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Formulation and Evaluation of Atenolol Tablets Incorporating Tamarind Kernel Powder as a Novel Natural Disintegrant

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ABSTRACT: The present study focuses on the formulation and evaluation of Atenolol tablet formulation using Tamarind Kernel Powder (TKP) as a novel natural disintegarant. Atenolol, a β-blocker drug used in hypertension and cardiovascular diseases, requires rapid disintegration for effective therapeutic action. Natural disintegrants like TKP offer advantages such as biocompatibility, cost-effectiveness, and sustainability compared to synthetic alternatives.Atenolol tablet formulation were developed using varying levels of tamarind kernel powder (TKP) and subjected to a comprehensive evaluation of their pre-compression and post-compression properties, covering a range of physical and functional characteristics, including density, flowability, mechanical strength, disintegration, uniformity, and dissolution behaviour. The results demonstrated that tablets containing TKP exhibited improved disintegration time and drug release profiles, meeting pharmacopoeial standards. The optimized formulation showed rapid disintegration and enhanced dissolution, indicating TKP's potential as an efficient natural disintegrant. This study highlights the feasibility of utilizing plant-based excipients in pharmaceutical formulations, promoting eco-friendly and sustainable drug delivery approaches.

Keywords: Atenolol, Tamarind Kernel Powder, Natural Disintegrant, Drug Release, Disintegration Time

I. INTRODUCTION:

Oral drug delivery is widely considered the preferred method of administration in the pharmaceutical industry, representing the most popular and accepted approach ,the safest, the most convenient and most economical method of drug delivery with the highest patient compliance. Among oral dosage forms, tablets constitute a major portion, requiring rapid disintegration for effective drug absorption.Tablet disintegration is a key step for achieving rapid drug release.[1] Disintegrants are substances or mixtures of substances used in medicine formulations to enhance dispersion or break up tablets and capsules into tiny particles for faster dissolving. Disintegrants are a class of materials that, when subjected to water, swell, hydrate, change volume or form, or react chemically to cause a disruptive change in the tablet.[2] The disintegration of dosage forms depends on various physical properties such as the percentage of disintegrants used, the proportion of disintegrants used, compatibility with other excipients, the presence of surfactants, the hardness of the tablets, the nature of drug substances, and the types of addition..Natural disintegrants produced from natural sources have several advantages, including low cost, nontoxicity, biodegradability, environmental friendliness, and less negative effects.Chemically, Atenolol is 4-(2-Hydroxy-3-[(1-methyl ethyl) amino] propoxy) benzene acetamide.[3]ß1-blocker is prescribed widely in diverse cardiovascular diseases, eg, hypertension, angina pectoris, arrhythmias, and myocardial infarction. The drug is also frequently indicated in the prophylactic treatment of migraine.[4] Oral bioavailability of Atenolol is around 50% and having half-life 6 to 7 hrs.[5]Mucilages and gums have been widely used in pharmaceuticals and cosmetic applications as a disintegrant, binder, emollient, gelling agent, emulsifier, granulating agent, suspending agent, lubricant, sustained release agent, and skin-soothing agent.[6]Polysaccharides are frequently used in drug delivery systems. Polysaccharide functional groups have been researched for chemical modification to alter properties such as swelling, solubility, viscosity, and degradation.[7]In this work, Tamarind kernel powder was used as a natural disintegrant. Tamarind, also known as Tamarindus indica, belongs to the Leguminosae (Fabaceae) family. Tamarind kernel powder is obtained from the endosperm of seeds. Seeds contain about 60–70% of polysaccharides.

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Chemically, it contains galactoxyloglucan as a major constituent. The tamarind seeds powder dispersed in water can form highly viscous solutions. [8] Tamarind kernel powder has many pharmaceutical applications such as a binder in tablet formulation, in sustained drug delivery, in ocular drug delivery, in textile industry, in paper industry etc.

II. MATERIALS AND METHODS:

Materials: Tamarind seed obtained from fruit of tamarind tree from local market. The chemicals were made available by LNJDP COP, Manur anddistilled water was produced from the laboratory..

Preparation of TKP from tamarind seeds: Collect mature tamarind seeds from tamarind fruit processing units. Clean the seeds to remove dirt, dust and pulp residues. Wash with water and dry under sunlight or hot air dryer. Further seeds are roasted at 120-150°C foe a few minutes.This makes the outer seed coat brittle and easy to remove.The outer brown coat is removed mechanically or manually (dehulling).(Figure 2 depicts picture of tamarind kernel powder) .This separates the white kernel from the husk. The dehulled kernels are ground in fine powder. The grinding process ensures a uniform particle size depending on industrial requirements. The ground powder is then passed through sieves to remove coarse particles (80-100 mesh sieve). This leads to uniform quality of final TKP.

Fig. 1: method of extraction for tamarind kernel powder

Fig. 2: preparation of tamarind kernel powder

III. EVALUATION:

3.1 Pre-compression studies of tamarind kernel powder:

To evaluate the powder properties before tablet compression, five key studies were performed: bulk density, tapped density, angle of repose, carr's Index, and hausner's ratio:

3.1.1: Bulk Density:

The bulk density of a powder is defined as its mass divided by its bulk volume, and is heavily influenced by particle size, shape, and the tendency of particles to stick together.

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$$\text{Bulk Density} = \frac{\text{M (mass of powder)}}{\text{V}_b \text{ (Bulk volume of powder)}}$$

3.1.2 : Tapped Density:

The powder mixture of known mass (M) was placed in a measuring cylinder and subjected to tapping for a fixed duration, resulting in a compacted volume (V_t) that was subsequently measured.

$$\text{Tapped Density} = \frac{\text{M (mass of powder)}}{\text{V}_t \text{ (Tapped volume of powder)}}$$

3.1.3: Angle of repose:

The funnel method was used to determine the maximum angle possible between the surface of a powder heap and the horizontal plane, also known as the angle of repose.[13] The heap's radius (r) was measured, and the angle of repose was determined using the following formula.

$$\text{Angle of repose: Tan } \theta = \frac{h}{r} \quad ;\theta = : \text{Tan} \frac{h}{r}$$

Where θ is angle of repose, h is the height of pile and r is the radius of the base of heap

3.1.4: Carr's Index:

Carr's Index is a pharmaceutical parameter used to assess powder compressibility, which is a key factor influencing powder flow. [14] Carr's index is calculated as follows:

$$\text{Carr's index} = \frac{\text{Tapped density} - \text{Bulk density}}{\text{Tapped density}}$$

3.1.5: Hausner ratio:

The Hausner Ratio is a measure that correlates with the flow properties of powders and granular materials, providing an indirect assessment of their flowability. [15]It is calculated by the following formula:

$$\text{Hausner Ratio} = \frac{\text{Tapped density}}{\text{Bulk density}}$$

3.2 Post-compression studies of tamarind kernel powder:

Post-compression studies involve a series of tests and evaluations conducted on tablets after they have been manufactured to guarantee they meet the required standards of quality, safety, and effectiveness. These studies examine the physical, mechanical, and chemical characteristics of the final product to ensure it adheres to established pharmaceutical specifications and guidelines.

3.2.1: Tablet Hardness:

Tablet hardness, or crushing strength, measures the force needed to apply sufficient pressure to cause a tablet to fracture or break apart.The hardness of the tablets was checked employing a Monsanto hardness tester.The tablet was positioned in between the tester's platens. Pressure was applied gradually until the tablet broke.[11] The amount of force necessary to fracture the tablet was measured and reported in kilograms per square centimeter.

3.2.2: Tablet Thickness:

Tablet thickness is the physical measurement of a tablet's height from one flat surface to the opposite flat surface. It is a critical quality parameter that ensures uniformity and consistency in manufacturing.Ensuring that tablets have consistent physical dimensions, including thickness and diameter, is essential for maintaining product quality and consumer satisfaction.[11]The dimensions of the tablet, including thickness and diameter, were accurately measured using a vernier caliper, with results expressed in millimeters.

Formulation table:

Table 1: Development of a disintegrating tablet formulation of atenolol incorporating tamarind kernel powder

Sr No	Ingredients(mg)	F1	F2	F3	F4	F5	F6
1.	Atenolol	100	100	100	100	100	**100**
2	TKP	5	7.5	10	15	20	**30**

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3	MCC	200	200	195	190	190	**180**
4	Lactose	77	72.5	75	75	70	**70**
5	Magnesiumstearate	8	10	10	10	10	**10**
6	Talc	5	5	5	5	5	**5**
Average Weight		395	395	395	395	395	**395**

3.3.3: Friability:

The term "tablet friability" defines a tablet's tendency to fracture or crumble into smaller pieces under mechanical stress, such as during handling, storage, or transit. A sample of twenty tablets was evaluated for friability employing a Roche friabilator of the USP type. The drum was loaded with pre-weighed tablets and revolved for four minutes at 25 rpm..After reweighing the tablets, the following formula was employed to determine the weight loss percentage:

$$\text{Friability} = \frac{\text{Initial Weight} - \text{Final Weigh}^{*}}{\text{Initial Weight}} \times 100$$

3.3.4: Weight Variation:

Weight variation of tablets is a critical quality control parameter in pharmaceutical manufacturing.It explains the weight variation among individual tablets from the same batch [16]. To perform the USP weight variation test, ten tablets were weighed separately, the average weight was determined, and the individual weights were compared with the average. The weight of ten tablets is shown in the following table:

Weight of 10 Tablets (mg) :

Table 2 : weight variation

1	380	6	395
2	392	7	385
3	377	8	392
4	387	9	389
5	388	10	380

3.3.5: Disintegration Test:

The disintegration time of the tablet was measured using a tablet disintegration test device, which determined how long it took for the tablet to break apart and disintegrate. The tablet disintegration testing apparatus was carried out with six tablets per tube. The duration required for the entire tablet to dissolve was tracked, and the medium was maintained at 37 ± 2°C.[17]A disintegration test is a standard quality control assessment in the pharmaceutical industry that evaluates the time required for a tablet to disintegrate into smaller fragments under specified conditions.

3.3.6: Dissolution Test:

The dissolution test evaluates how quickly and completely a drug dissolves in a specific solution, providing assurance that the drug will be consistently released and absorbed by the body. USP type 2 apparatus was used for dissolution purpose where a paddle speed of 50 rpm wasemployed. 900 ml phosphate buffer with 6.8 pH was used.Four tablets were placed in the basket, and samples of the dissolution medium were collected at set times - 5, 10, 15, 30, 45, and 60 minutes. The absorbance of each sample was then measured using a spectrophotometer at a wavelength of 226 nm.

Stability study:A 24-month stability study of atenolol Fast Dissolving Tablets (FDTs) was conducted under controlled conditions of temperature (25°C ± 2°C) and humidity (60% RH ± 5%), with the tablets stored in airtight containers and analyzed at regular one-month intervals.

Formulation of fast disintegrating tablet containing tamarind kernel powder as natural disintegrant:

The direct compression method was used to formulate the atenolol fast-disintegrating tablets. The ingredients were first sieved through an 80-mesh sieve and then blended together for 10 minutes to ensure uniformity. The powder mixture was then compressed into tablets using a tablet

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punching machine, resulting in six different formulations.

IV. RESULTS AND DISCUSSION

This study focused on developing fast disintegrating tablets of atenolol using tamarind kernel powder as a natural disintegrant. The tablets were prepared by direct compression, with microcrystalline cellulose serving as a directly compressible excipient, lactose as a filler, talc as a glidant to improve flow, and magnesium stearate as a lubricant to facilitate tablet ejection.

To assess the pre-compression characteristics of the powder blend, various parameters were evaluated, including bulk density, tapped density, angle of repose, hausner ratio, and carr's index. The results showed a bulk density of 0.38 g/cm³ and a tapped density of 0.60 g/cm³. The angle of repose was measured at 38°, indicating moderate flowability. Additionally, the Carr's index value of 20% suggested that the powder blend had acceptable flow properties, which is desirable for tablet compression. The Hausner ratio was determined to be 1.29, indicating acceptable flow characteristics.According to the findings, the powder blends had moderate flow characteristics, as summarized in Table 3. Following compression, the tablets were evaluated for various post-compression parameters, including thickness, hardness, friability, dissolution time, disintegration time, and weight variation, to assess their quality and performance and shown in Table 4.

The hardness of all the formulations was consistently measured at 4.1 kg/cm², indicating that the tablets possessed good mechanical strength. Additionally, the friability of the tablets was found to be 0.7%, which is well within the acceptable limit of 1%, suggesting that the tablets were resistant to wear and tear.Thickness of tablets was observed to be 10mm. After comparison, it was discovered that formulation F6 had the super disintegrating time, indicating that the tamarind kernel powder served as exceptional natural disintegrant in formulating FDTs of atenolol.The in-vitro dissolution study was conducted in phosphate buffer pH 6.8 for all formulations shown in table 5 and Fig 3.

Table 3: pre-compression parametres

Sr no	Parameters	Standard value	Observed Value	Conclusion
1	Bulk Density	0.40 – 0.60 g/ml	0.38 g/ml	Very loose
2	Tapped Density	0.58 – 0.78 g/ml	0.60 g/ml	Very loose
3	Angle of Repose	30° – 45°	38°	Moderate flow
4	Carr's Index	21 – 27 %	20 %	Fair
5	Hausner Ratio	1.2 – 1.5	1.29	passable

Table 4: post-compression parametres

Sr no	Parameters	Standard Value	Observed Value	Conclusion
1	Hardness	4 – 12 kg/cm^2	4.1 kg/cm^2	Low
2	Thickness	5 – 10 mm	10 mm	Pass
3	Friability	0.5 – 1 %	0.7 %	Excellent
4	Weight Variation	>500 mg ± 5%	414.75 or 375.25	Acceptable
5	Disintegration	<15 min	9 min 52 sec	Good
6	% Drug Release T90	30-60 min	60 min	Good

UV Absorbance and % Drug Release for Trial Batches(F1,F2,F3,F4) :

Table 5 : UV Absorbance and % Drug Release for Trial Batches.(F1,F2,F3,F4)

Sr no.	Time (min)	Absorbance				Concentration (µg/ml)				%DrugRelease			
		F1	F2	F3	F4	F1	F2	F3	F4	F1	F2	F3	F4
1.	5	0.014	0.015	0.020	0.029	0.24	0.29	0.54	0.99	2.20	2.85	4.48	6.95
2.	10	0.029	0.32	0.038	0.046	0.99	1.14	1.44	1.845	4.95	8.30	9.05	11.60
3.	15	0.052	0.57	0.065	0.076	2.14	2.39	2.79	3.34	9.30	14.55	18.11	24.06

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4.	30	0.081	0.86	0.097	0.13	3.59	3.84	4.09	6.04	13.35	22.75	29.85	39.40
5.	45	0.10	0.10	0.12	0.15	4.54	4.54	5.54	7.04	19.90	30.90	45.90	56.40
6.	60	0.11	0.13	0.15	0.20	5.045	6.04	7.04	9.54	28.40	39.40	53.40	68.90

Comparison between F5 and F6 batch:

After the completion of trial batches we found that F5 and F6 were the optimized batches and they gave satisfactory results surpassing other batches.

Table 6: Comparison between F5 and F6 batch

Sr No	Time (min)	Absorbance		Wavelength (nm)	Concentration (µg/ml)		% Drug Release	
		F5	F6		F5	F6	F5	F6
1.	5	0.035	0.05	226	1.295	2.045	7.15	9.74
2.	10	0.057	0.08	226	2.39	3.545	21.55	28.90
3.	15	0.083	0.11	226	3.69	5.045	33.25	35.40
4.	30	0.15	0.18	226	7.045	8.54	63.40	56.90
5.	45	0.190	0.22	226	9.04	10.54	71.40	68.90
6.	60	0.23	0.27	226	11.04	13.045	82.40	89.96

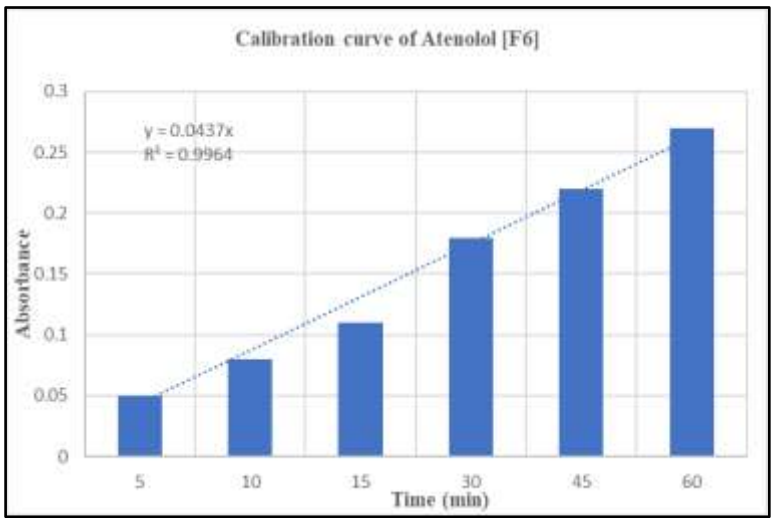

Fig 3 : calibration curve of atenolol (F6 batch)

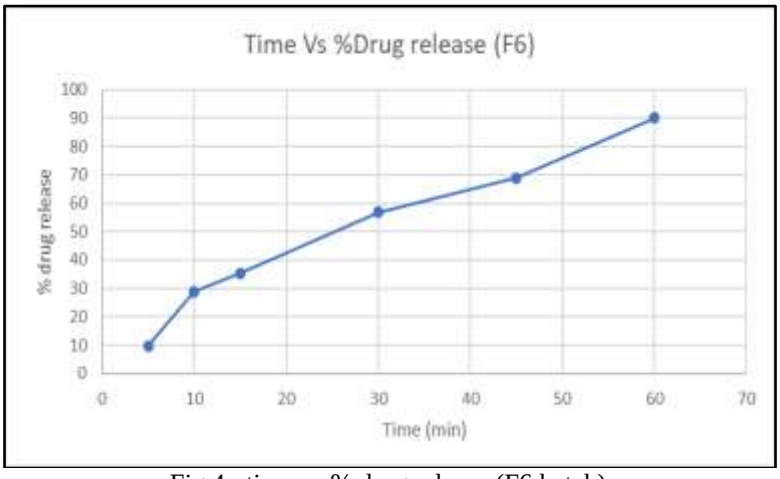

Fig 4 : time vs % drug release (F6 batch)

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Comparative study of time vs % drug release of all batches (F1,F2,F3,F4,F5,F6) :

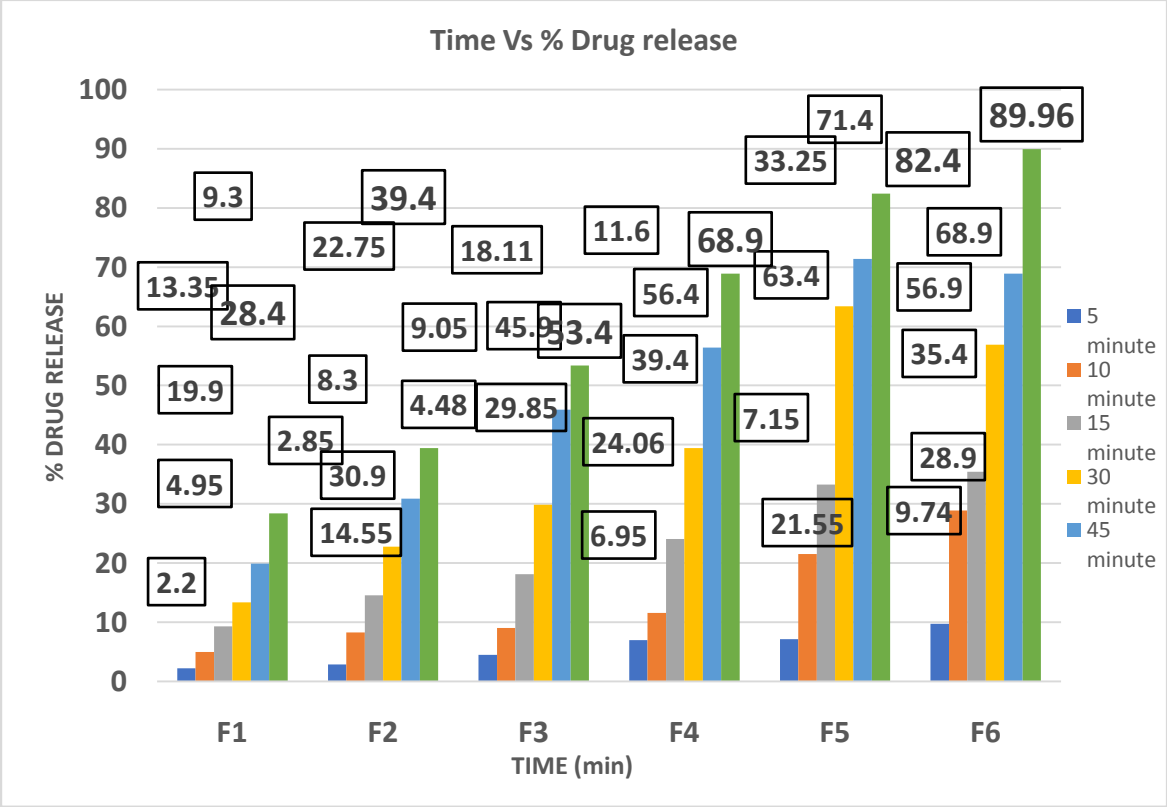

Fig 5 : comparative study of time vs % drug release of all batches(F1,F2,F3,F4,F5,F6)

V. CONCLUSION:

The study successfully developed and evaluated atenolol tablets incorporating tamarind kernel powder (TKP) as a novel natural disintegrant. Formulations with TKP exhibited excellent disintegration and dissolution properties, comparable to or better than synthetic disintegrants. The optimized F6 batch demonstrated rapid drug release, indicating TKP's effectiveness in enhancing tablet disintegration. This research highlights TKP as a promising, cost-effective, and eco-friendly alternative for pharmaceutical formulations, contributing to improved patient compliance in hypertension management.In future, this natural disintegrant is expected to play a key role in the development of fast disintegrating tablets that possess optimal physical and chemical properties, offering a promising alternative for pharmaceutical formulations.

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REFERENCES:

[1]. Chiranjib B B, Krishnakanth P, Chandira R M. Fast Dissolving Tablet: An Overview. Journal of Chemical and Pharmaceutical Research, 1(1):163-177, 2009

[2]. A brief review on natural and synthetic superdisintegrant PR Amaliyar, H Patel,SA Chaudhary, H Shah, A Patel, MA Suva Inventi journal, 2014

[3]. Government of India Ministry of Health and Family Welfare. The Pharmacopoeia ofIndia. Delhi: India: Controller of Publication; 1996.

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[4]. Roden DM. Antiarrhythmic Drugs, In: Goodman and Gilman‟s The Pharmacology Basisof Therapeutics. 10 ed., Mc Graw Hill Medical Publishing Division; New York, 2006;949-950.
[5]. The United States Pharmacopoeial Convention Inc., USP; 27-NF; 2002; 177-180
[6]. Alam MT, Parvez N, Sharma PK. FDA-approved natural polymers for fast dissolving tablets. J Pharm (Cairo) 2014;2014:952970. doi: 10.1155/2014/952970, PMID 26556207
[7]. Shihora H, Panda S. Superdisintegrants utility in dosage forms: A quick review. J Pharm Sci Biosci Res 2011;1:148-53.
[8]. Singh R, Malviya R, Sharma PK. Extraction and characterization of tamarind seed polysaccharide as a pharmaceutical excipient. Pharmacogn J 2011;3:17-9. doi: 10.5530/pj.2011.20.4
[9]. Bhatia NM, Salunkhe SS, Mali SS, Gadkari SS, Hajare AA, et al. Extraction and characterization of mucilage fromLepidium sativum L. Seeds. Sch Res Lib Pharm Lett 2014;6:65-70
[10]. Lachman L, Liberman H, Kanig J, The theory and practice of industrial pharmacy, 3rd edn., Varghese Publishing House, Mumbai, 1987, 297.
[11]. Dollery C. Therapeutic drugs. London: Churchill Livingstone:1991; 2: p 7-25.
[12]. Rajeshvar V, Ramana Mv. Formulation and evaluation of orodispersible rovustatin tablets: A comparative study on natural and synthetic superdisintegrants. Int J Pharm 2016;7:39-43
[13]. U S A Pharmacopeial Convention. National Formulary 35. United States Pharmacopeia 40. Rockville: United States Pharmacopeial Committee; 2017. p. 2886-8.
[14]. Kanig, Joseph L.; Lachman, Leon; Lieberman, Herbert A. (1986). The Theory and Practice of Industrial Pharmacy (3 ed.). Philadelphia: Lea & Febiger
[15]. Hausner, R. (1967). "Friction Conditions in a Mass Flow Bunker." Powder Technology, 1(3), 117- 125
[16]. Asian journal of pharmaceutical and clinical research formulation and evaluation of the first disintegrating tablet of propranolol hydrochloride. Page no. 187
[17]. Markl, D.; Zeitler, J. A. A review of disintegration mechanisms