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Review on Dispersible Tablets: A New Endeavor in Drug Delivery System

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Abstract
Nanomedicines have evolved into various forms including dendrimers, nanocrystals, emulsions, liposomes, solid lipid nanoparticles, micelles, and polymeric nanoparticles since their first launch in the market. Widely highlighted benefits of nanomedicines over conventional medicines include superior efficacy, safety, physicochemical properties, and pharmacokinetic/pharmacodynamic profiles of pharmaceutical ingredients. Especially, various kinetic characteristics of nanomedicines in body are further influenced by their formulations. This review provides an updated understanding of nanomedicines with respect to delivery and pharmacokinetics. It describes the process and advantages of the nanomedicines approved by FDA and EMA. New FDA and EMA guidelines will also be discussed. Based on the analysis of recent guidelines and approved nanomedicines, key issues in the future development of nanomedicines will be addressed.

Keywords
Nanomedicines · Pharmacokinetics · Delivery · Guidelines

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INTRODUCTION:
Formulation of drugs into a presentable form is the basic requirement and need of today. Dosage form is a mean of drug delivery system, used for the application of drug to a living body. Various type of dosage forms are available such as tablets, syrups, suspensions, suppositories, injections, transdermal patches having different type of drug delivery mechanisms. These classical/modern dosage forms have some advantages and disadvantages therefore the development of an ideal drug delivery system is a big challenge to the pharmacist in the present scenario. In order to get the desired effect, the drug should be delivered to its site of action at such rate and concentration to achieve the maximum therapeutic effect and minimum adverse effect [1].

The basic aim behind development of any drug delivery system (DDS) is to achieve a safe and effective therapy for the human being. For decades, oral drug delivery become the major segment in the global pharmaceutical market. It is growing day by day because of being a favorite route for drug administration [2]. In recent days tablets become the most favourable dosage form as compared to other available dosage form. The popularity of this dosage form is because of advantages such as ease to manufacturing, convenience in administration, and high accuracy in dosage, stability and safety [3].

A tablet is a compressed solid dosage form containing a single dose of one or more active ingredients produced by compressing uniform volumes of particles [4]. They are usually intended for oral administration although their use is not limited to this. The oral tablets can be swallowed whole, chewed and swallowed, dissolved or dispersed in water before administration or even placed in the mouth under the tongue where absorption occurs. The mode of administration will be determined by the type of tablet. Tablets can be grouped into several types which include; the chewable tablet, the sublingual tablet, the effervescent tablet, the buccal tablet, lozenges, dispersible tablet, sustained release tablet and delayed release tablet. The tablet type is majorly determined by the types of ingredients in the tablet and the manufacturing process it goes through. Depending on the API and site of action, tablet can be administered for local activity in the mouth or for systemic activity [5]. Tablets have been favored as a dosage form because;

- The oral route is convenient and relatively safe for drug administration
- Compared to liquid dosage forms tablets have general advantages in terms of the chemical and physical stability of the dosage form
- The preparation procedure enables accurate dosing of the drug
- They are convenient to handle and can be prepared in a versatile way with respect to their use and the delivery of the drug
- They can be cheaply produced
- They are less bulky compared to liquid dosage forms or even bulk powders

DISPERSIBLE TABLETS [6]:

Although the tablets and capsules considered as the most widely accepted dosage forms through oral route of administration with proven advantages for decades, it also have some drawback such as difficulty in swallowing as dysphasia in pediatric, geriatric and bedridden patients. The novel concept of dispersible drug delivery system emerged from the desire to provide patient with conventional mean of taking their medication. Recently oral administration of formulation become most popular route of administration due to its ease of ingestion, pain avoidance with respect to parenteral route, versatility and most importantly, patient compliance. Dispersible Tablets is a special formulation, which will quickly disintegrate in water to form a suspension that can be drunk. It combines the ease of swallowing and the potentially improved bioavailability of a liquid formulation with the accurate dosing. Active ingredients which are unstable in aqueous solution may be stable as a dispersible tablet.

Definition:

Dispersible tablets are uncoated or film-coated tablets that can be dispersed in liquid before administration giving a homogenous dispersion. Dispersible tablets usually disintegrate within three minutes when put in water or a small amount of breast milk. On the basis of recent developments dispersible tablets can be distinguished in two forms:

- One which directly disintegrates or dissolves in the mouth without a need of drinking water and
- Second which requires addition of water to form dispersion within seconds of time, and easy to take by the patient.

In both the cases, bioavailability of drug is significantly greater due to instant dispersion and solubility than those observed from conventional tablet dosage form [7]. The step by step disintegration process of dispersible tablets are given in figure 1.

Ideal properties of Dispersible tablets [8,9]:

- Ideally Rapid dispersible tablets require less amount of water for oral administration, the formulation should be easily disintegrated or dissolved in water within a few seconds to minutes.
- The formulation should have sufficient hardness and should be free from any friability problem to match the rigors of the manufacturing process and handling of finished product by target patient.
- The drug loading capacity of dispersible tablets should be high.
- The formulation should have been free from any bitter or unpleasant taste with better organoleptic properties.
- It should be stable with low manufacturing cost and the process should be amenable to existing processing and packaging machineries.
- It should be Cost-effective.
- It should have more stability when compared to liquid dosage forms.

Problem associated with Dispersible Tablets [10,11]:

- Drugs absorbed at specific site cannot be given in these dosage forms.
- These tablets show high friability, less hardness than conventional tablets.
- Drugs with relatively larger doses are difficult to formulate.

- Hygroscopic properties of formulation require extra moisture protection with special packaging for proper stability & safety of the products.

Advantages of dispersible tablets [12-14]:

- Easy to administer to the patient who cannot swallow such as pediatric, geriatric, bedridden, stroke victim and institutionalized patient (specially for mentally retarded and psychiatric patients)
- Excellent mouths feel property produced by use of flavors and sweeteners help to change the perception of "medication as bitter pill" especially in pediatric population.
- Fast disintegration of tablets leads to quick dissolution and rapid absorption which may produce rapid onset of action.
- Dispersible tablets offer all the advantages of solid dosage forms and liquid dosage forms.
- Convenience of administration and accurate dosing compared to liquids.

Recommendations for the use of dispersible formulations [7]:

- To be dispersed in a small amount (5 to 10ml) of liquid (clean water or milk).
- Use of a clean and appropriate container is recommended to disperse the tablets.
- The liquid can be softly stirred to aid dispersion before swallowing.
- As a proportion of the active substance may remain in the container after swallowing, it is advisable to rinse it with a small amount of water or milk and swallow again.
- The dispersible tablets should not be divided or chewed.
- Careful handling of dispersible tablets is necessary as, they are much more fragile than the regular tablets (more friable, less resistant to rubbing).
- Dispersible tablets must be used immediately after removal from the blister packaging. Their stability outside of the blister cannot be guaranteed.

Table 1 gives the list of dispersible tablets available in the market.

Table 1. List of dispersible tablets available in the market

Sl. No.	Active ingredient	Brand Name	Indication	Technology used	Manufacturer
1	Nimesulide	Nimulid-MD	Pain, Osteoarthritis	Direct compression	Panacea
2	Rofecoxib	Biotech Zyrofmeltab	Osteoarthritis, Rheumatoid arthritis, Acute pain in adults, and Primary dysmenorrhea, Migraine	Freeze drying	Zydus Cadila
3	Mosapride Citrate	Mosid-MD	Gastroesophageal Reflux Disease, Heartburn, Acidity, Indigestion, and Stomach pain	Lyophilization	Torrent Pharmaceuticals
4	Piroxicam	Feledine Melt	Pain, Swelling, and Joint stiffness from arthritis	Freeze drying	Pfizer
5	Famotidine	Maxalt ODT	Heartburn, Acid indigestion, Sour stomach, Zollinger–Ellison syndrome and Multiple endocrine adenomas, GERD	Direct compression	Merck
6	Mirtazapine	Remeron Sol Tab	Depressive disorder	Freeze drying	Organon
7	Montelukast	Romilast	Asthma, Exercise-induced bronchoconstriction (EIB)	Molding	Ranbaxy
8	Olanzepine	Manza BDT	Bipolar disorder, Treatment resistant depression (TRD)	Spray drying	Orchid
9	Olanzepine	Olanexinstab	Bipolar disorder, Treatment resistant depression (TRD)	Lyophilization	Ranbaxy

Table 2. List of synthetic and semisynthetic Super disitegrants with their concentration in dispersible tablets

Sl. No.	Superdisintegrant	Concentration in dispersible tablets (%w/w)
1	Starch USP	5-20
2	Starch 1500	5-50
3	MCC (Avicel)	10-20
4	Alginic Acid	1-5
5	Sodium Alginate	2.5-10
6	Explotab	2-8
7	Polyplasdone (XL)	0.5-5
8	Amberlite (IPR 88)	0.5-5
9	Ac-Di-Sol	1-3
10	Crosslinked pvp	2 – 5
11	Methyl Cellulose	2-10
12	Colloidal Silicon Dioxide	1-5
13	Sodium starch glycolate	10

Table 3. List of Binders

Sl.No.	Binder	Concentration in dispersible tablets (%w/w)
Saccharides and their derivatives:		
1	**Disaccharides:** Sucrose, Lactose	2-25
2	**Polysaccharides and their derivatives:**	2-5
	Starches, Cellulose or modified cellulose such as Microcrystalline cellulose and cellulose ethers such as Hydroxypropyl cellulose (HPC)	5-10
3	**Sugar alcohols:** Xylitol, Sorbitol or Maltitol	5-15
Protein:		
4	Gelatin	1-8
Synthetic polymers:		
5	Polyvinylpyrrolidone (PVP), Polyethylene glycol (PEG)	0.5-55

Table 4. List of Diluents and Fillers

Water insoluble	Partially soluble	Water soluble
Calcium carbonate	Pre-gelatinized starch	Dextrose
Calcium phosphates	Low-substituted Hydroxypropyl cellulose	Lactose
Magnesium carbonate	-	Mannitol
Microcrystalline cellulose	-	Sorbitol
Starch	-	Sucrose

Table 5. List of Lubricants

Sl.No	Lubricants	Concentration in dispersible tablets (%w/w)
Water soluble		
1	Boric acid	1
2	Sodium benzoate	5
3	Sodium oleate	5
4	Sodium acetate	5
5	Sodium lauryl sulphate	1-5
6	Magnesium lauryl sulphate	1-2

Water insoluble		
7	Sterate(Calcium, Sodium,Magnesium)	0.25-1
8	Talc	1-2
9	Sterotex	0.25-1
10	Wazes	1-5
11	Sterowet	1-5
12	Glyceryl behapet	1-5
13	Liquid paraffin	Upto 5

Table 6. List of Dispersible Formulation in Indian Market

Sl.No	Active Ingredients	Brand Name	Indications	Manufacturer
1	Imodium	Imodium Lingual	Diarrhoea	Janssen Pharmaceutica
2	Loratidine	Claritin Reditab	Allergic rhinitis	Bayer HealthCare llc
3	Piroxicam	Feldene Melt	Pain	Haupt Pharma Latina S.r.l.
4	Rizatriptan	Maxalt-MLT	To relieve headache, Pain, and Other migraine symptoms (including nausea, vomiting, sensitivity to light/sound)	Aurobindo pharma ltd
5	Famotidine	Pepcid RPD	Heartburn, Acid indigestion, Sour stomach, Zollinger–Ellison syndrome	Merck
6	Olanzapine	Zyprexa Zydis	Schizophrenia and Bipolar disorder (manic depression)	Eli Lilly
7	Artemether & Lumefantrine	Riamet	Anti-malarial	Novartis Australia
8	Lamotrigine	Lamotrigine	Anti-epilepsy and bipolar disease	Actavis
9	Amoxycillin trihydrate	Ranmoxy Distab	Anti-bacterial	Ranbaxy
10	Paracetamol	Rapidol	Analgesic and antipyretic	Ethypharm Industries, France
11	Tramadol HCl	Analtra-DT	Central Analgesic	May Flower, India
12	Azithromycin	Azcin-DT	Macrolide antibiotic	West Coast Pharmaceuticals
13	Cefpodoxime Proxetil	C Pod Dispersible Tablets	Antibiotic	Yash Pharma Laboratories
14	Acyclovir	Dispersible Acyclovir tablets	Antiviral	Yash Pharma Laboratories
15	Fluoxetine HCl	Lovan Tablets	selective serotonin reuptake inhibitor	Alphapharm P/L
16	Ivermectin	Ivamer	Anti Helmenthetics	Gen Pharma
17	Ivermectin & Albendazole	Ivaver DT Plus	Anti Helmenthetics	Gen Pharma
18	Cefixime trihydrate	Cefocef LB	Cephalosporin Antibiotic	Centaur Pharma
19	Piroxicam	Piram D	NSAID	Mylan Laboratories
20	Montelukast Sodium	Montasma	Leukotriene receptor antagonist	Icarus healthcare

Table 7. Various hardness tester

Sl.No	Hardness tester
1	Monsanto tester
2	Strong-Cobb tester
3	Pfizer tester
4	Erweka tester
5	Dr.Schleuniger Pharmatron tester

Table 8. Pharmacopoeial limits for friability

B.P/I.P	NMT 0.8% - 1.0%
U.S.P	NLT 0.5 - 1%

Table 9. Pharmacopoeial limits for drug content uniformity

IP	This test is applicable to tablets that contain 10mg or less than 10mg / 10%w/w of active ingredient.
USP	This test is applicable to tablets that contain 25mg or 25%w/w of active ingredient.
BP	This test is applicable to tablets that contain 2mg or 2%w/w of active ingredient.

Table 10. Limits for weight variation test

IP/BP	USP	Limit
80mg or less	130mg or less	+/- 10%
More than 80mg or less than 250mg.	130mg to 324mg	+/- 7.5%
250mg or more	More than 324mg	+/- 5%

Table 11. Pharmacopoeial conditions for disintegration

	IP	BP
Medium	Water	Water
Temperature	25 +/- 1°C	15-25°C
Limit	3- 5 minutes	3 minutes

Table 12. Marketed technologies for dispersible tablets [38, 39].

Patented Technology	Technique Employed	Innovator Company	Active Ingredient & Brand	Advantages
Zydis	Lyophillization	R.P. Scherer, Corp.	Loratidine (Claritin, Reditab Pharmaceuticals)	Highly porous in nature, faster dissolution rate of tablets than conventional
Quicksolv	Lyophillization	Janssen Pharma	Cisapride monohydrate (Propulsid Quicksolv)	Short disintegration time, good mouth feels property of tablets
Lyoc	Lyophillization	Farmalyoc	Phloroglucinol Hydrate (Spasfon Lyoc)	Accommodate high dose, disintegrates rapidly within a matter of seconds
Orasolv	Effervescent disintegrant compression	CIMA Labs, Inc.	Paracetamol (Tempra)	Unique taste masking, fast dissolution rate of tablets
Durasolv	Molding	CIMA Labs, Inc.	Hyoscyamine Sulfate (NuLev)	Good rigidity
Wowtab	Compression moulded tablets	Yamanouchi Pharma	Famotidine (Gaster D)	Adequate dissolution rate and hardness in tablets

Flash dose	Cotton Candy Process	Fuisz Technology Ltd	Tramadol HCl (Relivia Flash dose)	Highly porous in nature, and tablets shows pleasant mouth feel property
Flashtab	Effervescent Disintegrant	Prographarm Group	Ibuprofen (Nurofen Flash Tab)	Conventional tableting technology and faster dissolution rate
Ziplets	Molding	Eurand International	Ibuprofen (Cibalgin)	Sufficient mechanical strength

CHALLENGES IN THE FORMULATION OF DISPERSIBLE TABLETS [31]:

- **Mechanical strength and disintegration time:** Disintegration time will extend if the mechanical strength is more, so a good cooperation between these two parameters is always necessary.
- **Taste masking:** Efficient taste masking of the bitter drugs must be done so that the taste of the drug is not felt in the oral cavity.
- **Mouth feel:** Addition of flavors and cooling agents like menthol enhance the mouth feel.
- **Sensitivity to environmental conditions:** Dispersible tablets should have low sensitivity to environmental conditions such as humidity and temperature.
- **Cost:** The technology adopted for a dispersible tablet should be acceptable in terms of cost of the final product.

BASIC COMPONENTS OF DISPERSIBLE TABLET FORMULATION [15-19,36,37]:

1. Drug:

High dose drugs which are highly water soluble, poorly compressible and hygroscopic pose the greatest difficulty in a dispersible tablet formulation. Excipients must be carefully selected to produce a tablet matrix with high compressibility and low aqueous solubility and hygroscopicity.

2. Disintegrants:

A disintegrants accelerates the rate at which a tablet breaks up in water. The current research will use so-called super disintegrants, so-called because of high disintegrants efficiency attributed to their remarkable ability to absorb water and swell. Various types of synthetic, semi synthetic and natural super disintegrants are used. Natural super disintegrants includes **Plantago Ovata seed mucilage, Lapidium Sativum mucilage, Gum Karaya, Fanugreek Seed mucilage, Guar gum, Cassia Fistula gum, Locust bean gum(5%w/w), Hibiscus rosa-sinensis Linn mucilage, Isaphghulla Husk (10%), Soy polysaccharides, Xanthum Gum, Gallen Gum**. The schematic diagram for mechanism of disintegration is given in figure 2.

List of different types of superdisintegrants along with their concentration in dispersible tablets are given in table 2.

3. Binder:

The binder and solvent in wet granulation have a profound effect on the disintegration properties of the tablet. The aqueous solubility of the binder will affect tablet disintegration properties, and this is well documented. Table 3 gives the list of binders and their concentration in dispersible tablets.

4. Diluents:

A diluents or filler facilitates the compression of a formulation and gives tablet strength and acceptable appearance. Diluents can be broadly categorized by their aqueous solubility and choice is dependent on the physico-chemistry of the drug; solubility, hygroscopicity, compression properties, instability and the method of manufacture. Diluents used in dispersible tablet formulations are listed in the table 4.

5. Lubricants:

Stearic acid salts, such as magnesium Stearate, are potentially unsuitable in dispersible tablet formulations because they are hydrophobic and may form a scum giving an unpleasant appearance. Paradoxically most commercial dispersible tablets are lubricated using magnesium Stearate. Commonly used lubricants with their concentration in dispersible tablets are summarized in the table 5.

MANUFACTURING TECHNIQUES:

1. Direct Compression [20,21]:

This method can be applied to manufacture dispersible tablets by choosing appropriate combinations of excipients which can provide fast disintegration and good physical resistance. This technique is mainly preferred because of the availability of improved excipients especially superdisintegrants and sugar-based excipients. The flowchart describing direct compression process and its machine are represented by figures 3,4.

2. By Granulation Method [22,23]:

The manufacturing of Rapid dispersible tablets or Fast dissolving tablets is also prepared by various granulation techniques such as wet granulate on and

dry granulation methods. Wet granulation is the most widely used process of granulation, involves wet massing of the powder blend with a granulating liquid containing a suitable binder, sizing of wet granules and drying of granules in a suitable dryer. The flowchart describing granulation process and its machines are represented by figures 5-8.

3. Lyophillization or Freeze-Drying [24,25]:

Lyophillization also known as Freeze-drying is the most widely used conventional manufacturing techniques for the formulation of rapid dispersible tablets. More than 40 % of formulations of rapid dispersible tablets are manufactured with Lyophillization. In this process water is sublimed from the product after it is frozen. The schematic diagram of lyophilization cycle and freeze dryer are given in figures 9,10.

4. Spray-Drying [26]:

Spray drying can produce highly porous and fine powders that dissolve rapidly. The formulations are incorporated by hydrolyzed and non-hydrolyzed gelatins as supporting agents, Mannitol as bulking agent, sodium starch glycolate or Croscarmellose sodium as disintegrating and an acidic material (e.g. citric acid) and / or alkali material (e.g. sodium bicarbonate) to enhance disintegration and dissolution. Tablet compressed from the spray dried powder disintegrated within 20 seconds when immersed in an aqueous medium. The flow chart for spray drying process and spray dryer are represented by figures 11,12.

5. Tablet Moulding [27]:

Moulding process is of two type's i.e. solvent method and heat method. Solvent method involves moistening the powder blend with a hydro alcoholic solvent followed by compression at low pressures in molded plates to form a wetted mass (compression moulding). The solvent is then removed by air-drying. The tablets manufactured in this manner are less compact than compressed tablets and possess a porous structure that hastens dissolution. Tablet mould used for the manufacturing of tablet is given in figure 13.

6. Sublimation [28,29]:

The slow release profile of the compressed tablet containing even highly water-soluble diluents and excipients is basically due to the fact that the low porosity of the tablets reduces water penetration into the matrix. The incorporation of volatile materials during formulation of tablets using the conventional method resulting in highly porous structures, which can be easily removed by sublimation. The schematic representation of sublimation process is given in figure 14.

7. Cotton candy process [32,33]:

This process is so named as it utilizes a unique spinning mechanism to produce floss like crystalline structure, which mimics the cotton candy. Cotton candy process involves formation of matrix of polysaccharides or saccharides by simultaneous action of flash melting and spinning. The matrix formed is partially recrystallized to have improved flow properties and compressibility. This candy floss matrix is then milled and blended with active ingredients and excipients and subsequently compressed to dispersible tablets. This process can accommodate high dose of drug and offers improved mechanical strength. However, high process temperature limits the use of this process. The mould used in cotton candy process is given in figure 15.

8. Mass extrusion [34,35]:

This technology involves the softening the active blend using the solvent mixture of water-soluble polyethylene glycol and methanol and subsequent expulsion of softened mass through the extruder or syringe to get a cylinder of the product into even segments using heated blade to form tablets. The dried cylinder can also be used to coat granules for bitter drugs and thereby achieve taste masking. Mass extruder used for the manufacturing of tablets are given in figure 16.

9. Nanonisation [36,37]:

A recently developed nano melt technology involves reduction in the particle size of drug to nano size by wet milling technique. Surface adsorption of the nano crystals of the drug is done on selected stabilizers for stabilizing them against agglomeration, which are then incorporated into the dispersible tablets. This technique is mainly advantaging for poor water-soluble drug and also for wide range of doses (up to 200mg of drug per unit). List of dispersible formulations available in the Indian market is given in table 6.

DIFFERENT TYPES OF DISPERSIBLE TABLETS:

Different types of dispersible tablets are given in Figures 17-19.

Fig 1: Disintegration process of dispersible

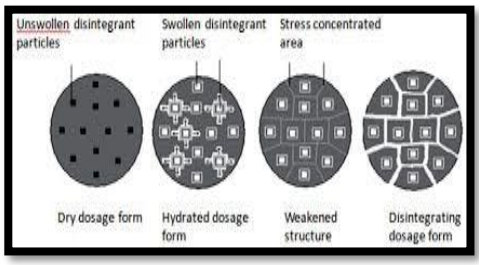

Fig 2: Schematic diagram for mechanism of disintegration

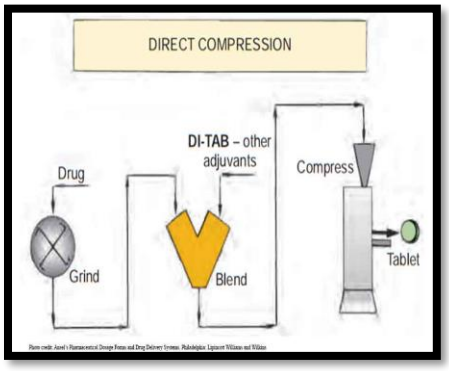

Fig 3: Direct compression

Fig 4: Direct compression machine

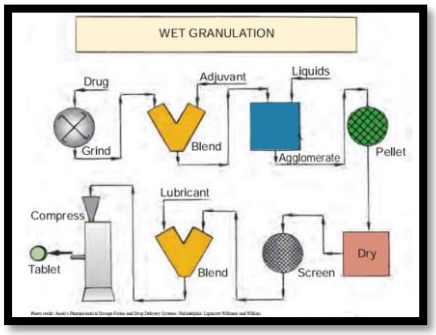

Fig 5: Wet granulation

Fig 6: Granulation machine 500x500

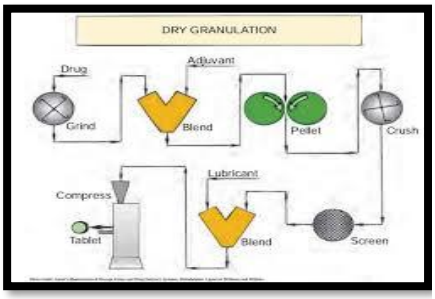

Fig 7: Dry granulation

Fig 8: Granulator machine

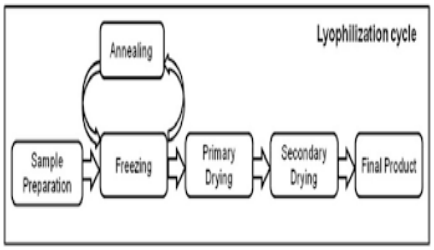

Fig 9: Lyophilization cycle

Fig 10: Freeze dryer

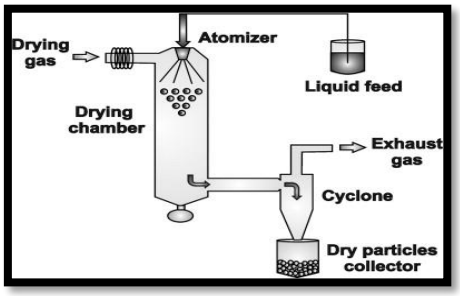

Fig 11: Spray-drying

Fig 12: Spray-dryer

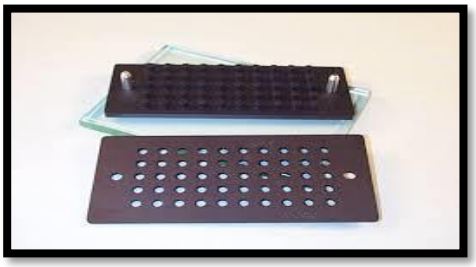

Fig 13: Tablet moulding

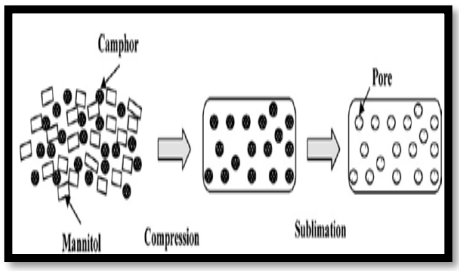

Fig 14: Sublimation

Fig 15: Candy mould

Fig 17. Uncoated tablets

Fig 18. Film coated tablets

Fig 19. Sugar coated tablets

EVALUATION OF DISPERSIBLE TABLETS [30,40,41]:

Appearance

Appearance is the first most required quality for the acceptance of tablet. General elegance and its identity play a major role for the consumer acceptance. Acceptance of the appearance of batches of the tablet has been done based on the measurement of the following factors like size and shape, color, presence or absence of odor, taste etc.

Organoleptic properties

Color should be distributed uniformly without appearance of any signs of mottling. Colour of the tablet should be compared with the standard colour for comparison. Taste should also be compared with the standard for better patient acceptance.

Size and shape

Size and shape of a tablet plays an important role in its patient compliance as the size of the tablet increases it will be difficult for its administration. Micrometer is the device which is used to determine the thickness of a tablet. It is acceptable if the batch falls within ±5% of standard deviation.

Hardness

The hardness test is performed to measure the tablet strength. Tablet should be hard enough to withstand packing and shipping. The hardness of 10 tablets is noted and the average hardness was calculated. It is expressed in N or kg/cm^2. Table 7 shows the different types of hardness tester.

Friability

Roche friabilator is the equipment which is used for the determination of friability. It is expressed in percentage. The initial weight of the tablets is noted individually (W initial). Tablets are placed in a plastic chamber which revolves at 25 rpm and they are subjected to fall from a height of 6 inches in the friabilator for about 100 revolutions. Then final weight of the tablet is measured (W final) and observe any weight difference before and after the friabilator processing.

Pharmacopoeial limits for friability tests are listed in table 8.

Percentage of friability is calculated as:

F= {(W initial)- (W final)/ (W initial)} ×100

Uniformity of drug content

The uniformity of drug content is determined by assayed for 10 tablets individually for their content (according to the method described in the individual monograph). The requirements for content uniformity are met if the amount of the active ingredients in each tablet lies within the range of 85% to 115% of the label claim (as per USP). The limits for drug content uniformity in other pharmacopoeias are listed in table 9.

Weight variation test

20 tablets are selected at random and weighed individually. The average weight of the tablet is then determined. NMT 2 of the individual weights deviates from the average weight by more than the percentage given in the pharmacopoeia and none deviates by more than twice the percentage. The limits of weight variation test in pharmacopoeias are listed in table 10.

Wetting time

A piece of tissue paper which is folded twice is kept in a petri dish containing 6 ml of water and place the tablet on the tissue paper. Observe the time taken for complete wetting of the tablet. The procedure should be followed for three times (three trial) and standard deviation is also calculated from the obtained results.

Water absorption ratio

A piece of tissue paper which is folded twice is kept in a petri dish (i.d.=6.5 cm) containing 6 ml of water and place the tablet on the tissue paper. Observe the time taken for complete wetting of the tablet. Thus, wetted tablet was weighed. Now the water absorption ratio R is calculated using the formula

R=100 × Wa –Wb/Wb

Wb is the weight of the tablet before absorption,
Wa is the weight of the tablet after absorption,

The procedure should be followed for three times (three trial) for each formulation and standard deviation is also calculated from the obtained results.

***In-vitro* dispersion time**

Dispersion time of a tablet is determined by placing a tablet in 6 ml of water and note down the time taken for complete dispersion of tablet. The procedure should be followed for three times (three trial) for each formulation and standard deviation is also calculated from the obtained results. Standard deviation time is also determined from the obtained results. It is expressed in seconds.

***In-vitro* disintegration test**

Disintegration time of a tablet is determined by using disintegration test apparatus as per pharmacopoeial specifications. Place each tablet in each 6 tubes of the disintegration apparatus, then add a disc to each tube containing suitable dissolution medium. The temperature of the medium should be maintained at 37° ± 2°C and run the apparatus raised and lowered for 30 cycles per minute. The time taken is noted down for the complete disintegration of the tablet without any remittent. Pharmacopoeial conditions for disintegration test is given in table 11.

Uniformity of dispersion:

This test is applicable only to dispersible tablets. In this method, two tablets are placed in 100ml of water and stirred gently until completely dispersed. A smooth dispersion must be obtained which passes through sieve screen with nominal mesh aperture of 710µm (sieve no. 22) indicates the uniform dispersion of dispersible tablets.

***In vitro* dissolution test**

Dissolution rate was studied by using 900 ml of water as dissolution medium. Temperature of the dissolution medium was maintained at 25° +/- 0.5°C, aliquot of dissolution medium was withdrawn at specific time intervals given in the monograph and the absorbance of the solution was measured by suitable analytical technique.

COMPARISON OF DIFFERENT PHARMACOPOEIAL QUALITY CONTROL TESTS FOR DISPERSIBLE TABLETS

- **BRITISH PHARMACOPOEIA**
  - Disintegration test
  - Uniformity of dispersion
  - Uniformity of weight
- **INDIAN PHARMACOPOEIA**
  - Uniformity of dispersion
  - Disintegration test
- **UNITED STATES PHARMACOPOEIA**

Official test:

- Weight variation
- Disintegration
- Dissolution
- Drug content

Unofficial test:

- Hardness
- Friability

Table 12 shows the list of marketed technologies for dispersible tablets.

CONCLUSION:

The introduction of dispersible dosage forms has solved some of the problems encountered in administration of drugs to the pediatric and elderly patients, which constitutes a large proportion of the world's population. Hence, patient demand and the availability of various technologies have increased the market share of dispersible tablets, which in turn prolongs the patient life of a drug. Recent trends of patient oriented practice demand design of patient oriented dosage form to achieve patient compliance. The number of formulation related factors contributes to the significant amount of non-compliance and hence there is a need to design patient-oriented drug delivery system. Dispersible tablets are ideal for many groups of patients

including geriatrics, pediatrics, psychiatrics and for those people who have difficulty in swallowing. By using such manufacturing technologies, many drugs can be formulated in the form of dispersible tablets to provide the advantages of liquid medication in the form of solid preparation. Keeping in view of the advantages of the delivery system, dispersible tablets have been successfully commercialized, and because of increased patient demand, these dosage forms are expected to become more popular.

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