DRUG DEVELOPMENT AND INDUSTRIAL PHARMACY, 16(6), 945-950 (1990)

RELATIONSHIP BETWEEN TEMPERATURE AND SWELLING OF METHYLCELLULOSE IN TABLETS

Lucy S.C. Wan and Kanneganti P.P. Prasad
Department of Pharmacy
National University of Singapore
10 Kent Ridge Crescent
Singapore 0511

ABSTRACT

The rate of swelling of methylcellulose (MC) films and the maximum swelling attained, decreased with an increase in temperature. The order for the uptake of water at different temperatures by tablets containing varying viscosity grade MC is 37 °C > 34 °C > 30 °C. The higher degree of swelling of MC at low temperatures causes it to block the pores within the tablet and retard water uptake. The disintegration time of the tablets is low at higher temperatures due to enhanced aqueous uptake.

INTRODUCTION

Methylcellulose (MC) has been found to improve tablet strength even when used in small amounts (1, 2). The mechanical properties of granules and tablets have been found to be influenced by film formation by MC when it is used as a solution binder (3). In this study, the authors report the influence of temperature on the swelling of MC films, aqueous uptake by tablets and disintegration. In earlier studies, the technique for measuring the swelling of MC films in water

Correspondence : Prof Lucy S.C. Wan
address as above

(4) was utilised to observe the effect of viscosity of MC on the swelling of both plain MC films and MC - disintegrant composite films (5).

EXPERIMENTAL

Material

Sulphanilamide B.P. was chosen as a model drug for the preparation of tablets. Methylcellulose of viscosity 80-120 and 800-1200 cps (Tokyo Kasei, Japan) were used to prepare the films and as binders in the tablets. Maize starch (Corn brand, The Netherlands) was used as a disintegrant.

Preparation of Tablets

The procedure adopted for preparing tablets is as described earlier (6). Each tablet contains 250 mg of sulphanilamide, 10% starch as disintegrant and 4% MC as a binder.

Preparation of Films

Free films of MC were cast according to the procedure detailed in an earlier study (4). An aqueous solution of 1% W/W of MC was poured into glass petri plates to form films, 1.410 mg/cm . The dried film was cut into 1cm x 1 cm squares which were used for swelling studies.

Water Penetration Measurement

The penetration of water into the tablets at 34°, 37°and 40°C was studied according to the method outlined in a previous report (7).

Disintegration of Tablets

The disintegration time of individual tablets at 30° , 34° , 37° and 40 °C was determined using a B.P. disintegration test apparatus (Van-Kel, model 71, USA) without the disc.

Swelling of Films in Water

The technique adopted to study the swelling of MC films involves the measurement of the linear expansion of MC films with time when placed in water by projecting an image of the film on a screen (4). The peak linear expansion attained is designated as E_{max} .

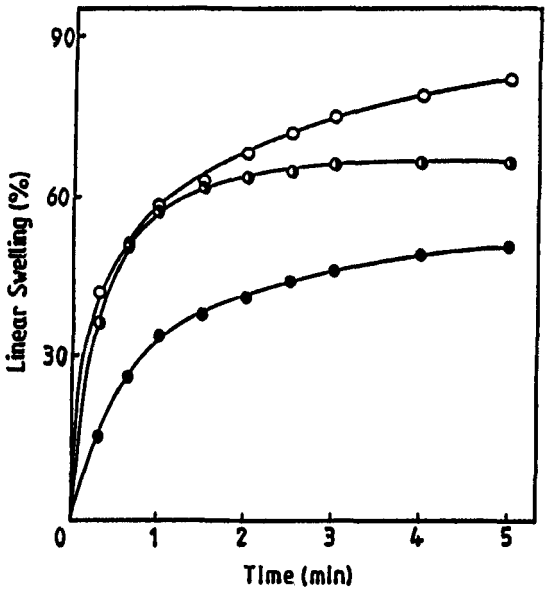

FIGURE 1

Effect of temperature on swelling of MC 80-120 films (1.410 mg/cm^2) : ○ , 34 °C; ◑ , 37 °C; ● , 40 °C.

Viscosity of Solutions

The viscosity of aqueous solutions of different viscosity MC was measured using a U-tube viscometer. To study the viscosity - temperature profile, the temperature was gradually raised (0.1 °C/min).

RESULTS AND DISCUSSION

Swelling of Films

Both the rate of swelling and the maximum swelling attained (E_{max})by MC 80-120 films decreased with an increase in temperature (Figure 1). At 34 °C, films swelled rapidly while swelling was lower at 37 °C and much less at 40 °C. A similar behaviour was also observed for MC 800-1200 films.

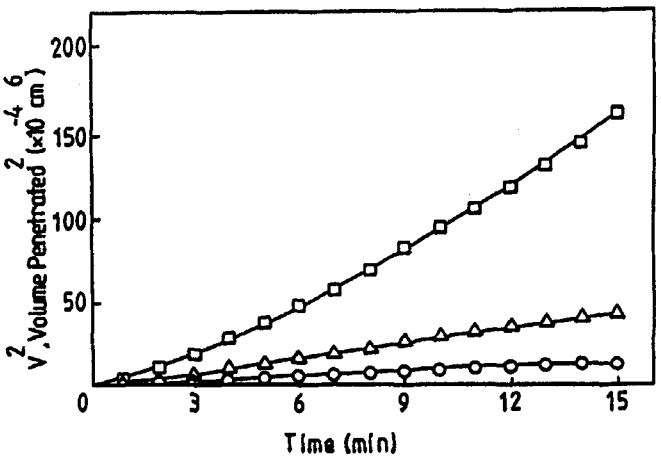

FIGURE 2

Penetration of water at different temperatures into sulphanilamide tablets containing 10 % starch and 4% MC 80-120 : ○, 30 °C; △, 34 °C; □, 37 °C.

TABLE 1

Effect of temperature on the disintegration of sulphanilamide tablets containing 10% starch and 4% MC

MC grade	Disintegration Time (sec)			
	30°C	34°C	37°C	40°C
MC 80-120	1235.67 ±18.50	638.33 ±9.50	303.33 ±8.50	255.00 ±12.53
MC 800-1200	1077.33 ±14.01	602.33 ±12.01	257.33 ±6.51	225.00 ±6.56

Penetration of Water into Tablets

The uptake of water increases with the temperature, the order being 30 °C < 34 °C < 37 °C (Figure 2). A similar order is also observed in the case of tablets formulated with MC 800-1200. Swelling of MC is much more at lower temperatures (Figure 1) and this causes blocking of the pores within the tablet making the tablet interior inaccessible to the penetrating water.

Quick uptake of water results in the tablet disintegrating before the MC can demonstrate its adhesive effects. High viscosity MC have a greater degree of polymerization and a higher capacity to hydrate. Tablets containing the higher viscosity MC have been observed to have enhanced water uptake capability in the presence of swellable disintegrants such as cross-linked sodium carboxymethylcellulose (6) and sodium starch glycolate (8). A similar effect is demonstrated when starch is present as the disintegrant in the tablets.

Disintegration of Tablets

The disintegration time (DT) of tablets increases with the lowering of temperature of the disintegrating medium (Table 1). Sulphanilamide compacts that contained neither binder nor disintegrant did not disintegrate even after 30 min at 37 °C (7).

At a high temperature, swelling of MC films is less (Figure 1) while the penetration of water is more (Figure 2). The DT is consequently low (Table 1). The opposite phenomena is observed when the temperature of water is low.

Thermal Gelation in MC

The temperature dependence of water penetration into tablets and swelling of MC films is a consequence of the characteristic solubility properties of MC. Viscosity of MC solutions falls when temperature is increased due to the dehydration of the polymer. At the gel-point however, the viscosity rises steeply.

To conclude, the swelling of MC is very much dependent on the temperature of the medium. At high temperatures, swelling of MC films is of a low order due to sol-gel transformation of MC while at low temperatures, rapid expansion of films is followed by their dissolution. Uptake of water is lov at the lover temperatures due to the swelling action of MC within the tablets. The DT of tablets at high temperature is low due to increased aqueous uptake.

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