EFFECT OF POWDER COMPONENT ON THE DISTRIBUTION OF COLOURING IN THE VARIOUS FRACTIONS OF GRANULES PREPARED FROM TWO–COMPONENT POWDER SYSTEMS

By

W. O. OPAKUNLE* AND O. A. OBOH

Department of Pharmaceutics and Industrial Pharmacy
College of Medicine, University of Ibadan,
Ibadan

**Correspondence*

ABSTRACT:

A colouring agent extracted from the heartwood of a local plant ***Baphia nitida*** *has been used in the investigation of the distributive properties of a colourant in the various granule size fractions of tablet granulations. As granules for tabletting were usually made from multi-component powder systems, two component powder mixtures in various proportions were investigated using two concentrations of colouring material.*

Investigations revealed that the solubilities of the components of the powder mixture in the granulating solution played an important role in the distribution of the colouring in the various size fractions of granules prepared from Boric acid: Magnesium Carbonate and Sodium bicarbonate: Magnesium carbonate mixtures. The best distribution of the colouring for the boric acid: Magnesium carbonate mixtures was obtained for the 50:50 mixture while 100% Sodium bicarbonate gave the best distribution of colouring for all batches prepared.

It was also revealed that as the quantity of the less soluble component of the mixture increased, the distribution of colouring in the various granule size fractions became poorer. It also seemed that irrespective of the total concentration of colouring in a granulating system, the presence of a large percentage of a powder which was soluble in the granulating solution would assist in obtaining good distribution of colouring in these granule size fractions.

1. INTRODUCTION

Tablets are coloured for various reasons notable among which are to provide aesthetic value, to distinguish one product from another and to provide control during manufacture. With recent shortages of materials normally imported into Nigeria, it was necessary to look inwards to local sources of materials for research into various aspects of drug formulation. A local dye, prepared from the extract of the heartwood of *Baphia nitida* had earlier been reported as a useful material in formulation investigations. Opakunle and Ajao (1985) (to be published) had earlier shown that the macerated extract of this plant provided a tool for investigating colour distribution in tablet granulations. The colour extract could be analysed easily as it followed the Beer-Lambert Law (concentration versus absorbance was linear passing through the origin). Results obtained by Opakunle and Ajao on single powder systems encouraged further investigation into the usefulness of this material on multi-component powder systems to see the effect of powder components on the distribution of the colouring in the various size fractions of granules prepared from such mixtures of powders.

This line of investigation was also found desirable since tablet granulations usually contain more than one powder and investigations by a number of workers in the past had shown considerable variation in the concentration of some components of powder mixtures in the various size fractions of tablet granulations. Johnson, in 1966 observed that a possible cause of unit-to-unit variation in a drug content of tablets is lack of uniformity in the distribution of drug throughout the granules. Earlier, Lachman and Sywestrowicz (1964) observed the concentration of drug in the larger granules of tablet granulation. As uneven distribution of drug substance had also been observed during drying by Chaudry and King (1961). Selkirk (1974), investigating the effect of massing time on the distribution of borax in the various size fractions of granules prepared also observed uneven distribution. Opakunle (1975) looked into the distribution of lactose in the various size fractions of granules prepared from mixtures of lactose/boric acid, lactose/citric acid, and lactose/sulphanilamide. The results obtained confirmed unevenness in lactose distribution which was dependent on factors such as volume of binder used, concentration of second component and massing time.

This investigation is therefore an attempt to observe the effect of powder components on the distribution of the local colouring material in the various size fractions of tablet granulations.

2. EXPERIMENTAL

2.1 Materials

Boric acid BP, Magnesium Carbonate Heavy, BPC (BDH Chemicals, Poole, England), Sodium bicarbonate, BP (Courtin and Warner U.K.) were used as supplied and acacia powder (BDH, Poole, U.K.) was used as the binder. Methanol (East Anglia Chemicals Sulfork, U.K.) was also used as supplied.

2.1.1 Preparation of Colourant

The heartwood of *Baphia nitida* obtained from the Forestry Research Institute of Nigeria, Ibadan, Nigeria was powdered coarsely and macerated using the B.P. method with methanol as the vehicle. After seven days the mixture was strained, the marc pressed and the liquid obtained evaporated the final drying obtained by evaporating the thick liquid in a hot air oven. The dry extract was then stored in a glass sample bottle and sealed firmly.

2.1.2 Granulation

The three powders selected were mixed in various proportions as shown in Table 1. As the powders have varying solubilities in the aqueous binder solution the various mixtures required different quantities of binder solution to form acceptable granules. The various proportions used and the quantity of granulating solution required are as shown in Table 1. Each blend was dry-mixed for twenty minutes and screened prior to wet granulation.

Batch No.	% Boric Acid	% Mag. Carbonate	% Sodium Bicarbonate	Vol. of Binder (ml)	Conc. of Colour Ext. %
1	100	0	–	50	0.5
2	75	25	–	60	0.5
3	50	50	–	80	0.5
4	25	75	–	100	0.5
5	0	100	–	100	0.5
6	100	0	-	50	0.1
7	75	25	–	60	0.1
8	80	75	–	100	0.1
9	25	75	–	100	0.1
10	0	100	–	100	0.1
11	–	0	100	20	0.5
12	–	25	75	50	0.5
13	–	50	50	80	0.5
14	–	75	25	100	0.5
15	–	100	0	120	0.5
16	–	0	100	20	0.1
17	–	25	75	50	0.1
18	–	50	50	80	0.1
19	–	75	25	100	0.1
20	–	100	0	120	0.1

TABLE 1: Granulating Systems Investigated

Constants:–
- Binder Solution: 20%w/v Acacia in water
- Massing Time: 10 minutes
- Dry Mixing Time: 20 minutes
- Wet Sieve Size: 1.4 mm
- Dry Sieve Size: 1.0 mm

200G of the sifted powder mixture was wet massed using the granulating solution into which had been incorporated the required concentration of colour extract (as shown in Table 1). Although the amount of binder solution used for each batch varied, the total wet massing time was kept constant for all batches. Wet massing was carried out in an Erweka LK 5 bowl mixer powered by an AR 400 power unit. After massing, the material was forced through a 1.40 mm stainless steel sieve. The wet granules wer then dried in a hot air oven at 60°C for 2hrs., this period having been found sufficient for effective drying. The dried grnules were subsequently forced through a 1.00mm sieve.

2.1.3 Sieve Analysis

The granules prepared were all analysed for size distribution using a nest of eight sieves and a vibratory sieve shaker (Pruseib JEL 200). The cummulative percent weight oversize was calculated for each batch of granules and plotted against the log of granule size for the required distribution profile. The sieve analysis was repeated twice for each batch to ensure reproducibility. The granules retained on each sieve were collected in sample tubes for subsequent colorimetric assay.

2.1.4 Colorimetry

A serial dilution of the colourant in methanol was made and the absorbance taken on a Corning 252 Colorimeter with a 470 nm filter. Methanol (analytical) was used for the calibration of the colorimeter. A plot of concentration against absorbance confirmed that the extract followed the Beer-Lambert Law which had earlier been claimed by Opakunle and Ajao (1985).

0.1gm of the granules of each sieve size was extracted with 10ml of methanol in aliquots of 5ml. The extracts were recovered and the absorbance read. To ensure complete extraction, another 10ml of methanol was used to extract the granules and the absorbance read, where the second extraction gave no reading on the colorimeter. Two determinations were carried out on each size fraction to ascertain reproducibility especially for the extraction process.

3. Results and Discussion

3.1 Sieve Analysis

Sieve analysis was carried out on all batches of granules prepared with varying concentrations of colour extract and proportions of powders in the powder mixtures. Sample data from the Sieve analysis results are as presented in Figure 1. Generally the concentration of colouring did not have any significant effect on the granule size distribution.

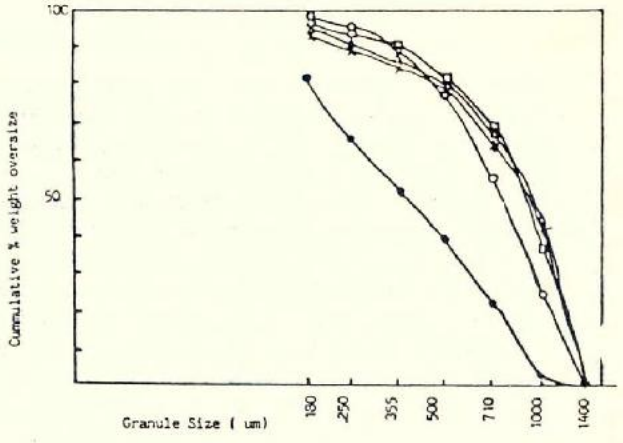

Figure 1 Granule size distribution profile of granules prepared

from a double component system.
Concentration of colourant used: 0.1%$^{w}/_{v}$ in Binder solution

Blends used:	Boric Acid	:	Mag.Carbonate
○	100	:	0
●	○	:	100
□	75	:	25
△	50	:	50
×	25	:	75

3.2 Colour Distribution

Results of the colorimetric assays carried out on the granule size fractions of all batches of the single and binary powder systems investigated are presented as graphs in Figures 2 to 5, where the concentration in mg/gm of granules are plotted against sieve size retaining the granules.

For the Boric acid: Magnesium carbonate mixtures, the best distribution of colouring was obtained with the 50:50 batch irrespective of the concentration of colourant used (0.1% and 0.5% w/v of colourant) (Figs. 2 & 3). However, for the sodium bicarbonate: Magnesium carbonate mixture, it was the pure sodium bicarbonate that gave the best distribution (Figs. 4 & 5). This is presumably due to the superior aqueous solubility of sodium bicarbonate (1 in 11) in the

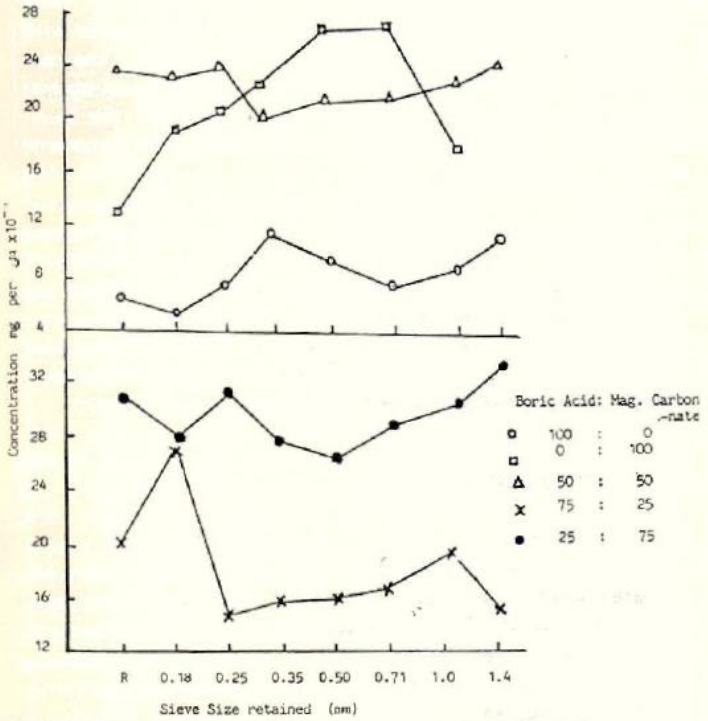

Figure. 2 Colour distribution profile of granules prepared from Boric Acid-Mag.Carbonate powder mixtures.
Concentration of Extract: 0.5%$^{w}/_{v}$ in Binder solution.

aqueous binder, the solubility of boric acid being 1 in 20 in water. This result is again a pointer to the fact that distribution of colouring in granules may be significantly dependent on the solubility of powders in the granulating fluid.

For the sodium bicarbonate: Magnesium carbonate mixtures, the best distribution of colouring was observed with the 75:25 mixture at 0.1%w/v colourant concentration and 50:50 at 0.5%w/v colourant concentration (Figures 4 & 5). It was observed generally that, in the sodium bicarbonate: Magnesium carbonate mixtures, as the quantity of the less aqueous soluble component of the mixture (magnesium carbonate) increased, the distribution of coloruing in the various size fractions became poorer. This again highlights the significant role played by solubility not only in enhancing

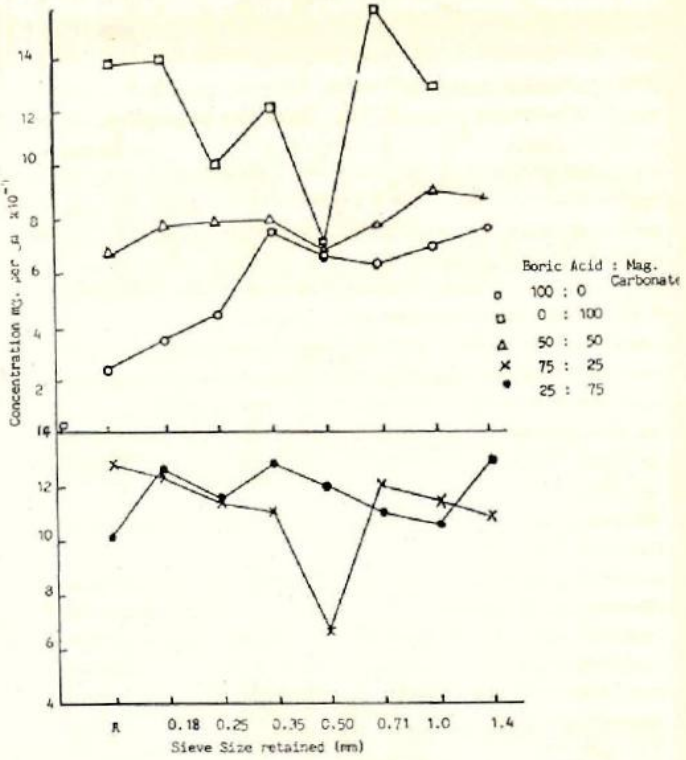

Figure. 3. Colour distribution profile of granules prepared from Boric acid-Magnesuim carbonate powder mixtures.
Concentration of Extract:0.1%$^{w}/_{v}$ in Binder solution

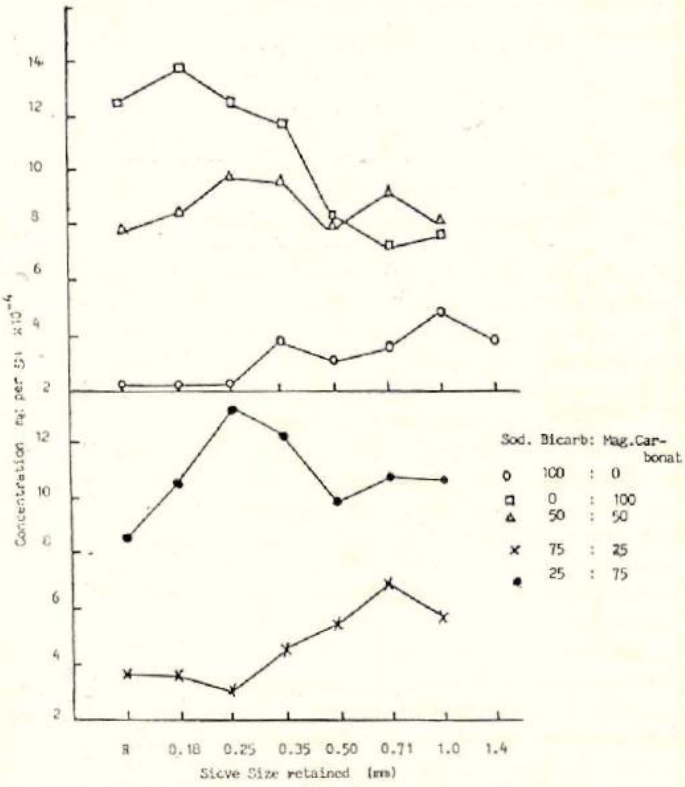

Figure. 4. Colour distribution profile of granules prepared from Sodium bicarbonate-Magnesum Carbonate powder mixtures, Concentration of Extract: 0.5%$^{w}/_{v}$ in Binder solution

granule growth but by improving the distributive quality of the mixture (Figure 4 & 5).

4. Conclusion

The distribution of coloruing in the various size fractions of granulations prepared from three pharmaceutical powders were investigated. Boric acid: Magnesium carbonate and sodium bicarbonate: Magnesium carbonate mixtures in varying proportions were granulated and two colour concentrations were incorporated.

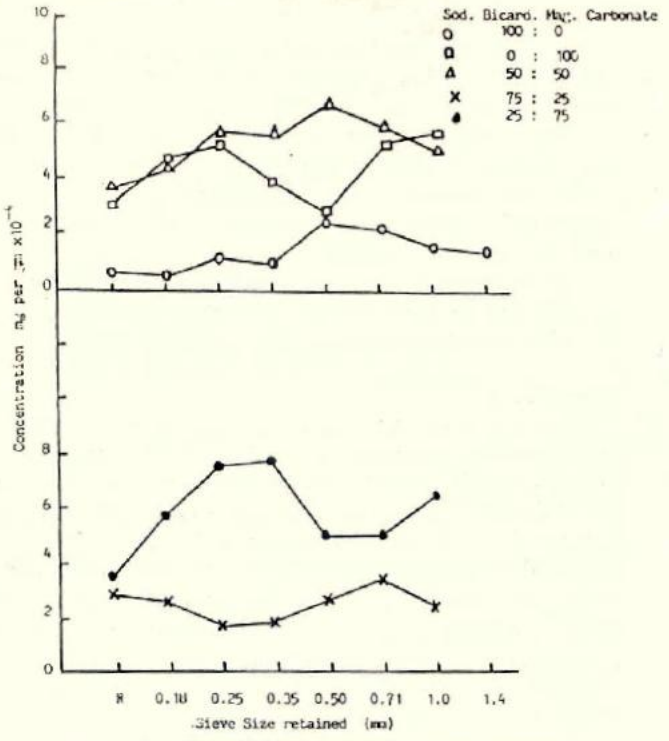

Figure. 5. Colour distribution profile of granules prepared from sodium bicarbonate-Mag.Carbonate powder-mixtures. Concentration of Extract: 0.1%w/v in Binder solution

From the results obtained it can be concluded that the solubilities of the components of the powder mixture (in the granulating solution) play an important role in the distribution of colouring in the various size fractions. The best distribution of the colouring for the boric acid: Magnesium carbonate mixtures was obtained for the 50:50 mixture while pure sodium bicarbonate gave the best distribution in all. For the sodium bicarbonate: Magnesium carbonate mixtures the best distribution of colouring was observed with the 75:25 mixture at 0.1%w/v colour concentration and 50:50 at 0.5% w/v colour concentration.

As the quantity of the less soluble component of the mixture increased, the distribution became poorer. It seems therefore that irrespective of total concentration of colouring in a granulating system, the presence of a large percentage of a powder which was soluble in the granulating solution will assist in obtaining good distribution of colouring in the various size fractions of the granules produced.

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