx of the Bombax flower using both hot and cold water extraction method. The gum was used as binder to prepare paracetamol granules in concentrations of 1, 1.5, 2, and 3 %. Acacia gum was used to prepare the standard at the same concentrations. The granule properties of all the batches; angle of repose, flow rate, true density, Carr's compressibility, Hausner's quotient, moisture content, bulk and tapped densities, granule porosity and particle size distribution were evaluated. The results show that though hot water extraction method gave a higher percentage yield, the gum obtained from cold water extraction method gave a much more suitable granule property when compared with the standard used.

Keywords: *Bombax ceiba*, Paracetamol; Granule properties

Introduction

Granulation is the process of increasing the particle size of powdered ingredients to confer fluidity and compressibility, two properties most desirable for tabletting. Rubinstein (1993) and Summers (1993) have enumerated reasons and advantages of granulating pharmaceutical powders before compression. Seagal *et al* (1979) have shown that the properties of granules are influenced by the manufacturing process, while Okafor and Danat (2004) established the influence of granulating solvent on drug release. Granulation is achieved by using binders. Summers (1993) has articulated particle bonding mechanisms involved and the mechanism of granule formation.

Binders coat the drug particle and therefore the solubility of the binder in water can determine the release rate of the active from the granule or tablet, (Wells, 1980). It has also been shown that the properties of granules majorly influence the properties of tablet made from them, (Summers, 1993, Rubinstein 1993 and Wells, 1980).

The bombax gum is extracted from the dried calyx of the *Bombax ceiba* plant, Family Bombaceace. The plant is native to South America. It is known as the silk cotton tree (Watson and Dallwitz, 1992) and is a wild plant in Nigeria, where it is called "*Rimi*" in Hausa, "*Akpe-eye*" in Igbo and "*Araba*" in Yoruba. Different parts of the plant has economic value, the wood being used in furniture making while the calyx is dried and powdered and used as soup thickener.

* Corresponding author. *E-mail address*: aududp@unijos.edu.ng Tel: +234 (0) 8037000340
ISSN 0189-8442

A previous paper has dealt with the sourcing, extraction and evaluation of the gum as a pharmaceutical agent (Audu-Peter *et al*, 2009) and this paper evaluates properties of granule prepared using the gum as a binder.

Experimental

The collection, identification and extraction of the gum by cold water (CWE) and hot water (HWE) extraction have been presented in our previous work (Audu-Peter *et al*, 2009).

Preparation of paracetamol granules. Using the tablet formula in Table I, four batches of each gum, (CWE, HWE and Acacia) were prepared using wet granulation methods.

Evaluation of granule properties:
Particle size analysis. From each batch, 50.0 g of the granule was placed in the top sieve of nest of sieves of sizes arranged in order of 60, 80 and 100 with fines collector. The nest was mechanically shaken on sieve shaker (Endicott, EFL 1 MK3) for 15 minutes and the quantity of granule retained on each sieve was weighed and the per cent weight retained was calculated, the results are presented in Table II.

True density. The true density of each granule batch was determined by the liquid displacement method using benzene as the immersion fluid and pycnometer bottle using the method of Okhamafe *et al* (1991).
Flow Rate. The method of Chukwu (1992) was used to determine the flow rate and the results are presented in Table III.

Angle of repose. The method of Builders *et al* 2005 was used to determine the angle of repose for each batch, taking three determinations each. The results are presented in Table III.

Bulk and tapped densities. The method of Ohwoavworhua and Kunle, 2006 was used and the results are presented in Table III.

Moisture Content. The method of BP 1980 was used. The results are presented in Table III.

Hausner and Carr's compressibility indices. These are derived functions and were calculated as reported by Staniforth, 1993.

Granule porosity. This was derived from the values of true and bulk densities (Ohwoavworhua and Kunle, 2006) when fitted into the equation

$$e = 1 - B_b / D_t \times 100.$$

Where B_b is the bulk density, D_t is the true density and e is the granule bed porosity when expressed in percentage (Staniforth, 1993).
The results are shown in Table III.

Results and Discussion

The results in Table III show that increasing the concentration of the gum in tablet formula produced better granule properties. It was also observed that values for true densities, flow rates and angles of repose for HWE, CWE and acacia increased with increase in concentration of the gums in the granules; while the bulk and tapped density values, Carr's and Hausner's Quotient values decreased with increase in concentrations for all the gums. Granule porosity increased with increasing gum concentrations, even though values fell below range of 30-50 % for pharmaceutical ingredients. These properties are essential for determining the suitability of a material for direct compression. Carr's index and Hausner's Quotient are useful for indirect measurement of powder flow (Staniforth, 1993). Hausner's Quotient indicates particle friction, while Carr's index shows the aptitude of a material to decrease in volume (Staniforth, 1993) and compress into a compact (compressibility). Granule porosity gives an indication of particle shape and size, and packing arrangement (Staniforth1993). The values for Carr's and Hausner's Quotient indices are inversely proportional to the powder flow and according to Staniforth

(1993), Hausner's ratio of greater than 1.25 indicates poor flow while Carr's index value below 16 % indicates good flow and above 35% is of poor flow. From Table III therefore, flow properties are poor, but increase in gum concentration gives increased flow rate for all gum types, and so while acacia had flow rate values for all gum concentrations used, HWE and CWE had values for only 2% and 3 % gum concentrations. This could be attributed to better granule formation at higher gum concentrations than lower concentrations observed from granule particle size distribution in Table II, and the higher moisture content of acacia gum batches, as moisture content was said to contribute to flow properties of powders and granules (Okhamafe *et al.*, 1991). Generally, binding action increases particle size, which in turn improves flow property.

It is however interesting to observe that whereas acacia had flow values for all its concentrations used, only the higher concentrations for HWE and CWE flowed, but their values had higher flow rate than for even the highest concentration of acacia used. The values for moisture content (MC) showed that all the granule batches had increasing moisture content as concentration of gums in them increased. This indicates a correlation between gum concentration and moisture content value for all the gums used. Acacia had the greater value of 9.0 % MC for 2.0 % and 3.0 % gum concentrations while its lower concentration had comparable values to higher concentrations of HWE and CWE gums. However, CWE had higher moisture content value than HWE and in fact, its least value of 2.7% at 1.0 % gum concentration was higher than for HWE at 3.0% gum concentration.

Table I: Formula for preparing paracetamol granule of batch size 100 tablets.

Ingredients	Batch											
	1	2	3	4	5	6	7	8	9	10	11	12
Paracetamol %	69.5	69.5	69.5	70.0	70.0	70.0	70.5	70.5	70.5	71.0	71.0	71.0
Maize starch %	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5
Magnesium stearate %	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Acacia gum %	3.0	-	-	2.0	-	-	1.5	-	-	1.0	-	-
CWE gum %	-	3.0	-	-	2.0	-	-	1.5	-	-	1.0	-
HWE gum %	-		3.0	-	-	2.0	-	-	1.5	-	-	1.0

Table II: Percent granule particle size oversize retained using various sieve sizes

Gum	Gum conc (%)	Sieve size (fines) 60	80	100	>100
		Percent granule oversize retained (%)			
Acacia (AC)	3.0	21.65	33.35	31.15	12.80
	2.0	19.50	36.70	27.70	15.01
	1.5	19.40	36.90	25.70	17.20
	1.0	18.10	39.30	24.50	17.00
CWE	3.0	19.70	35.60	27.03	17.40
	2.0	19.50	35.70	27.20	15.60
	1.5	15.50	40.90	25.80	15.80
	1.0	12.30	41.50	30.80	13.40
HWE	3.0	17.80	40.50	23.90	16.70
	2.0	17.50	41.20	23.50	16.00
	1.5	13.70	42.30	27.10	15.10
	1.0	10.30	44.60	27.50	15.50

Table III: Granule Properties

	Conc (%)	Bulk density (g/ml)	Tapped density (g/ml)	True density (g/ml)	Carr's Index (%)	Hausner's quotient	Flow rate (g/sec)	Angle of repose (^{o})	Granule porosity (%)	% Moisture Content
Acacia	3.0	0.494 (0.02)	0.561 (0.01)	1.87(0.02)	26.74	1.27	5.78(0.01)	21.93(0.15)	26.42	9.0(0.20)
	2.0	0.387 (0.01)	0.561 (0.00)	1.83(0.11)	30.76	1.45	5.52(0.00)	21.87(0.16)	21.15	9.0(0.20)
	1.5	0.387 (0.01)	0.551(0.00)	1.77(0.09)	29.56	1.42	5.32(0.01)	19.07(0.15)	22.50	3.7(0.10)
	1.0	0.375 (0.01)	0.632(0.01)	1.73(0.09)	40.62	1.60	5.05(0.10)	18.97(0.17)	21.68	3.0(0.12)
CWE	3.0	0.410 (0.01)	0.583(0.02)	1.83(0.10)	29.69	1.42	17.55(0.05)	22.09(0.16)	22.40	4.3(0.12)
	2.0	0.382 (0.02)	0.658(0.01)	1.83(0.09)	40.13	1.67	10.10(0.02)	22.52(0.15)	20.87	3.8(0.11)
	1.5	0.390 (0.01)	0.632(0.00)	1.82(0.09)	31.10	1.64	-	-	21.43	3.3(0.11)
	1.0	0.382 (0.02)	0.652(0.00)	1.82(0.09)	41.61	1.71	-	-	20.99	2.7(0.12)
HWE	3.0	0.392 (0.01)	0.594(0.00)	1.89(0.11)	33.91	1.51	17.58(0.12)	22.41(0.14)	20.74	2.5(0.11)
	2.0	0.382 (0.01)	0.594(0.01)	1.86(0.11)	35.66	1.55	9.80(0.11)	21.44(0.14)	20.54	2.0(0.12)
	1.5	0.375 (0.01)	0.612(0.01)	1.82(0.11)	38.75	1.63	-	-	20.60	1.5(0.15)
	1.0	0.372 (0.01)	0.659(0.00)	1.77(0.11)	40.52	1.68	-	-	21.02	1.2(0.12)

Values are mean and standard deviations are in parenthesis; number of replicates are three (n=3)

This trend was observed with pure samples of the gum where acacia had greatest moisture content followed by CWE and HWE (Audu-Peter *et al.*, 2009). Therefore it maybe said that the method of extraction may have affected the moisture content value, though it did not significantly improve flow rate of CWE and HWE as their flow were similar. However, as the two results had lower values than acacia, HWE of gum could be used for substances substantially affected by higher moisture content.

References

Audu-Peter J.D., Vandi, J.K and Bako, W. (2009). Evaluation of some physicochemical properties of Bombax gum. *J Pharm & Biores* Vol.6 no.2. pp78-83.

Builders, P.F, Kunle, O.O and Isimi, Y.C (2005). Gum from bark of Anogeissus leiocarpus as a potential pharmaceutical raw material- granule properties. *J. Pharm & Biores.* 2(7): 13-19

Ohwoavworhua, F.O., and Kunle, O.O. (2006). Properties of microcrystalline cellulose obtained from coconut (*Cocos nucufera*) husk. *J. Pharm & Biores*. 3(1): 12-18.

Okafor, I.S and Danat J.M (2004) The influence of granulating solvents on drug release from tablets containing grewia gum. *J. Pharm. Biores.* 1 (I) : 76-83.

Okhamafe, A.O., Igboechi, A and Obaseki, T.O.(1991). Cellulose extracted from groundnut shell and rice husk I: Preliminary physicochemical characterization. *Pharm. World J*. 8(4): 120-130

Rubinstein, M.H (1993). Tablets In: Pharmaceutics, The science of dosage form design. M.E Aulton (Ed) Churchill Livingstone. Pp 304-321. ELBS, Churhill Livingstone, UK

Summers, M.P (1993). Granulation; In: Pharmaceutics, The science of dosage form design. M.E Aulton (Ed) Churchill Livingstone. Pp 616-628. ELBS, Churhill Livingstone, UK

Staniforth, J.N (1993). Powder flow. In: Pharmaceutics, The science of dosage form design. M.E Aulton (Ed). Churchill Livingstone. Pp 600-615. ELBS, Churhill Livingstone, Hong Kong.

Seagal, H., Burt, I ,Ryder, J., Rue, P., Murray, S., Beal, N., and Warrack, J. K (1979).The relationship between granule structure, process of manufacture and the tabletting properties of a granulated product. *Int. J. Pharm. Tech. Prod. Mfr.,* **1**,36.

The British Pharmacopoeia.(1980). Vol. I &II. Her Majesty's Stationary Office, England

Wells, J.D (1980). PhD. Thesis, Liverpool Polytechnic, UK.

Watson, L. and Dallwitz, M.J (1992). The families of flowering plants. http://www.biodiversity.uno.edu/delta. accessed on 18th February, 2008