DEVELOPMENT AND EVALUATION OF ATENOLOL TABLET BY USING TAMARIND SEED KERNEL POWDER AS A NATURAL DISINTEGRANT

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ABSTRACT

Disintegrants play a crucial role in the formulation of tablets, facilitating the breakdown of the tablet in the gastrointestinal tract and ensuring the release of the active pharmaceutical ingredient. Synthetic disintegrants are commonly used, but natural alternatives are gaining attention due to their potential benefits, including improved biocompatibility and reduced environmental impact. Tamarind seed powder was extracted and characterized for its physical and chemical properties. Atenolol tablets were formulated using the tamarind seed powder as a disintegrant, and their physicochemical properties, such as hardness, friability, and disintegration time, were evaluated. The tablets were also subjected to in vitro dissolution studies to assess the release of atenolol.

Keywords: - *Tamarind seed polysaccharide (TSP), Natural Disintegrant, Biocompatibility*.

1. INTRODUCTION

Hypertension is a long-term medical condition that can lead to stroke, heart disease, and kidney disease. It is classified as primary or secondary and is influenced by lifestyle factors such as diet, weight, and physical activity. Normal blood pressure is typically below 130/80 mmHg, and high blood pressure is diagnosed at 140/90 mmHg or higher. Treatment includes lifestyle changes and medications. Tamarind seed polysaccharide (TSP) is a naturally occurring polymer with unique properties, such as its ability to form gels, stabilize emulsions, and exhibit antimicrobial activity.[1] It has been identified as a promising natural excipient due to its excellent physicochemical properties, biocompatibility, and non-toxicity. TSP can be used in various pharmaceutical applications, including as a binder, filler, disintegrant, and suspending agent, making it an attractive alternative to synthetic excipients.[2]

Natural Disintegrating agent

Disintegrating agent (disintegrant) is an important component of tablet dosage forms. They are added to a tablet formulation to break apart (disintegrate) the compressed tablet when placed in aqueous environments.[3] Disintegration of conventional compressed tablets must occur within 15 minutes. [4]

Properties of Tamarind Seed Polysaccharides

- ✓ Polysaccharide composition: Rich in polysaccharides, primarily xylose, glucose and galactose.[5]
- ✓ Swelling capacity: Absorbs water, swelling up to 10 times its original volume.[6]
- ✓ Mucoadhesive properties: Binds to mucous membranes, enhancing disintegration.[7]
- ✓ Solubility: Soluble in water, facilitating rapid hydration. [7]

Mechanism of Action of Tamarind Seed in Disintegration

- ✓ **Hydration and Swelling -** Rapid water absorption causes the powder to swell, increasing pressure within the tablet. Swelling breaks tablet structure, promoting disintegration.[8]
- ✓ **Polysaccharide Matrix Breakdown -** Polysaccharides (xylose, glucose and galactose) dissolve, weakening interparticulate bonds. Matrix breakdown facilitates tablet disintegration.[9]
- ✓ **Surface Tension Reduction -** Tamarind kernel powder reduces surface tension between particles. Decreased surface tension enhances water penetration, accelerating disintegration. [10]

Identification test for Tamarind Kernel Powder

Identification Test	Name of test	Result
Test for Carbohydrate	Molisch Test	+
Test for Mucilage	Ruthenium Test	+
Test for Monosaccharide	Benedicts Test	-
Test for Protein	Biuret Test	-
Test for Alkaloids	Wagner's Test	-
Test for Tannis	Ferric Chloride Test	-
Test for Amino acid	Ninhydrin Test	-
Test for Glycosides	Keller-killiani Test	-
Test for Starch	Iodine Test	-

Table No. 01: Identification test for Tamarind Kernel Powder

2. PRE-COMPRESSION EVALUATION (TABLET EVALUATION)

- ✓ Bulk density
- ✓ Tapped density
- ✓ Angle of repose
- ✓ Carr's index
- ✓ Hausner Ratio

Bulk density

In materials science, bulk density, also called apparent density, is a material property defined as the mass of the many particles of the material divided by the bulk volume. Bulk volume is defined as the total volume the particles occupy, including particle's own volume, inter-particle void volume, and the particles' internal pore volume.[11]

Bulk density = Mass of particles / Bulk volume

Tapped density

It may be defined as the ratio of the total mass of the powder to the tapped volume of the powder. It was determined by pouring the powder blend into the measuring cylinder. [11]

Bulk density = Total mass of powder / Tapped volume of powder

Angle of repose

The angle of repose was determined using the funnel method. The blend was poured through a funnel that can be raised vertically until a specified cone height (h) was obtained. The radius of the heap (r) was measured[12] and the angle of repose (θ) was calculated using the formula: $\tan \theta = h / r$

Carr's index

The Carr's index is frequently used in pharmaceutics as an indication of the compressibility of a powder. In a free-flowing powder, the bulk density and tapped density would be close in value, therefore, the Carr index would be small.[13]

Carr's index = (Tapped density - Bulk density) / Tapped density × 100

Hausner Ratio

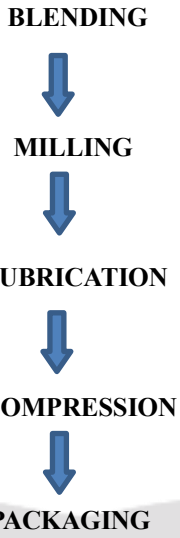
The Hausner Ratio (HR) principle is based on the comparison of two density measurements: Bulk Density and Tapped Density. The Hausner ratio is a number that is correlated to the flowability of a powder or granular material. [14]

HR = TD / BD

Methodology

Direct Compression Method

Direct compression is a tablet manufacturing process where powder blends are compressed directly into tablets without any intermediate processing steps (e.g., wet granulation, roller compaction). The step involved in direct compression.



3. FORMULATION TABLE

Sr. No	Ingredients	F1	F2	F3	F4	F5	F6
1	**Atenolol**	100	100	100	100	100	**100**
2	**TKP**	5	7.5	10	15	20	**30**
3	**MCC**	200	200	195	190	190	**180**
4	**Lactose**	77	72.5	75	75	70	**70**
5	**Mg.Stearate**	8	10	10	10	10	**10**
6	**Talc**	5	5	5	5	5	**5**
7	**Avg. Wt**	395	395	395	395	395	**395**

Table No. 02: Formulation Table

4. POST – COMPRESSION EVALUATION (TABLET EVALUATION)

- ✓ Tablet Hardness
- ✓ Tablet Thickness
- ✓ Weight Variation
- ✓ Friability
- ✓ In Vitro Disintegration
- ✓ In Vitro Dissolution
- ✓ UV Absorbance

Tablets Hardness

Tablet hardness" is a measure of the force required to break a tablet in a test apparatus that places the tablet under a tension or bending load. The hardness of a tablet plays a crucial role in its efficacy and overall performance, especially during packaging, shipping, and patient use.

Tablet Thickness

Tablet thickness refers to the distance through a tablet, typically measured in millimeters or inches. This measurement is crucial in determining packaging requirements, dissolution rates and overall quality control in pharmaceutical and food industries.

Weight Variation

Weight variation refers to the difference in weight among individual tablets or capsules in a batch. It's a critical quality control

parameter. Weight Variation of **10** Tablets.

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

Table No. 03: Weight Variation

Average weight of 10 Tablets **= 386.5 mg**
Weight variation limit for tablets having weight less than 500 mg according to various pharmacopoeias and regulatory guidelines.

✓ As per USP (United States Pharmacopoeia)

- For tablets < 250 mg: ±10%
- For tablets 250-500 mg: ±5%

✓ Calculation

Average weight of 1 tablets = **395** mg

395 x 5 / 100 = 19.75

395 ± 19.75 = 414.75 or 375.25

Friability

Friability refers to the tendency of a solid material, such as a tablet, to break or crumble into smaller pieces when subjected to mechanical stress, like handling or vibration.

In Vitro Disintegration

Using the tablet disintegration test device, the disintegration time of tablet was determined. The tablet disintegration testing apparatus came 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. In vitro disintegration time measures how long it takes for a tablet or capsule to break apart in a controlled laboratory environment, simulating bodily fluids. [15]

Test Method

Apparatus: A disintegration tester with baskets or a USP Disintegration Apparatus.

Medium: Distilled water

Procedure**:** Place 4 tablets in baskets, submerge in medium at controlled temperature (37°C) and observe.

In Vitro Dissolution

In vitro dissolution testing measures the rate and extent of drug release from a dosage form (tablet, capsule or injectable) in a controlled laboratory environment.[15]

Test Method

Place the sample: Put one dosage unit in each basket.

Start the apparatus: Begin agitation and timer. (50 RPM)

Collect samples: Withdraw samples at predetermined intervals. (5,10,15,30,45,60)

Analyse samples: Measure dissolved drug concentration using & UV-spectrophotometry

Record data: Document dissolution profile (% drug release vs time)

Formula

Amount of drug release(mg/ml) :-

Concentration × dissolution volume ×dilution factor / 1000

% Drug release :-

Amount of drug release / Total amount of drug in formulation (mg) × 1000

UV Absorbance

The UV absorbance principle measures the absorption of ultraviolet (UV) light by molecules, providing quantitative analysis of substances. Molecules absorb UV light, exciting electrons to higher energy states. Measuring absorbance (reduction in light intensity) reveals concentration and molecular structure. [16]

Standard Equation curve for Atenolol Tablet

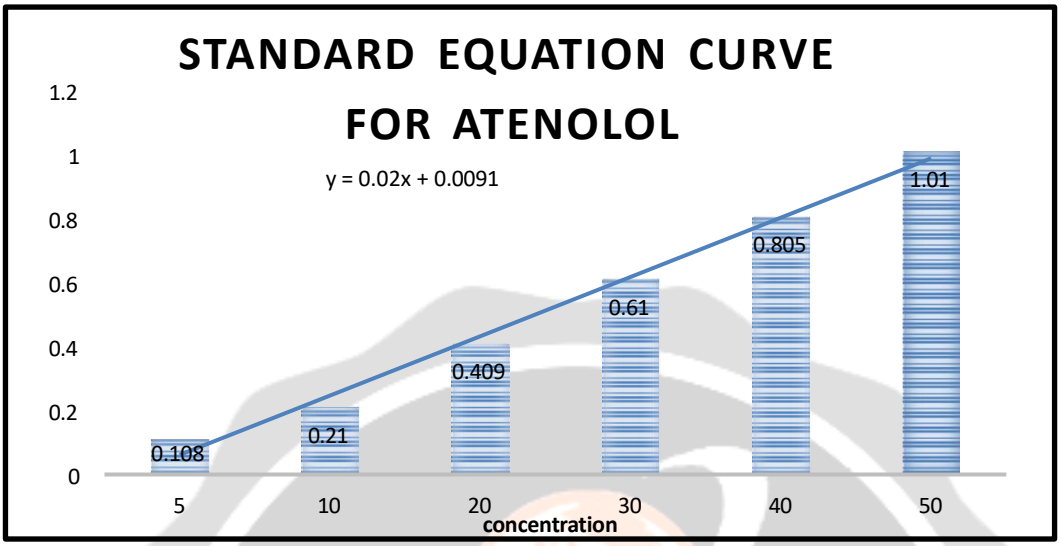


Fig No. 01: Standard Equation Curve for Atenolol Tablet.

UV absorbance and % Drug release for trial batches. (F1, F2, F3, F4, F5, F6)

For batch 1

Sr.No	Time (min)	Absorbance	Concentration (µg/ml)	% Drug Release
1	5	0.014	0.24	2.20
2	10	0.029	0.99	8.95
3	15	0.052	2.14	19.30
4	30	0.081	3.59	32.35
5	45	0.10	4.54	40.90
6	60	0.11	5.045	45.40

Table No. 03: UV Absorbance and % Drug release for F1 Batch

For batch 2

Sr.No	Time (min)	Absorbance	Concentration (µg/ml)	%Drug Release
1	5	0.015	0.29	2.65
2	10	0.32	1.14	10.30
3	15	0.57	2.39	21.55
4	30	0.86	3.84	34.60
5	45	0.10	4.54	40.90
6	60	0.13	6.04	54.40

Table No. 04: UV Absorbance and % Drug release for F2 Batch

For batch 3

Sr.No	Time (min)	Absorbance	Concentration (µg/ml)	%Drug Release
1	5	0.020	0.54	4.90
2	10	0.038	1.44	13.05
3	15	0.065	2.79	25.11

4	30	0.097	4.09	36.85
5	45	0.12	5.54	49.90
6	60	0.15	7.04	63.40

Table No. 05: UV Absorbance and % Drug release for F3 Batch

For batch 4

Sr.No	Time (min)	Absorbance	Concentration (µg/ml)	%Drug Release
1	5	0.029	0.99	8.95
2	10	0.046	1.845	16.60
3	15	0.076	3.34	30.06
4	30	0.13	6.04	54.40
5	45	0.15	7.04	63.40
6	60	0.20	9.54	85.90

Table No. 06: UV Absorbance and % Drug release for F4 Batch

For batch 5

Sr.No	Time (min)	Absorbance	Concentration (µg/ml)	%Drug Release
1	5	0.035	1.295	11.65
2	10	0.057	2.39	21.55
3	15	0.083	3.69	33.25
4	30	0.15	7.04	63.40
5	45	0.19	9.04	81.40
6	60	0.23	11.04	99.40

Table No. 07: UV Absorbance and % Drug release for F5 Batch

For batch 6 (Optimum Batch)

Sr.No	Time (min)	Absorbance	Concentration (µg/ml)	%Drug Release
1	5	0.05	2.04	18.40
2	10	0.08	3.54	31.90
3	15	0.11	5.04	45.40
4	30	0.18	8.54	76.90
5	45	0.22	10.54	94.90
6	60	0.27	13.04	117.40

Table No. 08: UV Absorbance and % Drug release for F6 Batch

Calibration curve for F6 Batch

Wavelength (λ) = 226 nm

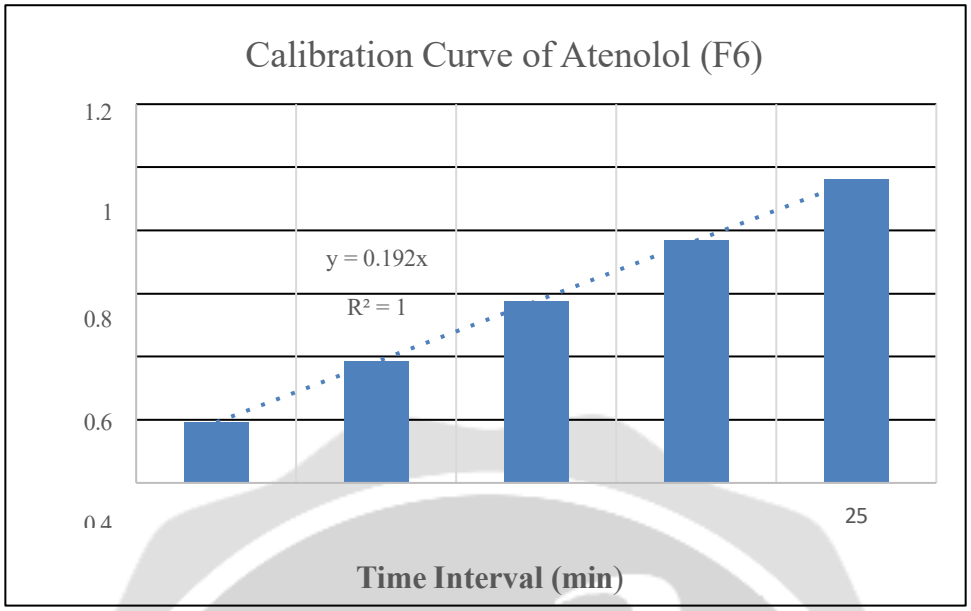


Fig No. 02: Calibration Curve of Atenolol (F6)

% Drug Released for F6 Batch

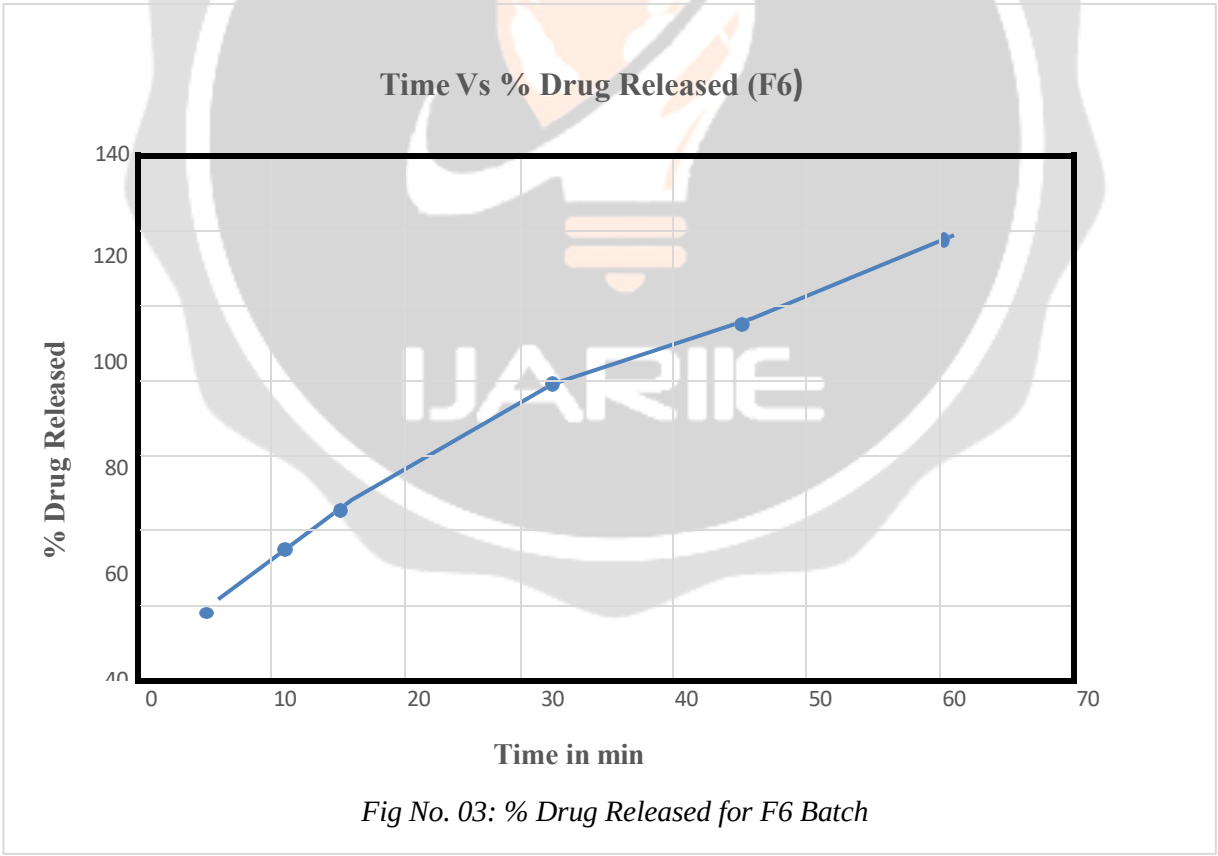


Fig No. 03: % Drug Released for F6 Batch

Comparative Study of all batches (F1, F2, F3, F4, F5, F6)

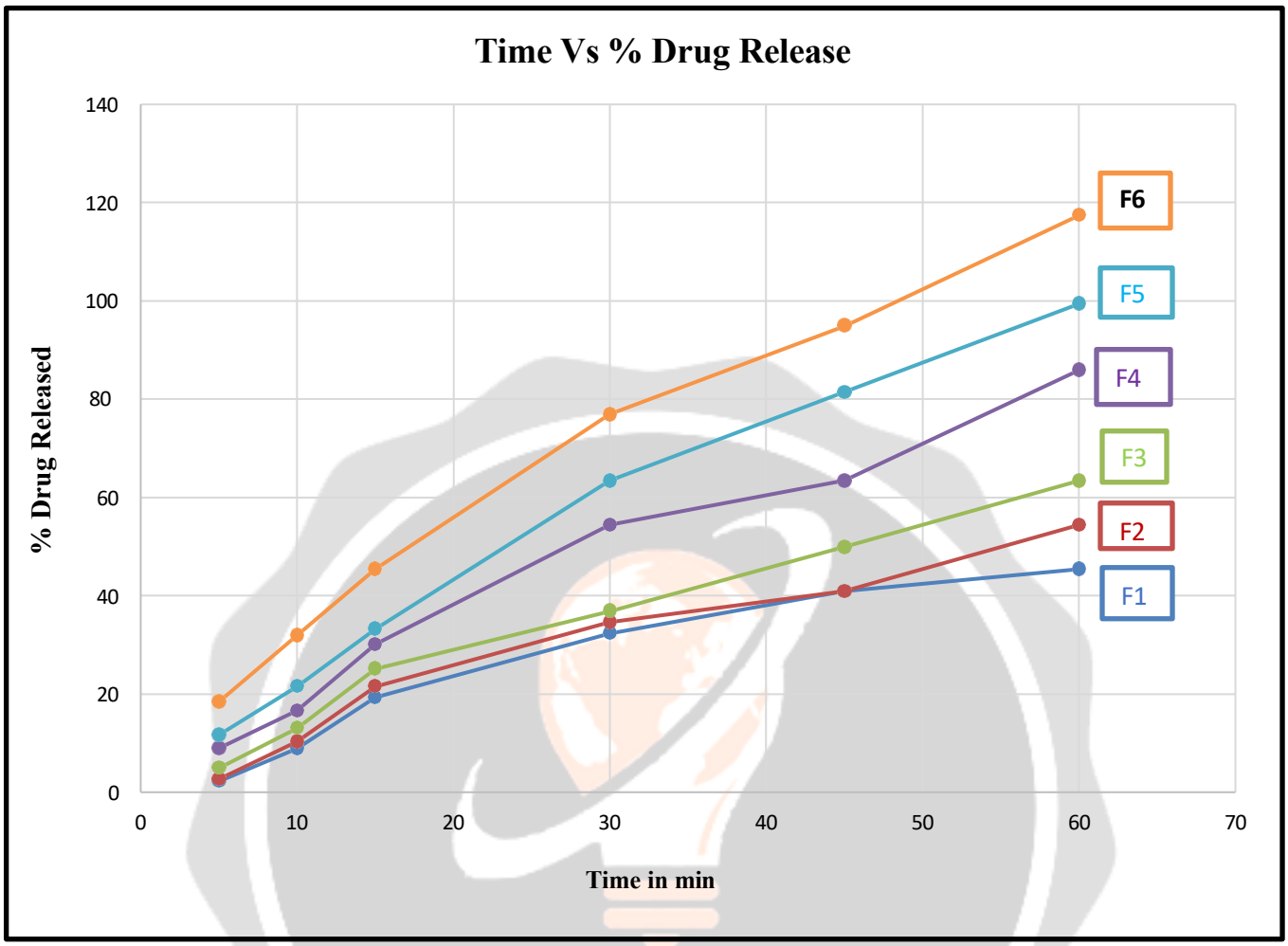


Fig No. 04: Comparative Study of time vs % drug release of all batches (F1, F2, F3, F4, F5, F6)

5. RESULT AND DISCUSSION

Sr.No	Test	Standard Value	Observed Value	Conclusion
1	**Pre Compression Evaluation**			
✓	Bulk Density	0.40 – 0.60 g/ml	0.38 g/ml	**Very loose**
✓	Tapped Density	0.58 – 0.78 g/ml	0.60 g/ml	**Very loose**
✓	Angle of Repose	$30^0 – 45^0$	38^0	**Moderate Flow**
✓	Carr's Index	21 – 27 %	20 %	**Fair**
✓	Hausner Ratio	1.2 – 1.5	1.29	**Passable**
2	**Post Compression Evaluation**			
✓	Hardness	4 – 12 kg/cm ^{2}	4.1 kg/cm ^{2}	**Low**
✓	Thickness	5 – 10 mm	10 mm	**Pass**

✓	Weight Variation	>500 mg ± 5%	414.75 or 375.25	**Acceptable**
✓	Friability	0.5 – 1 %	0.7 %	**Excellent**
✓	Disintegration	<15 min	9 min 52 sec	**Good**
✓	% Drug Release T90	30 – 60 min	42.67 min	**Good**

Table No. 09: Result and Discussion

6. CONCLUSION

On the basis of above pre-compression and post-compression evaluation parameters of natural tamarind kernel powder, our optimized F6 batch passes all the pre and post compression evaluation parameters and the results obtained were found to be satisfactory within the specified limits which show good disintegrating property.

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