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COMMUNICATIONS

Dissolution mechanism of tablets produced from coated lactose powder

C. Igwilo*, N. Pilpel†, *Chelsea Department of Pharmacy, King's College, University of London, Manresa Road, London SW3 6LX, UK*

The use of the equation of Kitazawa et al in the analysis of the dissolution process of tablets produced from lactose powder coated with paraffin has suggested either an initial breaking of the tablets into particles that subsequently break down into smaller particles or a progressive breaking of the tablet into smaller particles. The former produces a change in rate constant from k_1 to k_2.

Diluents (for example, lactose) included in the formulation of low dose potent drugs provide the main bulk of a tablet and play a significant role in the release of the drug substance (Wagner 1971). The wettability of the tablet surface also influences its disintegration and dissolution and subsequent release of the active ingredient. This report deals with the probable mechanisms involved in the dissolution of tablets produced from lactose powder coated with paraffins.

Materials and methods

Details of coating lactose powder with various paraffins have been given (Irono & Pilpel 1982). Also, the procedures used in the preparation of tablets (at 20 °C for this report), disintegration and dissolution tests have been previously discussed (Igwilo & Pilpel 1983). These tests were carried out at the tablet packing fraction (ρ_f) of 0·86 (selected because it involved minimum extrapolation of the experimental data).

Results

The integrated form of the Noyes & Whitney equation (1897), $\ln C_s/(C_s - C_t) = Kt$, as applied to uncoated caffeine tablets by Kitazawa et al (1975) was used to analyse the dissolution results. C_s is the concentration of the solute at saturation, C_t is the solute concentration at time t and k is the dissolution rate constant. Plots of $\ln C_s/(C_s - C_t)$ versus t will be expected to yield straight lines with slope K as shown in Fig. 1. Single or two straight lines were obtained (fitted by regression analysis with correlations >0·95). For those with the two straight lines, the time at which the two lines intersect is called t_1, the slope of the first being k_1 and that of the second k_2. The values of t_1, k_1 and k_2 are listed in Table 1.

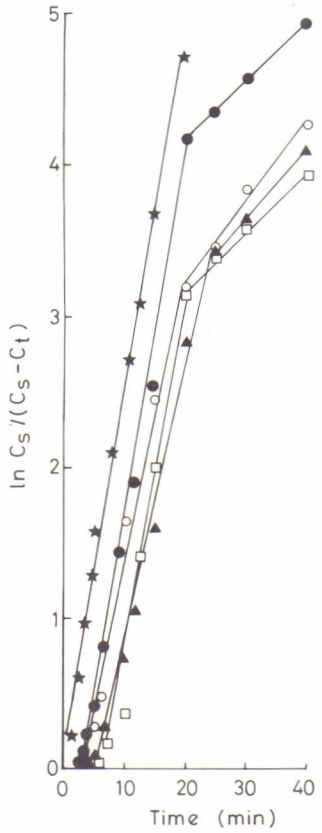

FIG. 1. $\ln C_s/(C_s - C_t)$ vs time plots (Kitazawa) for tablets (ρ_f 0·86) containing $5{\cdot}0 \times 10^{-5}$ mol g^{-1} of various paraffins compressed at 20 °C. ★ 'Blank' lactose. ● Light liquid paraffin. ○ Liquid paraffin. ▲ White soft paraffin. □ Paraffin wax.

* Present address: Faculty of Pharmacy, University of Ife, Nigeria.
† Correspondence.

Table 1. Disintegration and dissolution results using Kitazawa et al (1975) equation at approximately ρ_f 0·86 at 20 °C.

Lactose + paraffin	Paraffin content (mol $g^{-1} \times 10^5$)	t_1 (min)	k_1 (min^{-1})	k_2 (min^{-1})	Disint. time (min)
'Blank' lactose	—	[a]	0·211	[a]	2·21
Light liquid paraffin	0·5	15	0·191	0·091	4·49
	1·0	7	0·249	0·163	4·81
	2·0	15	0·193	0·050	5·07
	5·0	20	0·225	0·040	5·13
	10·0	20	0·219	0·138	5·40
Liquid paraffin	0·5	5	0·090	0·202	4·50
	1·0	[a]	0·206	[a]	5·26
	2·0	10	0·224	0·117	5·53
	5·0	20	0·191	0·059	5·69
	10·0	15	0·212	0·075	6·00
White soft paraffin	0·5	7	0·148	0·255	6·33
	1·0	5	0·058	0·220	6·60
	2·0	7	0·099	0·220	7·09
	5·0	25	0·172	0·036	7·52
	10·0	20	0·197	0·125	7·74
Paraffin wax	0·5	10	0·363	0·177	8·43
	1·0	[a]	0·227	[a]	8·67
	2·0	15	0·185	0·104	9·21
	5·0	20	0·219	0·069	9·49
	10·0	15	0·164	0·257	9·80

[a] Indicates where a single straight line with slope k_1 was obtained.

Discussion

Samples containing up to 10·0 × 10^{-5} mol g^{-1} of paraffin generally gave two straight lines in the Kitazawa et al (1975) plots shown in Fig. 1. These changes in dissolution rate constant from k_1 to k_2 at times t_1 may be due to break up of the tablet into large and small particles depending on the rate at which water enters the tablet matrix. The paraffins decrease the wetting of the surface of the tablet and its capillaries thereby decreasing the rate of water penetration into it. The fact that the curves in Fig. 1 are separate indicates that during tableting the paraffins remain on the surfaces of the particles, since it has been shown previously (Igwilo & Pilpel 1983) that the paraffin coating affects the rate of dissolution of a tablet by altering its contact angle with water. In addition, the fact that the breaks in Fig. 1 occur at values of $\ln C_s/(C_s - C_t) > 3$ indicates that the value of C_t approaches C_s.

The disintegration times (shown in Table 1) were in most cases less than t_1. Water absorption by the tablet initiates disintegration (Matsumaru 1959). Hence, the short disintegration times are probably due to rapid water absorption by the tablets and their subsequent breaking up into particles that passed through the screen of the basket of the disintegration apparatus. This observation might be useful in further dissolution studies in that it distinguishes the period of disintegration process of tablets produced from lactose powder coated with paraffins.

After a certain time of dissolution had elapsed at time t_1, depending on the nature and amount of coating, another breakage (Kitazawa et al 1975) or even aggregation (Esezobo & Offiong 1986) of particles occurred producing the second segment of the straight line with slope k_2.

However single straight lines obtained with some samples might be due to rapid break up of the tablet in the dissolution medium into smaller particles to produce a maximum surface area for dissolution after which the surface area decreases progressively with time.

Conclusion. The dissolution of tablets produced from coated lactose appears to depend on the rate of water absorption by the tablets and the subsequent breakage of the tablet particles.

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