Drug Development and Industrial Pharmacy, 23(4), 419–423 (1997)

COMMUNICATION

Effects of Solvents, Temperature, and Plasticizer on Film Coating of Tablets

K. V. Rangaiah,[1,2] Sarat C. Chattaraj,[1,3,4,*] and Sudip K. Das[4]

[1]*Cadilla Laboratories, Ahmedabad, India*
[2]*Ranbaxy Laboratories, New Delhi, India*
[3]*Rhodes University, Grahamstown, South Africa*
[4]*Nova Southeastern University, College of Pharmacy, Ft. Lauderdale, Florida, USA*

ABSTRACT

The effects of solvent composition, temperature, solvent retention, plasticizers, and polishing on the disintegration and percent dissolution of various nonaqueous film coated tablets were studied. A mixture of isopropanol–dichloromethane used as solvent systems for the film coating of ranitidine hydrochloride tablets resulted in reduced film peel-off time, decreased disintegration time, and increased percent dissolution. The effect of prewarming the coating bed of cimetidine tablets revealed an increase in percent dissolution compared to no prewarming condition. In contrast, an increase in temperature of the tablet bed resulted in higher disintegration time and lower percent dissolution of ibuprofen tablets. Ranitidine hydrochloride film coated tablets polished with polyethylene glycol showed lower disintegration time and higher percent dissolution than those polished with beeswax. The presence of plasticizer in the coating solution resulted in decreased disintegration time and higher percent dissolution for norfloxacin tablets.

*To whom correspondence should be sent at Nova Southeastern University, College of Pharmacy, 3200 South University Drive, Ft. Lauderdale, FL 33328, USA.

INTRODUCTION

The application of materials to the surface of compressed tablets is done to mask objectionable tastes or odors, protect unstable core ingredients, impart aesthetic appearance, or for separation of incompatible ingredients by incorporation of one in the core and the other in the coating solutions. The design of new equipment, development of new coating materials, and advances in technology contributing to improved product manufacturing are important to assure rapid release of medicaments from the core tablet (1). Insufficient information is available about the influence of excipients on coating solutions and variables of coating techniques on physicochemical parameters such as hardness, disintegration time (DT), percent dissolution (PD), drug stability, and bioavailability of coated tablets. Coat processing parameters such as temperature, spray rate, composition of coating solution (i.e., proportion of different polymers), solvent systems, plasticizers, and excipients within the tablet core influence the coating film formation and are likely to influence final tablet parameters such as DT and PD. As a result, stability of the product under accelerated stability studies may also be misrepresented.

Stress may be created when a film is deposited on a tablet substrate and shrinks on evaporation of the solvent. These stresses depend on the thermal expansion of coating and substrate, and are usually manifested as edge splitting, peeling, and cracking (2,3). The problem of localized cracking around pigment particles in tablet film coating has been treated as being analogous to stress coating in two-phase ceramics. Solid excipients in the form of aluminum lakes of water-soluble dyes, opacifiers (titanium dioxide), and various inorganic materials (e.g., iron oxide, calcium carbonate, talc, and colloidal silica) are often used in film coating to improve color and opacity. These increase the prospect of localized cracking around individual particles. Edge splitting can be caused by major thermal expansion of the excipients and film coating materials (2). A study has been performed to investigate the influence of polymer type and its concentration; plasticizer type and its concentration; solvent type and its composition, and solvent retention; and tablet bed temperature on tablet parameters such as disintegration time, film peel-off time, and percent dissolution.

EXPERIMENTAL

Effect of Solvent System

The composition of solvent systems for nonaqueous film coating is critical. There should be a balance between the hydrophilic and hydrophobic nature of the solvents it should partially dissolve a portion of the polymer, and the remaining portion should be dispersed uniformly. An ideal suitable solvent system should contain not less than 30% and not more than 50% of the solvent that can dissolve the polymer. Ranitidine hydrochloride tablets were coated with hydroxypropylmethylcellulose (HPMC) solution using different proportions of isopropyl alcohol (IPA) and dichloromethane (DCM). The tablets coated with 100% IPA in the coating solution showed an increase in DT (25 min) and a poor PD in compared to mixtures of IPA with DCM. An increase in the DCM portion of the solvent system showed a significant increase in PD and improvements in DT and film peeling time up to 60% IPA and 40% DCM. This was probably due to HPMC in IPA producing an inferior-quality film than that produced by HPMC in IPA and DCM mixture, with faster evaporation rate (2). Increasing the DCM concentration to 60% resulted in poor DT, PD, and film peel-off time (Table 1).

Effect of Temperature and Solvent Retention

Film coating techniques utilize hot air blowers to facilitate the evaporation of solvent used in the coating solution. The temperature influences evaporation rate and subsequent film formation on the tablet surface. To compare the effect of coating temperature on a cimetidine tablet core, the following studies were conducted:

- The tablet bed was warmed to between 35° and 40°C before coating.
- Coating was performed at room temperature.

DT and PD of the coated tablets were evaluated, and no difference in DT was observed. However, significant differences in PD were observed. Tablets that had been prewarmed showed better PD (90%) than the tablets coated at room temperature (60%) (Table 2). This was probably due to solvent retention in the micropores of the tablet core during the initial stages of coating at room temperature, which promoted the hydrophobic nature of the tablet core.

Ibuprofen tablets coated by maintaining a constant tablet bed temperature of 55° ± 5°C showed poor DT and PD. This may be a result of reversible melting of ibuprofen, which forms flakes and changes the pattern of disintegration. Coating of ibuprofen tablets at a tablet bed temperature of 20°–25°C gave solvent retention effects similar to those observed with cimetidine. The DT and PD of coated tablets immediately after coating

Table 1

Effect of Solvent Systems on the Film Coating of Ranitidine Hydrochloride Tablets

Solvent System	Film Peel-off Time (min)	DT[a] (min)	Percent Dissolution (%)		
			15 min	30 min	45 min
100% IPA and 0% DCM	17	25		30	43
60% IPA and 40% DCM	7	13	30	69	80
40% IPA and 60% DCM	2	8	47	81	100

[a]DT: disintegration time.

Table 2

Effect of Temperature (Prewarming and No Prewarming of the Bed) on the Film Coating of Cimetidine Tablets

Treatment	Bed Temperature (°C)		Film Peel-off Time (min)	Film DT[a] (min)	Film PD[a] (%)
	Beginning of Coating	Maintained During Coating			
No prewarming of the bed	20–25	35–38	1.5	2	60
Prewarming of the bed	35–40	35–38	1.5	2	90

[a]DT: disintegration time; PD: percent dissolution.

Table 3

Effect of Solvent Retention and Temperature on the Film Coating of Ibuprofen Tablets

Temp. of Tablet Bed	DT[a] (min)	PD[a] (%)		
		10 min	20 min	30 min
45° ± 5°C	20	6	12	30
35° ± 5°C	12	20	35	50
25° ± 2°C				
Immediately after coating	12	30	37	50
Dried for 12 hr at room temp. after coating[b]	2	40	90	100

[a]DT: disintegration time; PD: percent dissolution.
[b]Weight loss on drying was 2% w/w.

were 12 min and 50%, respectively. After air drying at room temperature for 12 hr these values reduced to 2 min and 100%, respectively (Table 3). Identical formulation and similar conditions of coating were maintained in all the studies.

Effect of Plasticizer and Film Polishing

A commonly used method for modifying the properties of polymers and enhancing their film-forming properties is the addition of plasticizers (4–7). They increase the flexibility of the film formed and produce more pliable and tougher films with an improved resistance to mechanical stress (7). In a study to determine the effect of plasticizers on tablet parameters such as DT and PD, ranitidine hydrochloride tablets were coated with HPMC coating solution. The coated tablets were polished with polyethylene glycol (PEG) solution and beeswax. Tablets polished with PEG solution showed better DT and PD than unpolished tablets or the tablets polished with beeswax (Table 4).

Norfloxacin tablets were coated with a coating solution without PEG, with PEG 400, and with PEG 6000. There was a significant improvement of DT and PD in case of tablets coated with PEG 400 and PEG 6000 (Table 5). The addition of PEG increases the hydrophilic nature of the film, thereby increasing the water penetrability of the tablet core. A polymer in the coating solvent system forms a gel in which the plasticizer molecules interpose between the polymer chain and interact with forces holding the chains together, thereby extending and softening the polymer matrix (3,4,6) by increasing the free polymer chain mobility. Hence, the plasticizer increases the porosity of the film.

Good edge stability was observed for the norfloxacin tablets with coating solutions containing hydroxypropylmethylcellulose, 4 cps 3% w/w, and polyethylene glycol 400, 0.1% w/w. Edge stability was improved by changing the composition of the coating solution to HPMC 15 cps 3% w/w + PEG 6000 0.1% w/w. Increased viscosity grade or higher molecular weight of polymer and plasticizer increased the tensile strength of the coating film and prevented edge splitting. In the two phases of experiment the coating parameters were kept constant.

CONCLUSION

It was observed that isopropyl alcohol is a poor solvent for film coating using HPMC as a coating polymer. Experiments with ranitidine hydrochloride tablets re-

Table 4

Effect of Polishing on the Film Coating of Ranitidine Hydrochloride Tablets

Uncoated		Coated		Polished with PEG		Polished with Beeswax	
DT[a] (min)	PD[a] (%)	DT (min)	PD (%)	DT (min)	PD (%)	DT (min)	PD (%)
9	93	11	85	7	98	15	70

[a]DT: disintegration time; PD: percent dissolution.

Table 5

Effect of Plasticizer in Coating Solution on the Film Coating of Norfloxacin Tablets

		Coated with					
Uncoated		No PEG		PEG 400		PEG 6000	
DT[a] (min)	PD[a] (%)	DT (min)	PD (%)	DT (min)	PD (%)	DT (min)	PD (%)
4	86	6	77	5	87	3	100

[a]DT: disintegration time; PD: percent dissolution.

sulted in increased disintegration time and poor dissolution, which is due to the poor quality of film developed using HPMC. Solvent retention influenced retardation of disintegration and dissolution. Prewarming of the coating bed significantly enhanced the percent dissolution to 90% in cimetidine tablets. Film coating of ibuprofen tablets at increased bed temperature resulted in increase of disintegration time and decrease in percent dissolution due to the melting of ibuprofen.

Polishing of the coated ranitidine tablet with polyethylene glycol and beeswax resulted in a significant effect on disintegration time and percent dissolution. It was observed that PEG reduced the disintegration time and enhanced the percent dissolution of ranitidine tablet compared to polishing with beeswax or uncoated tablet. Film coating of norfloxacin tablet using different molecular grades of PEG (400 and 6000) as plasticizer resulted in reduced disintegration time and increased percent dissolution with plasticizer having higher molecular weight.

REFERENCES

1. S. C. Porter and C. H. Bruno, *Pharmaceutical Dosage Forms: Tablets*, 2nd ed., Marcel Dekker, New York, 1990, Vol. 3, p. 77.
2. C. R. Rowe, J. Pharm. Pharmacol., 33, 423 (1981).
3. C. R. Rowe and S. F. Forse, J. Pharm. Pharmacol., 32, 583 (1980).
4. C. R. Rowe and S. F. Forse, J. Pharm. Pharmacol., 33, 174 (1981).
5. C. A. Entwistle and C. R. Rowe, J. Pharm. Pharmacol., 31, 269 (1979).
6. S. C. Porter and K. Ridgway, J. Pharm. Pharmacol., 35, 341 (1983).
7. P. Sakellariou, C. R. Rowe, and E. F. T. White, Int. J. Pharm., 31, 55 (1986).