IJBPAS, October, 2025, 14(10): 5549-5560

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

FORMULATION AND EVALUATION OF ATORVASTATIN CALCIUM TABLETS BY PROCESS VALIDATION

SINGH J*[1], ASHOK PK[1] AND PARVEEN G[1]

[1]Gyani Inder Singh Institute of Professional Studies, Dehradun, Uttarakhand

***Corresponding Author: Mr. Jitendra Singh: E Mail: chin297@rediffmail.com**

Received 26th April 2024; Revised 29th Aug. 2024; Accepted 18th Oct. 2024; Available online 1st Oct. 2025

https://doi.org/10.31032/IJBPAS/2025/14.10.9501

ABSTRACT

Atorvastatin is a lipid-lowering drug included in the statin class of medications. By inhibiting the endogenous production of cholesterol in the liver, statins lower abnormal cholesterol and lipid levels, and ultimately reduce the risk of cardiovascular disease. The present research work focused on formulation and concurrent process validation for Atorvastatin calcium 40 mg tablets. By wet granulation method the tablets are manufactured. Validation is an integral part of quality assurance; it involves systematically studying systems, facilities and processes to determine whether they perform their intended functions adequately and consistently as specified. This study took three batch of Atorvastatin tablets with same size, method, equipment & validation criteria. As part of the validation protocol, various critical parameters were identified and evaluated during dry mixing, wet granulation, drying, lubrication, compression, and coating stages. Throughout the process, process validation data provided high degrees of assurance that the manufacturing process would produce a product with the predetermined quality attributes that were given. This study concludes that the wet granulation method is effective in ensuring uniform distribution of Atorvastatin and reproducible quality standards in manufacturing tablets.

Keywords: Validation, Atorvastatin, Compression, Wet granulation

INTRODUCTION:

Validation is an integral part of quality assurance which has been demonstrated to

provide a high degree of assurance that uniform batches will be produced that meet the required specifications and has therefore been formally approved **[1]**. Validation in itself does not improve processes but confirms that the processes have been properly developed and are under control **[2]**.

USFDA defines validation as: "Validation is establishing documented evidence which provides a high degree of assurance that a specific process will consistently produce a product meeting its pre-determined specifications and quality characteristics **[3]**. According to the European Commission: Validation is defined as "Action providing in accordance with the principles of GMP, that any procedure, process, equipment, material, activity or system actually led to the expected results **[4]**.

Process validation establishes the flexibility and constraints in the manufacturing process controls in the attainment of desirable attributes in the drug product while preventing undesirable properties **[5]**. This is an important concept, since it serves to support the underlying definition of validation, which is a systematic approach to identifying, measuring, evaluating, documenting, and reevaluating a series of critical steps in the manufacturing process that require control to ensure a reproducible final product **[6]**.

Atorvastatin is indicated for the treatment of several types of dyslipidemias, including primary hyperlipidemia and mixed dyslipidemia in adults, hypertriglyceridemia, primary lipoproteinemia, homozygous familial hypercholesterolemia, and heterozygous familial hypercholesterolemia in adolescent patients with failed dietary modifications **[7]**. Prescribing of statin medications are considered standard practice following any cardiovascular events and for people with a moderate to high risk of development of CVD **[8]**.

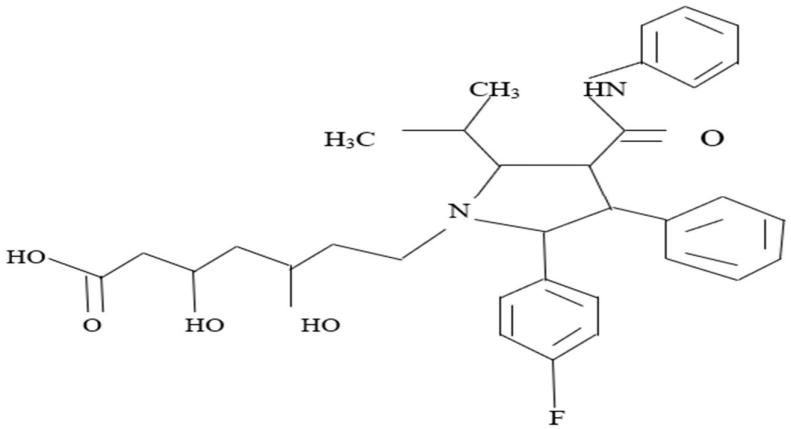

Figure 1: Chemical Structure of Atorvastatin

Atorvastatin is a statin medication and a competitive inhibitor of the enzyme HMG-CoA (3-hydroxy-3-methylglutaryl coenzyme A) reductase, which catalyzes the conversion of HMG-CoA to mevalonate, an early rate-limiting step in cholesterol biosynthesis **[9]**. Atorvastatin acts primarily in the liver, where decreased hepatic cholesterol concentrations stimulate the upregulation of hepatic low-density lipoprotein (LDL) receptors, which increases hepatic uptake of LDL **[10]**. Atorvastatin also reduces Very-Low-Density Lipoprotein-Cholesterol (VLDL-C), serum triglycerides (TG) and Intermediate Density Lipoproteins (IDL), as well as the number of apolipoprotein B (apo B) containing particles, but increases High-Density Lipoprotein Cholesterol (HDL-C) **[11]**.

MATERIALS AND METHODS:

Experiment/Methodology

Table 1: Product Profile of Atorvastatin Calcium Tablets

Report No.:	**VR-PV-S-2024-01-00**
Dosage Form:	**Tablet**
Product Name:	**Atorvastatin Calcium Tablets 40 mg**
Generic Name:	**Atorvastatin Calcium Tablets 40 mg**
Batch Size:	**10,000 Tablets Nos.**

The manufacturing formula for a batch size of 10,000 tablets is given below:

Table 2: Batch No.: First Batch

Sr. No.	Name of material	Spec.	Qty. / Batch [in kg.]
Granulation:			
1.	Atorvastatin Calcium (Crystalline)	USP	0.414
2.	Lactose Monohydrate (Pharmatose 200 M)	USP-NF	1.342
3.	Microcrystalline Cellulose(Avicel PH-101)	USP-NF	2.390
4.	Croscarmellose Sodium (Ac-di-Sol SD 711)	USP-NF	0.210
5.	Calcium Carbonate (Calopake Extra light)	USP-NF	1.320
Granulating Fluid (Binder)			
6.	Polysorbate 80 [Tween 80-HP-LQ-(MH)]	USP-NF	0.024
7.	Hydroxypropyl Cellulose (Klucel- LF PHARM)	USP-NF	0.120
8.	Purified Water	USP-NF	3.400
Extra granular &Lubrication			
9.	Croscarmellose Sodium (Ac-di-Sol SD 711)	USP-NF	0.150
10.	Magnesium Stearate	USP	0.030
Coating (in 2Lots)			
11.	Opadry White (YS-1-7040)	IH	0.252
12.	Purified Water	USP-NF	2.268

Table 3: Batch No.: Second Batch

Sr. No.	Name of material	Spec.	Qty. / Batch [in kg.]
Granulation:			
1.	Atorvastatin Calcium (Crystalline)	USP	0.414
2.	Lactose Monohydrate (Pharmatose 200 M)	USP-NF	1.342
3.	Microcrystalline Cellulose(Avicel PH-101)	USP-NF	2.390
4.	Croscarmellose Sodium (Ac-di-Sol SD 711)	USP-NF	0.210
5.	Calcium Carbonate (Calopake Extra light)	USP-NF	1.320
Granulating Fluid (Binder)			
6.	Polysorbate 80 [Tween 80-HP-LQ-(MH)]	USP-NF	0.024
7.	Hydroxypropyl Cellulose (Klucel- LF PHARM)	USP-NF	0.120
8.	Purified Water	USP-NF	3.400
Extra granular &Lubrication			
9.	Croscarmellose Sodium (Ac-di-Sol SD 711)	USP-NF	0.150
10.	Magnesium Stearate	USP	0.030
Coating (in 2Lots)			
11.	Opadry White (YS-1-7040)	IH	0.252
12.	Purified Water	USP-NF	2.268

Table 4: Batch No.: Third Batch

Sr. No.	Name of material	Spec.	Qty. / Batch [in kg.]
Granulation:			
1.	Atorvastatin Calcium (Crystalline)	USP	0.414
2.	Lactose Monohydrate (Pharmatose 200 M)	USP-NF	1.342
3.	Microcrystalline Cellulose(Avicel PH-101)	USP-NF	2.390
4.	Croscarmellose Sodium (Ac-di-Sol SD 711)	USP-NF	0.210
5.	Calcium Carbonate (Calopake Extra light)	USP-NF	1.320
Granulating Fluid (Binder)			
6.	Polysorbate 80 [Tween 80-HP-LQ-(MH)]	USP-NF	0.024
7.	Hydroxypropyl Cellulose (Klucel- LF PHARM)	USP-NF	0.120
8.	Purified Water	USP-NF	3.400
Extra granular &Lubrication			
9.	Croscarmellose Sodium (Ac-di-Sol SD 711)	USP-NF	0.150
10.	Magnesium Stearate	USP	0.030
Coating (in 2Lots)			
11.	Opadry White (YS-1-7040)	IH	0.252
12.	Purified Water	USP-NF	2.268

Methodology:

WET GRANULATION:

Take 3.400 kg of purified water in a paste kettle and Boil up to a boiling point, i.e. 100ºC and then cool to 50 ºC. Take 1.190 kg of Purified Water from step – I with stirring and add 0.024 Kg of polysorbate 80 and mix for 5 minutes, now Disperse 0.120 kg of Hydroxypropyl Cellulose in warm polysorbate 80 solution for another 5 minutes. Add 1.190 kg from the remaining quantity of Purified water in step- II and allow hydrating for 4 hours.[12]

Film Coating:

Preparation of Coating solution (For individual lot): -

Step – I: Boil 1.361 Kg (20% extra to the required quantity) of purified water up to boiling point, i.e. 100^0C, and cool it up to 50^0C.

Step – II: Take the required qty (1.134 kg) of boiled Purified water in an S.S vessel and keep under

stirring while stirring the purified water, slowly disperse Opedry White (YS-1-7040) in the vortex format to avoid the formation of lumps, stir for 45 minutes at slow speed.

Step – III: Filter the solution# through 200 # mesh nylon cloth **[13]**.

RESULTS AND DISCUSSION:

Table 5: Material Sifting & Co –Sifting

Parameters & Acceptance Criteria	Batch No.			Acceptance Criteria
	FIRST BATCH	SECOND BATCH	THIRD BATCH	
Co - Shift Atorvastatin calcium & Calcium carbonate through 24#	24 #	24 #	24 #	24#
Above material resift through 24# (Two times): Step – A	24 #	24 #	24 #	24#
Co-Lactose monohydrate, Microcrystalline Cellulose & Croscarmellose Sodium Co -Sift through 40 #: Step – B	40#	40#	40#	40 #
Step – A and B sift through 24# geometrically dilution process.	24 #	24 #	24 #	24#
Above material resift (Two times) through 24 #: Step – C	24 #	24 #	24 #	24 #

Table 6: Dry Mixing

Parameters	Batch No.			Acceptance Criteria
	FIRST BATCH	SECOND BATCH	THIRD BATCH	
Charged material Step – C in Rapid Mixer Granulator and process for below mention parameters				
RPM of Impeller	Slow	Slow	Slow	Slow(70RPM)
Copper Speed	Off	Off	Off	Off
Dry Mixing Time	10 Min	10 Min	10 Min	10 Min

Table 7: Blend Uniformity Results After Dry Mixing

Batch No.	Blend Uniformity Results (%)					Average	% RSD	Acceptance criteria
	S1	S2	S3	S4	S5			
FIRST BATCH	96%	97%	98%	97%	100%	97.52%	1.45%	Each individual assay value is between ± 10% of mean value of label claim RSD – NMT 5 % Mean of individual assay value between 95.0% to 105.0%
SECOND BATCH	100%	101%	99%	97%	97%	98.70%	1.72%	
THIRD BATCH	99%	97%	102%	99%	102%	99.84%	2.26%	

Table 7 A: Bulk Density Reuslts After Dry Mixing

Batch No.	Bulk Density Results
FIRST BATCH	0.408 g/cc
SECOND BATCH	0.434 g/cc
THIRD BATCH	0.41 g/cc

Table 8: Wet Granulation				
Parameters	FIRST BATCH	SECOND BATCH	THIRD BATCH	Acceptance Criteria
Granulating Fluid Quantity	3.944	3.944	3.944	3.944 kg
30 % (1.183 kg) Granulating fluid addition time at slow impeller speed (70 RPM) & chopper Off)	2minutes	2minutes	2minutes	2 minutes
Impeller Speed	Slow (70 RPM)	Slow (70 RPM)	Slow (70 RPM)	Slow (70 RPM)
Chopper Speed	Off	Off	Off	Off
Remaining 70% (2.761kg) Granulating fluid addition time (at slow impeller speed (70 RPM) & slow chopper speed)	5minutes	5minutes	5minutes	5 minutes
Impeller Speed	Slow	Slow	Slow	Slow
Chopper Speed	Slow	Slow	Slow	Slow
Addition of extra quantity of Purified Water added (If required Not more than 1.020 kg) at fast impeller speed & slow chopper speed	3minutes	3minutes	3minutes	3 minutes
Addition of extra quantity of Purified Water	N.A	N.A	N.A	NMT 1.020 Kg
Impeller Speed	Fast	Fast	Fast	Fast
Chopper Speed	Slow	Slow	Slow	Slow
Wet mixing time At fast impeller speed & slow chopper speed.	02 minutes	02 minutes	02 minutes	02 minutes
Impeller Speed	Fast	Fast	Fast	Fast
Chopper Speed	Slow	Slow	Slow	Slow
Ampere load at the end of granulation	41 A^0	42 A^0	42 A^0	43±3 A^0

Table 9: Drying Process

Parameters	FIRST BATCH	SECOND BATCH	THIRD BATCH	Acceptance Criteria
Inlet air temperature	60.8°C to 63.5°C	58.1°C to 62.7°C	59.1°C to 62.7°C	55 – 65 °C
Exhaust air temperature	26.2°C to 39.9°C	26.1°C to 39.7°C	25.7°C to 39.6°C	39°C ± 1°C (Final Drying Temp)
LOD at 105°C after completion of drying	3.54%	3.24%	3.42%	2.0 – 4.0 % w/w
Drying Cycle time	180 Min	180 Min	180 Min	Approximate 250 minutes
Blower CFM exhaust	2200 CFM	2200 CFM	2200 CFM	2200 – 1800 CFM
Shaking time	01 Min	01 Min	01 Min	01 Minutes
Shaking Interval time	15 Min	15 Min	15 Min	15 Minutes

Table 10: Sifting & Sizing of Dried Granules

Parameters	FIRST BATCH	SECOND BATCH	THIRD BATCH	Acceptance Criteria
Mesh size	20 #	20 #	20 #	20 #
Screen Size	2.0 mm	2.0 mm	2.0 mm	2.0 mm
Speed of Multi-mill	Slow knife forward	Slow knife forward	Slow knife forward	Slow speed & knife forward direction
Re-sifting of milled material (Mesh size)	20 #	20 #	20 #	20 #
Multi 20 # retains (Screen Size)	1.5 mm	1.5 mm	1.5 mm	1.5 mm
Speed of Multi-mill	Slow knife forward	Slow knife forward	Slow knife forward	Slow speed & knife forward direction

Table 11: Blending & Prelubrication Results

Acceptance criteria	Each individual assay value is between ± 10% of mean value of label claim RSD – NMT 5 % Mean of individual assay value between 95.0% to 105.0%												
	Blend Uniformity Results %											Average %	% RSD
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11		
FIRST BATCH	96%	96%	95%	97%	95 %	96 %	96%	95%	98%	96%	98%	96.1%	1.02%
SECOND BATCH	98%	100 %	97%	97%	96 %	96 %	100 %	97%	95%	98%	97%	97.3%	1.78%
THIRD BATCH	93%	93%	94%	95%	94 %	94 %	95%	98%	94%	94%	93%	97.5%	1.60%

Table 12: Lubricated Blend

Acceptance criteria	Each individual assay value is between ± 10% of mean value of label claim RSD – NMT 5 % Mean of individual assay value between 95.0% to 105.0%												
	Blend Uniformity Results %											Average %	% RSD
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11		
FIRST BATCH	99%	94%	96%	96%	96 %	96 %	97%	98%	98%	98%	98%	97.1%	1.70%
SECOND BATCH	95%	98%	95%	95%	98 %	96 %	97%	98%	96%	97%	96%	96.4%	1.11%
THIRD BATCH	97%	98%	97%	96%	97 %	97 %	99%	98%	96%	100 %	97%	97.3%	1.24%

Table 13: Lubricated Blend Evaluation

Parameters	FIRST BATCH	SECOND BATCH	SECOND BATCH	Acceptance Criteria
Description	White granular powder.	White granular powder.	White granular powder.	White to off white granular powder.
Assay	100.42%	100.48%	97.49%	95.0 – 105.0 % of the labeled amount of Atorvastatin
Water content	3.023% w/w	2.96%	2.99% w/w	NMT 5.0 % w/w
Bulk density	0.625 g/cc	0.597 g/cc	0.645 g/cc	0.50 to 0.70 gm/cc
Tap Density	0.727% g/cc	0.80 g/cc	0.754 g/cc	To be recorded
Sieve Analysis				
a. Retains on #60.	22.89%	25.95%	26.46%	NMT 40% w/w
b. Cumulative Retains on # 100.	27.35%	31.31%	32.63%	NMT 50% w/w

Table 13 A: Hardness

Test parameters	Observations/Results		Acceptance criteria
	LHS	RHS	
1. Description	White, oval shaped, biconvex, uncoated tablets debossed with "I 40" on one side and plain on other side	White, oval shaped, biconvex, uncoated tablets debossed with "I 40" on one side and plain on other side	White to off white, oval shaped, biconvex, uncoated tablets debossed with "I 40" on one side and plain on other side.
2. Average weight of tablet	599.04 mg	600.70 mg	600.0 mg ± 3.0 %
3. Uniformity of weight	-1.50 to 1.32%	-1.44 to 1.38%	600.0 mg ± 5.0%
4. Thickness	5.72 to 5.88 mm	5.78 to 5.90 mm	6.00 mm ± 0.3 mm
5. Hardness	168 to 188 N	170 to 190 N	80 – 210 N
6. Friability	0.090%	0.046%	Not more than 1.0 % w/w
7. Disintegration time	01:54	01:52	Not more than 15 minutes
8. Dissolution	1) 96%		Not less than 80% (Q) of labeled amount of Atorvastatin is dissolved in 30 minutes.
	2) 95%		
	3) 93%		
	4) 93%		
	5) 93 %		
	6) 94%		
	Min.: 93%		
	Max.: 96 %		
	Avg.: 94%		

Table 14: Compression

Test parameters	Initial	Middle	End	Acceptance criteria
1. Description	White to off white, oval shaped, biconvex, uncoated tablets debossed with "I 40" on one side and plain on other side.	White to off white, oval shaped, biconvex, uncoated tablets debossed with "I 40" on one side and plain on other side.	White to off white, oval shaped, biconvex, uncoated tablets debossed with "I 40" on one side and plain on other side.	White to off white, oval shaped, biconvex, uncoated tablets debossed with "I 40" on one side and plain on other side.
2. Average wt. of tablet	600.92 mg	600.84	600.41 mg	600.0 mg ± 3.0 %
3. Uniformity of weight	-1.48 to 1.34%	-1.30 to 1.19%	-1.40 to 1.26%	600.0 mg ± 5.0%
4. Cpk	2.53			For Information
5. Thickness	5.92 to 6.09 mm	5.92 to 6.10 mm	5.93 to 6.08 mm	6.00 mm ± 0.3 mm
6. Hardness	132 to 170 N	134 to 170 N	134 to 172 N	80 – 210 N
7. Friability	0.046%	0.060%	0.076%	Not more than 1.0 % w/w
8. Disintegration time	01:50	01:49	01:53	Not more than 15 minutes
9. Uniformity of dosage units	3.52	3.96	3.05	The acceptance value (AV) of 10 dosage units ≤ 15
10. Assay	100.74%	101.18%	100.98%	95 – 105 % of labeled amount of Atorvastatin

Table 15: Analytical Results Of Uncoated Tablets

Test parameters	FIRST BATCH	SECOND BATCH	THIRD BATCH	Acceptance criteria
1. Description	White to off white, oval shaped, biconvex, uncoated tablets debossed with "I 40" on one side and plain on other side.	White to off white, oval shaped, biconvex, uncoated tablets debossed with "I 40" on one side and plain on other side.	White to off white, oval shaped, biconvex, uncoated tablets debossed with "I 40" on one side and plain on other side.	White to off white, oval shaped, biconvex, uncoated tablets debossed with "I 140" on one side and plain on other side.
2. Average wt. of tablet	600.19 mg	597.99 mg	602.59 mg	600.0 mg ± 3.0 %
3. Uniformity of weight	-0.98 to 0.71%	-1.18 to 0.85%	-0.96 to 1.09%	600.0 mg ± 5.0%
4. Hardness	155 to 165 N	143 to 158 N	150 to 176 N	80 – 210 N
5. Thickness	5.87 to 5.90 mm	5.87 to 5.89 mm	5.89 to 5.95 mm	6.00 mm ± 0.3 mm
6. Friability	0.06%	0.36%	0.39%	Not more than 1.0 % w/w
7. Disintegration time	02:20	02:38	02:03	Not more than 15 minutes
8. Dissolution	1) 89%	1) 94%	1) 99%	Not less than 80% (Q) of labeled amount of Atorvastatin is dissolved in 30 minutes.
	2) 91%	2) 93%	2) 96%	
	3) 90%	3) 95%	3) 98%	
	4) 91%	4) 96%	4) 99%	
	5) 86%	5) 95%	5) 100%	
	6) 90%	6) 94%	6) 98%	
	Min.:86%	Min.:93%	Min.:98%	
	Max.: 91%	Max.: 96%	Max.: 100%	
	Avg.: 90%	Avg.: 94%	Avg.: 99%	
9. Assay	100.83%	99.37%	99.79%	95 – 105 % of labeled amount of Atorvastatin
10. Uniformity of dosage units	3.62	7.87	1.8	The acceptance value (AV) of 10 dosage units ≤ 15

Table 16: Film Coating

Process parameters	First, Second and Third Batch		Acceptance criteria
	Lot-I	Lot-II	
Qty. of Purified water	1.134	1.134	1.134
Coating Pan Size	10"	10"	10"
No. of spray gun	01 Nos.	01 Nos.	01 Nos.
LOD of uncoated tablets	2.88%	2.32%	To be recorded
Inlet air Temperature	70.2 to 73.6°C	71.8 to 73.8°C	70°C ± 5°C (To be validated)
Exhaust air Temperature	43.4 to 45.2 °C	43.4 to 44.4 °C	45°C ± 5°C (To be validated)
Product Bed Temperature	42.3 to 44.2 °C	42.2 to 43.8 °C	45 °C ± 5 °C (To be validated)
Pan speed	2 to 6 RPM	2 to 6 RPM	1– 4 rpm (To be validated)
Peristaltic pump speed	8 to 12 RPM	8 to 12 RPM	5 to 20 RPM (To be validated)
Spray Rate	16 to 24 g/gun /min	16 to 24 g/gun /min	10-36 g/gun/Min (To be validated)
Atomizing Air Pressure	3.0 Kg/cm^2	3.0 Kg/cm^2	3.0 – 4.0 Kg/cm^2 (To be validated)
Distance of gun from bed	9"	9"	12 '' approximately (To be validated)
Fan Air Pressure	4.0 Kg/cm^2	4.0 Kg/cm^2	2.0 to 4.0 Kg/cm^2
Gun position	complies	complies	Perpendicular to the bed

Table 17: Dissolution Results (After Coating)

Test parameters	First Batch		Second Batch		Third Batch		Acceptance criteria
	Lot-I	Lot-II	Lot-I	Lot-II	Lot-I	Lot-II	
Dissolution	1) 96%	1) 97%	1) 94%	1) 89%	1) 89%	1) 91%	Not less than 80% (Q) of labelled amount of Atorvastatin is dissolved in 30 minutes
	2) 96%	2) 98%	2) 97%	2) 91%	2) 89%	2) 89%	
	3) 97%	3) 98%	3) 96%	3) 92%	3) 90%	3) 90%	
	4) 97%	4) 99%	4) 96%	4) 92%	4) 90%	4) 91%	
	5) 97%	5) 98%	5) 97%	5) 92%	5) 90%	5) 87%	
	6) 96%	6) 97%	6) 96%	6) 92%	6) 89%	6) 91%	
	Min.:96%	Min.:97%	Min.:94%	Min.:89%	Min.:89%	Min.:87%	
	Max.:97%	Max.:99%	Max.:97%	Max.:92%	Max.:90%	Max.:91%	
	Avg.: 97%	Avg.: 98%	Avg.: 96%	Avg.: 91%	Avg.: 89%	Avg.: 90%	

Table 18: Film-Coated Tablets (Composite)

Test parameters	Batch No.			Acceptance criteria
	FIRST BATCH	SECOND BATCH	THIRD BATCH	
1. Description	White colored, oval shaped, biconvex, film coated tablets debossed with "I40" on one side and plain on other side	White colored, oval shaped, biconvex, film coated tablets debossed with "I40" on one side and plain on other side	White colored, oval shaped, biconvex, film coated tablets debossed with "I40" on one side and plain on other side	White to off white colored, oval shaped, biconvex, film coated tablets debossed with "I40" on one side and plain on other side.
2.Identification:				
By: HPLC	Complies	Complies	Complies	The retention time of the major peak in the chromatogram of the test preparation correspond to that in the chromatogram of the standard preparation obtained in assay
3.Average wt. of tablet	618.09 mg	617.84 mg	618.35 mg	618.0 g ± 3 %
4.Uniformity of weight	-0.87 to 0.68%	-0.96 to 0.93%	-0.73 to 1.10%	618.0 g ± 5 %
5.Thickness	5.98 to 6.05 mm	5.96 to 6.05 mm	6.03 to 6.08 mm	1.10 mm ± 0.3 mm
6.Disintegration time	02:36	01:43	03:08	NMT 30 minutes
7.Water	3.861% w/w	3.80627%	3.3609%	NMT 5.0% w/w
8.Uniformity of Dosage Units	2.79	1.51	2.32	The acceptance Value o 10 dosage unit ≤ 15.

Table 19: Yield Details

Sr. No.	Stage	Yield Limit	Observations			
			Batch No.			Remarks
			FIRST BATCH	SECOND BATCH	THIRD BATCH	
1.	Granulation	98%	98.94%	98.73%	98.64%	Ok
2.	Compression	96%	95.59%	97.04%	96.65%	Ok
3.	Coating	95%	95.29%	96.90%	96.59%	Ok

CONCLUSION:

The Process Validation study of Atorvastatin Tablets 40 mg has been carried out on three consecutive validation batches, i.e., FIRST BATCH, SECOND BATCH & THIRD BATCH with recommended batch size of 100,000 tablets prepared**.** Batches were manufactured as per protocol recommendations, sampling of blend uniformity results were performed at dry mixing stage, pre-lubrication and post lubrication stage. Blend uniformity results of all stages have been found well within the acceptance criteria. % RSD for blend uniformity results for all samples found well within 5% limit. Blend evaluation for all three batches was carried out and found well within the pre-determined specification limit. The critical process parameter during compression and coating stages of manufacturing process were performed & evaluated as per the protocol recommendations. Sampling was carried out as mentioned in protocol & samples were analyzed as per established standard test procedures. Speed challenge study was performed on batch i.e. FIRST BATCH at speeds (Minimum–10 RPM, Maximum – 30

RPM & Speed between minimum & maximum – 20 RPM.). The results of speed challenge study found complying with the established acceptance criteria. Hardness challenge study at compression stage was carried out on FIRST BATCH, and minimum hardness & maximum hardness samples send to QC for dissolution. The results of hardness challenge study found complying with the established acceptance criteria. Samples collected at compression stage from different stages send to Quality control. The results of different stages samples are complying established acceptance criteria. In – process controls at compression stage found complying with established acceptance criteria. Coating was performed using 10" coating machine in 2 lots, Critical process parameters along with physical parameters were verified and found satisfactory. Dissolution sample from initial 02 lots of each batch was sent to QC for analysis, dissolution results of all three lots found complying the specification.

Composite sample from all 02 lots for all three batches were collected and send to QC for complete analysis, analytical results for composite sample for all three batches, found well within the specification. Percent yields obtained at different steps of manufacturing process have been recorded.

REFERENCES:

[1] Karthick C, Kathiresan K, Pharmaceutical *et al*. "Process Validation": A Review, Journal of Drug Delivery and Therapeutics. 2022; 12(1-s):164-170

[2] Shital. R. Khot, Khobare R.S., Patil P.S., Patil. S. V. *et al*. "Review article process validation as quality assurance tool", International Journal of Creative Research Thought "Vol. 9, issue 7 july 2021.

[3] Mishra M. K. and Kumari P. *et al*. "A review on pharmaceutical process validation" The Pharma Innovation Journal 2019; 8(6): 950-958

[4] Sharma Shiwani, Goyal S., Chouhan "A Review on Analytical Method Development and Validation" International Journal of applied Pharmaceutical Vol 10, Issue 6,2018.

[5] Sharma Sumeet, Singh Gurpreet, Seth Nimrat *et al*. "Process Validation In Pharmaceutical Industry", Journal of Drug Delivery & Therapeutics; 2013, 3(4), 184-188.

[6] Jain K, Agarwal P, Bharkatiya M. *et al*. "A review on pharmaceutical validation and its implications"; International Journal of Pharmacy and Biological Sciences ISSN: 2321-3272 (Print), ISSN: 2230-7605 (Online) IJPBS. 2018; 8(2):117-126.

[7] Qiu S, Zhuo W, Sun C, Su Z, Yan A, Shen L "Effects of atorvastatin on chronic subdural hematoma: A systematic review"**.** 2017 Jun;96(26):e7290.

[8] Machado JC, Lange AD, Todeschini V, Volpato NM. Development and validation of a discriminative dissolution method for atorvastatin calcium tablets using in vivo data by LC and UV methods. AAPS PharmSciTech. 2014 Feb;15:189-97.

[9] Sonje VM, Kumar L, Meena CL, Kohli G, Puri V, Jain R, Bansal AK, Brittain HG. Atorvastatin calcium. InProfiles of drug substances, excipients and related methodology 2010 Jan 1 (Vol. 35, pp. 1-70). Academic Press.

[10] Chung M, Calcagni A, Glue P, Bramson C. Bioavailability of amlodipine besylate/atorvastatin calcium combination tablet. The Journal of Clinical Pharmacology. 2006 Sep;46(9):1030-7.

[11] Virani P, Sojitra R, Raj H, Jain V. Atorvastatin: A review on analytical method and its determination in pharmaceuticals and biological matrix. Asian Journal of Pharmaceutical Analysis. 2015;5(3):151-60.

[12] Sinha SK, Sharma HK. Formulation And Process Validation Of Atorvastatin Film Coated Tablet.

[13] Simionato LD, Ferello L, Repetto MF, Zubata PD, Segall AI. A validated reversed-phase HPLC method for the determination of atorvastatin calcium in tablets.