IJPSR (2016), Vol. 7, Issue 3 (Review Article)

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 18 September, 2015; received in revised form, 09 December, 2015; accepted, 05 January, 2016; published 01 March, 2016

EMERGING TRENDS IN COMPRESSION COATED TABLET DOSAGE FORMS: A REVIEW

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Keywords:

Tablet, Coated Tablets, Compression Coating, Polymers, Exist Formulation.

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ABSTRACT: Tablets are widely used and most preferred dosage form because of its ease of manufacture and administration, lower cost, good aesthetic appearance. Now a days new trends are going to develop in formulation of conventional tablet in to modified tablet dosage forms like floating, sustained release matrix, coated tablets, controlled release, fast release etc. This review provides the detail information of compression coated tablets including its classes, polymers commonly used in different layers, methods of preparation of subsequent layers of tablets and exist formulations of various categories of drugs.

INTRODUCTION: Tablet is defined as a compressed solid dosage form containing medicaments with or without excipients. They vary in shape and differ greatly in size and weight, depending on amount of medicinal substances and the intended mode of administration. It is the most popular dosage form and 70% of the total medicines are dispensed in the form of tablet. All medicaments are available in the Tablet form except where it is difficult to formulate or administer.

1. Type of tablets:

(A) Tablets ingested orally:

1. Compressed tablet:

These tablets are prepared simply with the help of compressive force. They may be coated or uncoated depending on the property of the material to be coated. Methods such as dry granulation, wet granulation or direct compression are generally used for compressed tablets.

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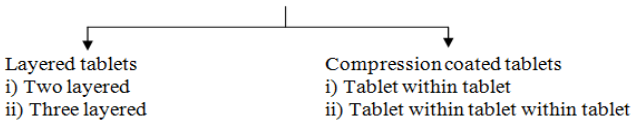
DOI: 10.13040/IJPSR.0975-8232.7(3).930--38

Article can be accessed online on: www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.7 (3).930-38

2. Multiple compressed tablet:

This method is used when there is involvement of two or more incompatible materials within the same tablet:



Benefits:

A. Extended release of drug

B. Controlled release of drug

C. Incompatible materials can be incorporated within same tablet

3. Repeat action tablet:

In this tablet, the compression coating technique or sugar coating is used. The active constituents are

divided in parts and are coated to release the drug at specific intervals of time. Generally, the core tablet is incorporated in coating tablet and the action is repeated by degradation (disintegration) of coating tablet.

4. Delayed release tablet:
The enteric coated tablets are coated with the material resistant to acidic medium (stomach environment) and hence are not able to release drug in stomach. Whereas, it easily releases drug in intestine (alkaline) media. Hence, drugs have to pass through stomach and the time of release of drug is delayed and hence called delayed action tablet.

5. Sugar coated tablet:
Sugar coated tablets are prepared generally in cases where the drug has some unacceptable properties like taste, odor, colour etc. In sugar coated tablets, the sugar solutions are used to coat the tablet and to provide it a glossy appearance. The patient acceptability also increases due to the sweet taste of tablet.

6. Film coated tablet:
In case to provide more strength to the tablet, film coating is used as alternative to sugar coating. The polymers such as HPC (Hydroxypropyl cellulose), HPMC (Hydroxypropylmethyl cellulose), Ethyl cellulose are used for this technique. It is also a fast process than the sugar coating technique.

7. Chewable tablet:
These tablets are chewed in the mouth for their effect before swallowing. The tablet should not have a bad taste to avoid patient incompliance. The antacids are given by these type of tablets.

(B) Tablets used in oral cavity:
1. Buccal tablet:
These tablets are placed in the cheek pouch or in between the cheek and teeth.

2. Sublingual tablet:
These tablets are placed below the tongue for fast release and to avoid first pass effect.

3. Troches or lozenges:
These are candy like tablets used for the local action of the drug. The cough lozenges of Zeal, Vicks and Strepsils etc are the good examples of troches and lozenges. They start dissolving in mouth after taken and slowly dissolve and releases drug for longer time.

4. Dental cone:
These tablets are prepared to place in the dental cavities. These tablets are generally used to avoid microbial attack in teeth cavities.

(C) Tablets administered by other route:
1. Implantation tablet:
These tablets are implanted in the body cavities for a prolonged effect from several days to months up to year. These tablets are small in size and cylinder like in shape. Hormones are generally implanted by using these tablets.

2. Vaginal tablet:
These tablets are incorporated in vaginal cavity to prevent the infections. The dissolution and drug release of these tablets is slow.

(D) Tablets used to prepare solution:
1. Effervescent tablet:
These tablets are dispersed in the water to produce a solution or suspension with release of carbon dioxide before the administration. These tablets are generally used for carminative effect to expel the gases from the G.I.T.

2. Dispensing tablet:
These are near about same as effervescent tablets as dispersed in water but the concentration of the drug in the dispersion are taken into consideration.

3. Hypodermic tablet:
These are one type of sterile preparations. In these, tablets are dissolved in the WFI or sterile water to inject before the actual injection in the hypodermic cavity.

4. Tablet triturates:
These are usually prepared by using triturate moulds which are rapidly and almost completely soluble.

TABLE 1: EXAMPLES OF THE TYPES OF TABLETS ARE AS FOLLOWS

Sr. No.	Type of Tablet	Example	Brand Name	Manufacturer
		(A) Tablets ingested orally		
1.	Compressed tablet	Acetaminophen	Calpol	GlaxoSmithkline
2.	Multiple compressed tablet	Orphenadrine citrate	Norgesic	3M P'ceuticals
3.	Repeat action tablet	Dexchlorpheniramine maleate	Dexchlor	Taj P'ceuticals
4.	Enteric coated tablet	Naproxen	Naprosyn	Roche Palo
5.	Sugar coated tablet	Conjugated oestrogen	Premarin	Wyeth Ltd.
6.	Film coated tablet	Diclofenac	Voltaren	Novartis P'ceuticals
7.	Chewable tablet	Pyrantel embonate	Combantrin	Johnson & Johnson
		(B) Tablets used in oral cavity		
1.	Buccal tablet	Fentanyl	Onsolis	Mylan P'ceuticals
2.	Sublingual tablet	Nitroglycerine	Nitrostat	Pfizer
3.	Troches and lozenges	Clotrimazole troches	Mycelex	Jeednya Pharma
		Nystatin lozenges	Mycostatin	Bristol-Myeres Squib
4.	Dental cones	Collagen	Parasorb	Resorba
		(C) Tablets administered by other route		
1.	Implantation tablet	Estradiol	Vagifem	Novo Nordisk Inc
2.	Vaginal tablet	Clotrimazole vaginal	Lotrimin	MSD Consumer Care
		(D) Tablets used to prepare solution		
1.	Effervescent tablet	Ranitidine	Zantac	Glaxo Smithkline
2.	Dispensing tablet	Naproxen sodium	Aleve	Bayer Healthcare
3.	Hypodermic tablet	Morphine sulfate		Parke, davis and co.
4.	Tablet triturates	Enzyme tablet	Digiplex	Medplus Pharmacy

2. Tablet Coating:

After the compression of the tablet is finished, it may have some unacceptable properties such as color, odor, taste, appearance, etc. Thus, it is necessary to decrease or to remove such properties to improve the patient acceptance. The easy process to improve such characteristics is to coat the tablet with suitable polymer which gives the tablet suitable color, odor, taste and gloss.

Advantages:

1. The tablets can be prevented from the erosion by the external environment with the help of coating.
2. Coating is advantageous to provide a gloss to the tablet.
3. Coating helps to mask the unacceptable taste and odor of the tablet.
4. The colorful tablets can also be prepared by the use of dye in the coating solution.

Disadvantages:

1. The uneven coat may produce rough surface of the tablet.
2. The coating solutions used to coat the tablet may be toxic in nature.
3. The coating may increase the bulk and weight of the tablet.

Depending upon the type of material used, coating process can be classified as:

i. Sugar coating:

This process of coating involves the use of particularly sucrose as a coating material and the process is called as sugar coating.

ii. Film coating:

In this process, water soluble film forming polymers are used to coat the tablet and hence the process is called as film coating.

iii. Enteric coating:

In this type of coating, the substances which are soluble in intestinal secretions and not in stomach are used to coat the tablet and hence the process is called as the enteric coating.

3. Types of coating:

Coating technique can be classified depending upon the process of coating as follows:

1) Pan coating:

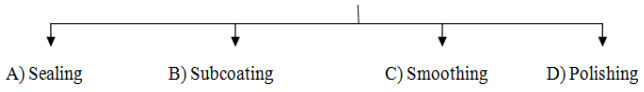
In this type of coating, tablets prepared previously are added to a pan or cone like pot which is adjusted such that it will make an angle of 30^0 with the horizontal plane. The coating solution is then added to the pan with the help of atomizer to spray evenly on the tablet surface. The tablets are operated manually or the baffles are attached with pan to get an even coat of the material. The speed of atomization should be maintained such that no additional coating solution gets added which results in cohesion of tablets and no inadequate solution is added such that tablets will remain partly uncoated and coated. The appropriate dry and hot air supply should also be provided to prevent further cohesion and proper drying of the coated surface. The coating powder is also added for fast drying.

The pan coating is further divided into 3 types as follows:

These coating types depend upon the type of materials used to coat the tablet.

a) Sugar coating:

As sucrose solution is used to coat the tablet in this type, it is called as sugar coating which is further divided into 4 types:



A) Sealing:

Sealing is done with either shellac or dextran and gelatin in alcohol (30-50%) for hygroscopic materials and water can be used for non-hygroscopic materials. This step of sugar coating is helpful to ensure good coating adhesion to the tablet.

B) Subcoating:

This process is applied to cover all the edges of tablet and to provide a spherical appearance to the tablet. The filler (Calcium carbonate and talc) is added in this process to cover the edges of the tablet. Aqueous sucrose solution is used to coat in subcoating process. The process generally starts with placing the tablet in aqueous coat solution. Sometimes acacia or gelatin is also added to impart adhesiveness.

C) Smoothing:

The coloring to the tablet can be done in this process. Commonly 60% sucrose solution is used at this step. This process is done to provide smoothening to the tablet surface.

D) Polishing:

This is final stage of sugar coating process in which the glossy appearance is provided to the tablet surface.

b) Film coating:

In case of sugar coating, the weight and size of the tablet may get increase which is not of use in case of uncoated large tablets. In film coating technology, the thin layer of the coating material can be applied without affecting other appearances of the tablet. The polymers in this technique can be used are advantageous to coat the water sensitive materials also as they are soluble in organic solvents. The polymers like polyvinylpyrrolidone (PVP), Hydroxypropylmethyl cellulose (HPMC), ethyl cellulose are commonly used. The plasticizers are also added in the organic solution of film former to prevent brittleness to the film. e.g. Diethyl phthalate.

c) Enteric coating:

The drug is released in the enteron i.e. intestinal part of the G.I.T. in this technique and hence the name enteric coating. Some drugs when get released in the stomach, they may cause irritation or may get degrade. Hence, it is necessary to protect those drugs from such an environment. The site specificity is also important. To protect those drugs, the enteric coating is applied. The polymers of acrylic or phthalic acid with carboxyl group are useful. The cellulose acetate phthalate (CAP), hydroxy propyl methyl cellulose phthalate (HPMCP) etc are some of the polymers mainly used in this technique. They get dissolved in the pH range above 5.8 and hence can't get disrupt in the stomach. The plasticizers such as diethyl phthalate, castor oil are also added to provide toughness to the film. These polymers are soluble in volatile solvents such as alcohol, acetone etc and hence are useful in coating of water sensitive drugs.

d) Automated pan coating:

In the pan coating process, the uniform spraying of the coating material on the tablet surface is not possible manually as the error may occur due to the lack of knowledge or the operational handling of

the operator. Thus, automated pan coating technique comes into process for uniform coat with the help of baffles and maintained drying rate. As the uniform coating and drying rate is maintained, it is very useful process than simple (manual) pan coating.

2) Fluid bed coating:

In this technique, the tablets are suspended in a chamber provided with an air stream carrying the coating solution in it. As the tablets are coated in a fluid bed, it is called fluid bed coating. The uniform coating can be obtained within a short period of time with simultaneous drying of the coat with hot air stream flow.

3) Compression coating:

The compression-coating granulation or blend can be preformulated to provide desired functionalities to the coating. The only requirement for producing the compression-coated tablet dosage form described herein is that the core material should possess the ability to flow into a die during production. The various approaches that have been studied for targeting orally administered drugs include use of pro-drugs, pH sensitive polymers and time dependent dosage forms. A relatively more recent approach that has come into existence is the one that combines the features of both controlled release tablets and immediate release tablet in one dosage form. Such a system is known as compression coated tablets. Compression coated tablets function like sugar-coated or film-coated tablets in that the coating may cover a bitter substance. Conceal an unpleasant or mottled appearance, or provide a barrier for a substance irritating to the stomach or one inactivated by gastric juice. Another application of the compression-coated dosage form is in sustained-release preparations. A coating containing the immediate-release portion is compressed around a slowly releasing core. This gives a far more accurate dose than is the case with sugar coating. This tablet involves the compaction of granular materials around a preformed tablet core using specially designed tabletting equipment. Compression coating is a dry process. This type of tablet has two parts, internal core and surrounding coat.

a. Core Tablet:

Core tablet is the innermost part of the compression coated tablet. The core tablet in general contains the active pharmaceutical ingredient (API) which is compressed with the additives compatible with it. The core tablet is always compressed by using a small punch (diameter). The polymers are selected according to the release of the drug required. It means that the drug should be mixed or coated with the polymers according to its nature such as rapid release, extended release or controlled release etc. The core tablet is covered with the coating material to modify the release and to protect the drug from the external environment.

Polymers Used:

TABLE 2: POLYMERS COMMONLY USED IN CORE TABLET

Sr. No.	Name of Polymer	Use of Polymer	Frequency Used In Formulation
1	Hydroxypropylmethyl cellulose (HPMC)	-Film former	4
2	Ethyl cellulose (EC)	-Either as binder or as disintegrant	3
3	Xanthan gum (XG)	-Thickening and stabilizing agent	2
4	Carbopol (CBP)	-controlled release and bioadhesion	1
5	Polyvinylpyrrolidone (PVP)	-As binder or coater	6
6	Microcrystalline cellulose (MCC)	-Excellent compressibility, filler and binder	8
7	Hydroxypropyl Cellulose	-Control drug release rate	2
8	Ludipress (LDP)	-Directly compressible lactose	1
9	Compritol (CMT)	-Sustained release coating agent	3

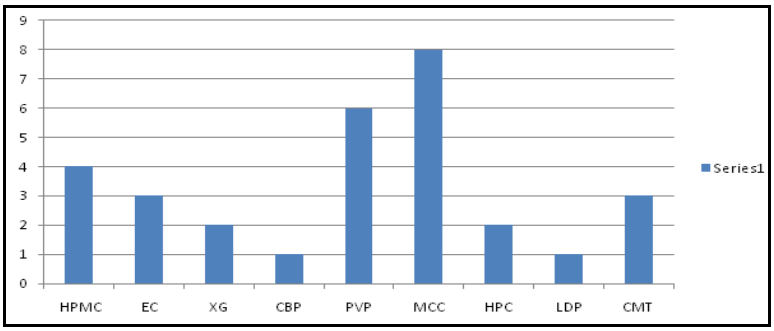
ii. Method of Preparation:

The core tablet is prepared simply by the compression of the active drug along with the suitable polymer and additives. The additives and drug are well mixed and the granules are prepared by any one suitable method and then dried. The dried granules are passed to the die cavities through the hopper. The necessary compression force and

weight required are adjusted with the knobs and the tablets are compressed with the punch having lower diameter than the diameter of the coating tablet.

a. Coating Tablet:

Coating tablet is the outermost part of the compression coated tablet. This tablet is prepared by the compression of the polymers with or without active drug and excipients depending upon the type of tablet on the surface of the core tablet. As this tablet is used to coat the core tablet, the name coating tablet is given to it. The coating tablet sometimes may contain a drug to incorporate two incompatible drugs in one tablet having core and coat part.

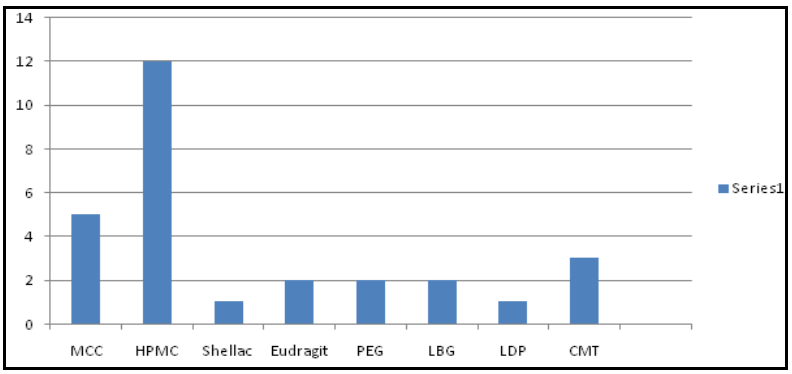


GRAPH 1: POLYMERS MOST COMMONLY USED IN CORE TABLET

Polymers Used:

TABLE 1: POLYMERS COMMONLY USED

Sr. No.	Name of Polymer	Use of Polymer	Frequency Used In Formulation
1	Microcrystalline cellulose (MCC)	-Excellent compressibility, filler and binder	5
2	Hydroxypropylmethyl cellulose	-Film former	12
3	Shellac	-Moisture protective & extended release	1
4	Eudragit	- controlled release film coating	2
5	Polyethylene glycol-6000 (PEG)	-Film property modifier	2
6	Locust bean gum (LBG)	-Alone gives very soft coat	2
7	Ludipress (LDP)	-Directly compressible lactose	1
8	Compritol (CMT)	-Sustained release coating agent	3



GRAPH 2: POLYMERS MOST COMMONLY USED IN CORE TABLET

ii. Method of Preparation:

The core tablet prepared by compression is transferred again into the die already filled with the 70% of coating material and larger in diameter in such a manner that it will be placed exactly at the centre. It is done either manually or if the double press automatic compression machine is available, then automatically. Then the remaining 30% of the coating material is added above the core tablet and then the compression force is applied with the larger punch in diameter than the core tablet.

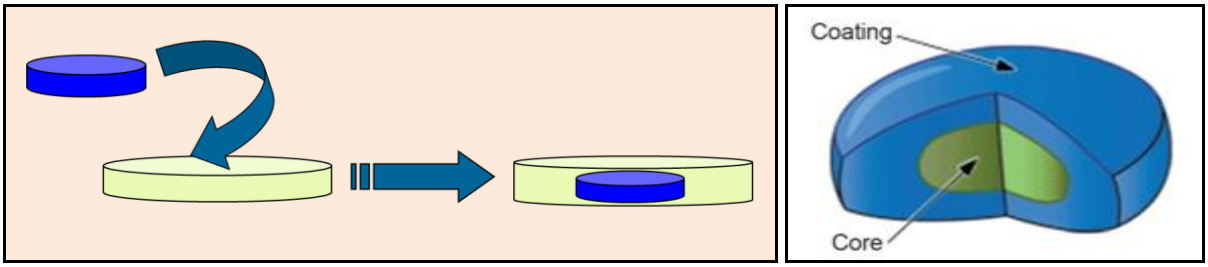


FIG. 1: COMPRESSION COATED TABLET WITH PROCESS

1. Classification:

I) Controlled release system:

Compression coated tablet is prepared by the core coated with the coating material with polymer, diluents and drug. The coating polymer may be of different release patterns. Depending on this, the tablet with modified and extended release pattern with different core and coat materials can be prepared. The drug gets release from the core by disruption of the coat matrix according to the environment and the release can be controlled.

II) Multiphasic release:

Some diseases need the different concentrations of drug at different conditions depending on the severity of the disease. Thus, it is necessary to provide appropriate concentration of drug at various intervals of time. Thus, the tablet should be compressed in a manner such that the drug will get release with conditions. This can be achieved by varying concentration of polymer and drug in core and coat layer. The concentration of drug and polymer should be changed in core and coat to do so. Sometimes, we need the drug to be released rapidly to cure in emergency and then to release drug slowly for longer time. This can be done by incorporating the drug and the rapidly disintegrating polymer in coat layer and the extended release polymer along with drug in core tablet.

III) Delayed release:

Delayed release is divided in two parts. In first part, the lag phase is present in which the drug remains in bound form and after the lag phase gets over, the drug gets released. The lag time can be adjusted with the use of single or combination of polymers to coat the core tablet. This release is pH independent.

IV) Time controlled release:

In time controlled release of the drug from compression coated tablet, the release of drug can be obtained by the use of the salt and surfactant with their types and concentration. It can be done by the lowering of the critical point solution temperature (LCST). The water insoluble polymers can be dissolved in aqueous phase below LCST and remain insoluble above the LCST. Thus, the release can be modified with time and temperature.

V) pH controlled release:

pH controlled release is obtained by the coating of core tablet with the pH sensitive polymers like acrylates used for enteric coating. The drug remains unable to release in the acidic medium as the acrylates are insoluble is stomach pH medium. As the pH increases in the intestine, the acrylates starts to erode and the drug gets released. Hence, these are called as pH controlled release compression coated tablets.

VI) Microbial controlled release:

In case of microbial controlled release tablets, the release of drugs depends upon the enzymes secreted by the enterobacteria (microbes) which degrade the polymers. The polysaccharides having glycosidic linkages are useful polymers in this technique. The alginates, chitosan, cellulose are some of the examples.

1. Adavantages:

a) This technique is simple and inexpensive.

b) Two incompatible materials can be given in one tablet using compression coating.

c) The modified release products can be prepared using compression coating technique.

d) The organic solvents useful in this technique are required in very less quantity and hence the hazard to the environment is very less using this method.

e) The pharmacokinetic drug-drug interactions can also be avoided by this method.

f) The chronological conditions can be well handled by using compression coated tablets.

g) This is a short manufacturing process requires less time as compared to liquid coating.

2. Disadvantages:

a) Specially designed tablet compression machines are required to prepare compression coated tablets.

b) The erosion of the core tablet may occur during the second compression of the coat.

c) Unequal width of the coat diameter may occur in this method.

d) Polymer mixing during the compression may alter the release pattern of the drug.

e) The placement of the core tablet exactly at the centre is one of the challenging task in this method.

7. Applications:

a) The compression coated tablets are very useful in the chronological conditions.

b) This technique is applicable to protect the water, light, oxygen and acid sensitive materials.

c) It is also applicable to separate two incompatible materials.

d) The sustained release formulation is one of the wide applications of this technique.

e) The pulsatile release formulation is one of the best applications of this technique

TABLE 4: ORAL PULSATILE DRUG DELIVERY TABLETS PREPARED BY COMPRESSION COATING

Sr. No.	Drug	Formulation Of Inner Core	Formulation Of Outer Layer	References
1.	5-Fluorouracil	Drug+MCC/PVP K30, MgSt	HPMC, lactose, MgSt	Pharm Devel Technol. 12: 203–210 (2007)
2.	Nicorandil	Drug+mann Na-CMC, corn starch, stearic acid, CaSt.	Fumaric acid, CaHPO4,corn starch, stearic acid, CaSt	Chem Pharm Bull. 56: 464–467 (2008)
3.	Nifedipine	Spray-dried (Drug+HPMC 2910), sucrose, PEO	PEO, PEG 6000	Int J Pharm. 280: 103–111 (2004)
4.	Theophylline	Drug+MCC, Ac-Di-Sol, lactose	PVP, HPMC, PEO, PEO/PVP	Pharm Devel Technol. 15: 305–310 (2010)
5.	Budesonide	Drug+anhydrous lactose	Eudragit S, Eudragit L, HPMC, cellulose acetate butyrate, Pectin, guar gum	AAPS PharmSciTech. 10: 147–157 (2009)
6.	Mesalamine	Drug+PVP K30, MgSt	Pectin, Pectin/Compritol ATO 888	Acta Pharm. 60: 39–54 (2010)
7.	Mesalazine	Drug+MCC, dried starch, SLS, talc, MgSt	Locust bean gum, chitosan, MCC	Chem. Pharm. Bull. 50: 892–895 (2002)
8.	Dicyclomine	Dicyclominemicrosponges+Na CMC, MgSt	Pectin:HPMC (4:1)	J Pharm Sci. 100: 1545–1552 (2011)

9.	Paracetamol	Paracetamol loaded Eudragit based microsponges+Na CMC, MgSt	Pectin:PMC (4:1)	Acta Pol Pharm. 67: 407–415 (2010)
10.	Flurbiprofen	Flurbiprofenmicrosponges+Na CMC, MgSt	Pectin:HPMC (4:1)	Int J Pharm. 318: 103–117 (2006)
11.	5-Fluorouracil	Drug+cross-PVP	Xanthan gum, guar gum, starch	Int J Pharm.269: 101–108 (2004)
12.	Tinidazole	Drug+spray-dried lactose, sodium starch glycolate, talc, MgSt	Guar gum, HPMC, starch, talc, MgSt	Drug Delivery, 10: 263–268 (2003)

Note: MgSt: magnesium stearate; HPMC: hydroxypropylmethylcllulose; EC: ethylcellulose; PEO: polyethylene oxide; NaCMC: sodium carboxymethylcellulose; MCC: microcrystalline cellulose; PVP: polyvinylpyrrolidine; CaSt: calcium stearate; Ac-Di-Sol: sodium croscarmellose; HPC: hydroxypropylcellulose; Ca CMC; calcium carboxymethylcellulose; DCP: dicalcium phosphate dihydrate; PEG: polyethylene glycol; HPMCAS: hydroxylpropylmethylcellulose acetate succinate; PNIPAAm: poly(N-isopropylacrylamide); PNIPAAm-co-NVA: poly(N-isopropylacrylamide) co-N-vinylacetamide; HEC: hydroxyethylcellulose.

CONCLUSION: The compression-coated tablet process provides compression coating by simple modifications to different layers. There are many advantages of this process over traditional compression coating. Separate formation of a core is not necessary hence no transfer mechanism is required for the core and the literature reveals that amongst various polymers micro crystalline cellulose in core tablet and hydroxypropylmethyl cellulose are widely preferred polymers in exist compression coated tablet formulations.

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How to cite this article:
Patil PR, Bobade VD, Sawant PL and Marathe RP: Emerging Trends in Compression Coated Tablet Dosage Forms: A Review. Int J Pharm Sci Res 2016; 7(3): 930-38.doi: 10.13040/IJPSR.0975-8232.7(3).930-38.