Functional Advantages of a Novel Modified Starch over HPMC in Aqueous Film Coating of Tablets

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INTRODUCTION

Aqueous film coating is widely used in the pharmaceutical industry for improving organoleptic properties (color/taste/odor), easier brand identification, facilitating swallowing, protection from light and humidity etc. Many synthetic polymers, predominantly modified celluloses, are the most widely used tablet coating polymers, but suffer from drawbacks such as:

- Strong unwanted taste/odor and yellowish color to the solution,
- Difficulty in solubilization due to lumping and foam formation,
- "Bearding" on spray nozzles causing frequent production stops for cleaning,
- High coating cost per tablet due to cost of polymer and long coating times.

An ideal polymer for aqueous tablet coating should provide the following:

- Free flowing, granular nature with immediate solubilization in water,
- No lumping or foam formation, neutral color, taste and odor,
- High solids loading at low viscosity for rapid coating process,
- Excellent film integrity and stability without affecting tablet performance.

A specially pregelatinized, new-generation, hydroxypropyl starch polymer (LYCOAT®), ensures low viscosity dispersions at much higher solids content vs. HPMC. The entire coating process can be completed in approx 30min while maintaining a core tablet bed temp of 32°C.

Absence of "bearding" with LYCOAT® minimizes production stops for cleaning. Excellent film integrity and adhesion provides additional advantage vs. HPMC in aqueous film coating. Data supporting the superiority of LYCOAT® vs. HPMC in aqueous film coating is presented.

MATERIALS & METHODS

Preparation of Dispersions: HPMC was dispersed in water at 20°C and LYCOAT® was completely dispersed in water at room temperature using a magnetic stirrer. Glyceryl monostearate (GMS) emulsion and PEG 400 were used as plasticizers with LYCOAT® and HPMC respectively. Polymer & plasticizer mix was made in water using a magnetic stirrer while the TiO2 and lake color were dispersed using a high shear mixer. Viscosity of the dispersions was measured using a Brookfield viscometer RDV VI+ & Physica MCR 301 rheometer.

Evaluation of Films: Films with same dry solids content were cast in a mold and dried for 24 hours at 20°C, 50% RH before evaluation. Mechanical properties were measured using Instron apparatus. Thermal analysis was conducted using a Mettler DSC 30 Differential Scanning Calorimeter (DSC). Films were observed using a Quanta FED200-FEI Environmental Scanning Electron Microsocope (ESEM). Water vapor permeability was evaluated by measuring the moisture uptake of anhydrous calcium phosphate in a sealed cell.

Tablet Coating: 5kg PEARLITOL® tablets (10mm, 85N, 330mg) were coated with aqueous dispersions of LYCOAT® and HPMC using a FC19 (NR industries) coating equipment. Detailed coating parameters are described in Figure 7.

Evaluation of Coated Tablets: Hardness, friability, and in-vitro disintegration time (DT) were measured using appropriate Erweka equipment and USP methods. Tablet surface gloss was measured as a function of the light reflection angle using a Byk-Gardner Micro Tri gloss meter.

RESULTS & DISCUSSION

Dispersion Preparation at its Simplest

Figure 1. Ease of Dispersing LYCOAT® vs. HPMC.

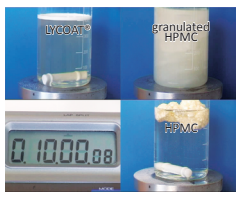
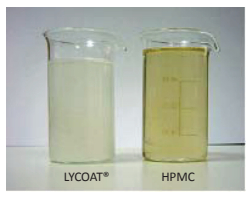


Figure 2. Neutral LYCOAT® - No Off Color.



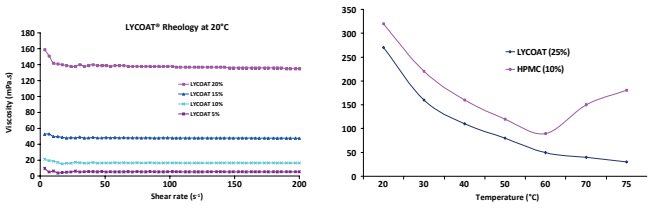
Instant dispersion of LYCOAT® at room temp using only a magnetic stirrer Lumping or foam formation is NOT observed (**Fig 1**).

LYCOAT® suspensions are neutral in color (**Fig 2**) and odor NO off-taste or undesirable color is imparted to coated tablets.

LYCOAT® suspension is stable upto 48 hrs at room temp without preservatives.

Low Viscosity at High Solids Content Allows Faster and Uniform Coating

Figure 3. LYCOAT® Newtonian Rheology & Viscosity as a Function of Temperature.



LYCOAT® exhibits significantly lower viscosity vs. HPMC even at much higher solids content. HPMC undergoes gelation at higher temp whereas no gelation occurs with LYCOAT® at higher temperature.

Low viscosity at high solids & Newtonian rheology enables spray uniformity and rapid completion of the coating process with LYCOAT®.

These characteristics also prevent "bearding" on spray-nozzles, thus minimizing production run stops for equipment cleaning.

Mechanical & Thermal Properties of Films

Table 1. Mechanical Properties by Instron.

Film Parameters	HPMC	LYCOAT®
Young's Modulus	4920 ± 700	4040 ± 400
Elongation (mm)	1.50 ± 0.5	2.00 ± 0.8
Breaking Force (N)	76 ± 19	70 ± 17
Thickness (mm)	0.058	0.062

LYCOAT® films exhibit comparable or superior mechanical properties vs. HPMC Higher elongation with LYCOAT® allows better flexibility and resistance to deformation and stress.

Table 2. Thermal Properties by DSC.

Film Evaluated	DSC Endothermic Transitions			
	Onset (°C)	Peak (°C)	ΔH (J/g)	Tg (°C)
HPMC (Control)	43.6	51.8	1.1	91.7
LYCOAT® (Test)	39.0	51.7	0.6	69.8

Lower Tg of LYCOAT® enables film formation at a much lower temp and may require less plasticizer

Water Vapor Permeability, ESEM Studies

Figure 4. Moisture Permeability vs. %RH.

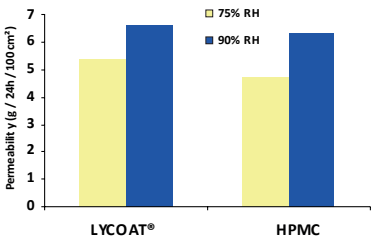


Figure 5. ESEM - LYCOAT® Film Surface.

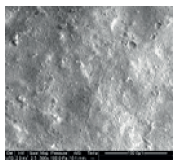
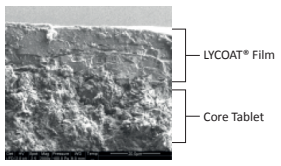


Figure 6. ESEM Cross-section of LYCOAT® Coated Tablet.



LYCOAT® enables similar moisture barrier at different RH as HPMC ESEM photo shows a smooth film surface Films cannot be peeled off from coated tablets, implying strong adhesion of the film to the tablet surface.

Coating Formulations & Parameters

Figure 7. Spray-coating Parameters Used.

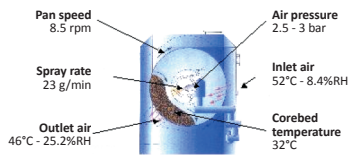


Table 3. Coating Formulations Tested.

Ingredients	LYCOAT®	HPMC
Polymer	136.5g	62.6g
GMS	12.5g	-
PEG 400	-	5.5g
Tween 80	1g	-
TiO2	48g	21g
Lake color	2g	0.9g
Water	800g	910g
Total	1000g	1000g
Solids level	20%	9%
Viscosity	140 mPa.s	150 mPa.s

Table 4. Core Tablet Formulation.

PEARLITOL® 200SD	95.5%
GLYCOLYS®	3.0%
Mg stearate	1.5%
Tablet Shape	Biconvex
Tablet Diameter	10 mm
Tablet weight (uncoated)	330 mg
Tablet Hardness (uncoated)	85N
Tablet loading	5 kg

Table 5. Film Coating Results.

	LYCOAT®	HPMC
Total Solution Used	750g	1667g
Mean Coated Tablet weight	340 mg	340 mg
Mean % weight gain	3.03%	3.03%
Total Coating Time	32 min	72 min

Coating Completed in 60% Less Time

Figure 8. Reduced Coating time LYCOAT® vs. HPMC.

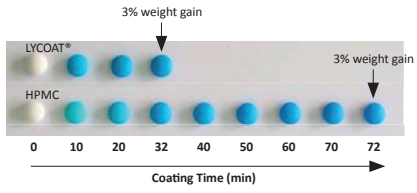
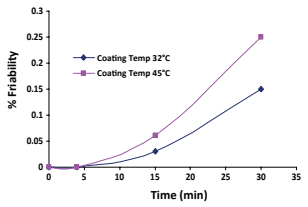


Figure 9. LYCOAT® Enables Coating Over a Range of Temperatures.



60% reduced coating time at 32°C enables significant cost savings LYCOAT® can be used over a wide temp range but slight changes in properties of films are observed.

Evaluation of Film Coated Tablets

Figure 10. LYCOAT® Does Not Alter Tablet Disintegration Over Wide pH-Range.

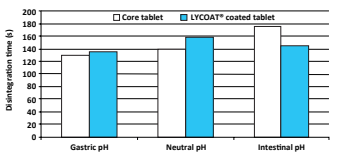
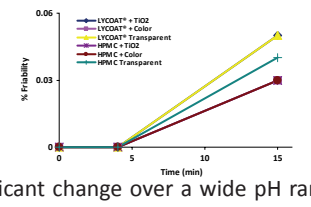


Figure 11. Friability of tablets coated with LYCOAT® vs. HPMC.



DT with LYCOAT® exhibits no significant change over a wide pH range (2.0 - 8.0) API release is NOT affected, a basic requirement for non-functional coating (**Fig. 10**).

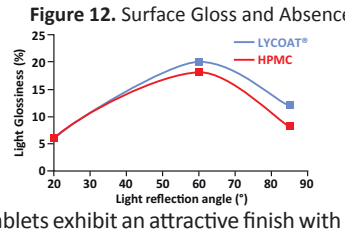
Coated tablets exhibit NO weight loss (friability) after 4 min rotation. Tablet appearance remains unchanged (no chipping).

No significant difference is observed in friability of LYCOAT® vs. HPMC coated tablets over a period of 15 min (**Fig. 11**).

Coated tablets exhibit excellent stability over wide humidity range (33% to 85% RH at 20°C) and at 40°C / 75% RH during a 3 month period.

Evaluation of Tablet Appearance

Figure 12. Surface Gloss and Absence of logo-bridging with LYCOAT®.



Tablets exhibit an attractive finish with uniform color and smooth surface.

LYCOAT® coated tablets appear glossier than HPMC coated tablets.

At 3% weight gain, no infilling or bridging of logos was observed.

Regulatory Aspects

- LYCOAT® fulfils the specified tests of modified and pregelatinized starch USP/NF monographs LYCOAT® fulfils all the analytical specifications of major food or pharmaceutical modified starch monographs,
- LYCOAT® has food regulatory status:
  - ✔ E1440 - European directive on food additives,
  - ✔ 21 CFR.
- In Japan, LYCOAT® is considered as a natural food ingredient,
- EP regulatory status of LYCOAT® is under progress (Chemically modified starches).

CONCLUSION

The specially pregelatinized, new-generation, hydroxypropyl starch polymer (LYCOAT®), exhibits significant advantages over HPMC in aqueous film coating:

- Free flowing, granular nature with immediate solubilization in water,
- Stable solution, no lumping or foam formation, neutral in color, taste and odor,
- Significantly lower viscosity even at high solids content,
- Lower Tg and higher elasticity allows more flexible and robust film formation,
- Spray uniformity and completion of coating in 60% less time than HPMC,
- Uniform glossy coating achieved at a low tablet bed temperature of 32°C,
- No logo-bridging or infilling observed,
- No "bearding" on spray nozzles, minimizing production halts,
- Faster coating and minimal production halts allow significant cost-savings.