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Quality and Pharmaceutical Equivalence Determinations of Commercially Available Amlodipine Besylate Immediate Release Tablets

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Abstract

Counterfeit and substandard drugs possess serious health risks. Regular quality screening is very important to ensure the standard and efficacy of pharmaceutical products. The study aimed to compare the quality of amlodipine besylate tablets available in the Bangladesh drug market and examine their physical and pharmaceutical equivalence. The various physico-chemical parameters such as diameter, shape, size, weight variation, thickness, hardness, loss on drying (LOD), friability, disintegration, dissolution, and assay have been determined according to the methods mentioned in the United States Pharmacopoeia (USP) and British Pharmacopoeia (BP). Four brands of amlodipine besylate were purchased from different local retail stores and coded as ALT_1, AMT_2, AMT_3, and AST_4 on the basis of their market share. All four brands met official USP specifications. Pharmaceutical equivalence was determined from the dissolution profile which gives acceptable difference (f_1) and similarity (f_2) factor values for all the brands compared with the benchmark brand for its highest market share. All the brands also met the USP criteria for assay of not less than 90.0% and not more than 110.0% of the labeled amount of amlodipine ($C_{20}H_{25}N_2O_5Cl$).

Keywords

Assay, Disintegration, Dissolution, Friability, Pharmacopoeia

1. Introduction

According to ISO 8402-1986, quality is the totality of features and characteristics

of a product or service that bears its ability to satisfy stated or implicated needs [1]. Nowadays counterfeit and substandard drugs are a serious and growing problem around the world. Again, when a number of different formulations are available for the same active ingredient, it is essential to ensure that all of them are pharmaceutically equivalent [2]. Pharmaceutical equivalence is the condition in which drug products, containing the identical quantity of active substance (but not necessarily containing the same excipients), in an identical comparable dosage form, meet all applicable standards of identical strength, quality, purity, and potency [3]. Amlodipine, also known as norvasc, is a second-generation 1,4-dihydropyridine derivative, a calcium channel blocker [4]. Chemically, it is 2-[(2-aminoethoxy)methyl]-4-(2-chlorophenyl)-1,4-dihydro-6-methyl-3,5-pyrid inedicarboxylic acid 3-ethyl 5-methyl ester. It has greater selectivity for the vascular smooth muscle than myocardial tissue and a longer half-life (34 hours). It is one of the most frequently prescribed drugs for the treatment of mild-to-moderate essential hypertension and chronic stable angina in Bangladesh. It is marketed as the benzene sulfonic acid salt (besylate) [5] (**Figure 1**).

Previously few works on quality evaluation of amlodipine besylate have been done. In 2014, Anjum *et al.* conducted a quality control research on six different generic brands of amlodipine besylate tablets available in the Pakistani drug market and found that all the generics are interchangeable and therapeutically equivalent [6]. The next year Hussein and Mustafa did a similar kind of research with innovator brands, Norvasc (USA) and two other brands, Myodipine (Jordan) and Nordip (Sudan). The findings of this research showed satisfactory results for the chemical and physical tests [7]. Physicochemical properties of eleven brands of amlodipine besylate available in the Nepalese market were assessed by Thapa *et al.* in 2018. No significant differences were found among various brands in terms of quality assurance [8]. Igboasoiyi *et al.* assessed the quality of ten different brands of amlodipine besylate tablets at hand in Uyo, Nigeria in 2020. The research showed that only five out of nine brands assayed (55.6%) could be used interchangeably [9]. In 2021, Najmi *et al.* attempted to evaluate the pharmaceutical properties and in vitro drug release of one innovator product (Norvasc) and four generic brands of amlodipine tablets (5 mg) available in Saudi Arabia. The

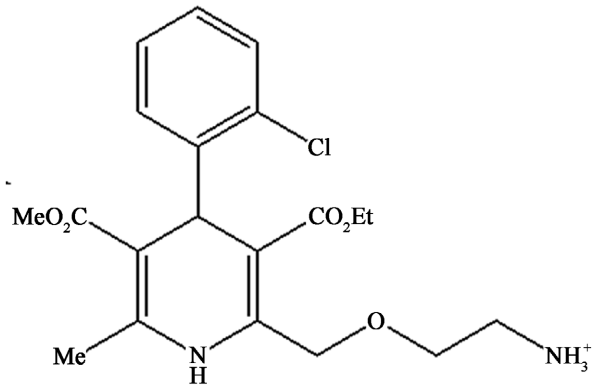

Figure 1. Amlodipine besylate.

tested brands met WHO BCS-based biowaiver criteria for in vitro dissolution testing, which ensured their pharmaceutical and therapeutic equivalence without in vivo screening and interchangeability with the innovator product [10].

In the same year, Arwa Alshargabi has done a similar kind of research on amlodipine 5 mg tablets marketed in Sana'a-Yemen and reported that all the selected brands met USP specifications [11]. To the best of our knowledge in Bangladesh, not much research has been done on the quality and pharmaceutical equivalence of amlodipine besylate. In 2016, Karmoker *et al.* intended to evaluate the different physical parameters of generic amlodipine besylate tablets from different manufacturers. Data exhibits that all brands included in this study have good overall quality [12].

The aim of this study was to determine the pharmaceutical equivalence of Amlodipine besylate tablets available in the Bangladesh drug market and to ensure that they meet the pharmacopoeial quality parameters and thus are reliable, satisfying, and safe.

2. Method and Materials

2.1. Chemicals and Reagents

Amlodipine besylate (standard) was obtained as a gift from Beximco Pharmaceuticals Limited. Hydrochloric Acid (HCl), 37%; Methanol was purchased from Active Fine Chemicals Ltd., Bangladesh.

2.2. Maintaining the Integrity of the Specifications

On the basis of local market share, four national brands of marketed Amlodipine besylate tablets were purchased from retail pharmacy situated inside and outside of city area. These brands here are represented as ALT_1, AMT_2, AMT_3 and AST_4. Here "L", "M" and "S" stand for "large", "medium" and "small" market share. This study was done in late 2021. The samples were properly checked for their license number, batch number, manufacturing date and expiry date before purchasing. Amlodipine besylate tablets with 5 mg Amlodipine packaged in blister packing were stored at 25˚C ± 2˚C for four weeks before the quality determination study in order to evaluate any change.

2.3. Visual Inspection

Appearance and identification marking of the tablets were visually inspected to check the presence of any physical flaws and legible identifying markings for ensuring tablet-to-tablet uniformity. The sizes, shape, and color of the tablets were also checked for their uniformity.

2.4. Weight Variation Test Procedure

For each brand, twenty tablets were randomly selected and weighed individually with the help of scientech electronic balance (USA). The average weights were determined and the percentage deviations from mean values were calculated us-

ing the formula [13]:

$$\frac{\text{Individual weight} - \text{Average weight}}{\text{Average weight}} \times 100\%$$

2.5. Hardness Test Procedure

Copley Tablet Hardness tester (England) was used to evaluate the tablet hardness of randomly selected 10 tablets. The instrument reads in kilogram units [13].

2.6. Thickness Test Procedure

The crown thickness of the individual tablet was measured with a micrometer. Tablet thickness should be controlled within a ± 5% variation of a standard value [13].

2.7. Friability Test Procedure

20 tablets were weighed accurately by using an electronic balance. The Copley friabilator (England) was run for 4 minutes at 25 rpm or 100 revolutions to expose the tablets to rolling and repeated shocks resulting from free fall within the apparatus [13]. After run completion, the tablets were collected and weighed again and friability was calculated using the following formula:

$$\text{Friability} = \frac{I_w - F_w}{I_w} \times 100\%$$

where I_w is the weight of the tablets before the test and F_w is the weight of the tablets after test. A maximum mean weight should not be more than 1%.

2.8. Loss on Drying

The test was conducted on 1 to 2 g test specimens. In the case of a large crystal form specimen, particle size was reduced to about 2 mm by quickly crushing in a mortar pestle. The test specimen was distributed as evenly as practicable to a depth of about 5 mm on a tray by gentle shaking. The tray was placed in the moisture analyzer and the test was started.

2.9. Disintegration Test Procedure

The disintegration test was done by a tablet disintegration tester (Copley, England). One dosage unit was placed in each of the 6 tubes of the basket and a disc was added to each of the tubes. The apparatus was operated using 800 mL distilled water as the immersion fluid, maintained at 37˚C ± 2˚C At the end of the specified time, the basket was lifted from the fluid and the dosage units were observed [14].

2.10. Dissolution Test Procedure

2.10.1. Preparation of Dissolution Media

500 mL 0.01N hydrochloric acid (HCl) was used as the dissolution medium. To prepare 0.01 N HCl 0.9 mL of 37% HCl was mixed in distilled water and volume

was made up to 1000 mL [14].

2.10.2. Preparation of Calibration Curve

22.4 mg of standard Amlodipine besylate (equivalent to 16.15 mg of Amlodipine) was dissolved in 100 mL dissolution media. 1 mL, 2 mL, 3 mL, 4 mL and 5 mL of this solution was diluted up to 50 mL with dissolution media to produce concentration of 3.22 µg/mL, 6.45 µg/mL, 9.67 µg/mL, 12.89 µg/mL, and 16.12 µg/mL of amlodipine, respectively. The absorbance of these solutions was measured by UV-Vis spectrophotometer (Analytik jena, Germany) at the wavelength of maximum absorbance at about 237 nm (**Figure 2**).

2.10.3. Determination of Dissolution Time and Rate

The dissolution studies were carried out according to the USP paddle method. The stirring rate was 75 rpm at 37˚C ± 0.5˚C and dissolution medium was 500 mL 0.01N HCl. 10 mL of the dissolution medium (n = 6) was withdrawn at 5, 10, 15, 20 and 30-minute intervals and each time a fresh 10 mL of dissolution medium was added. The collected solution was filtered through Whatman no. 1 filter paper. The samples were assayed by using UV-Vis absorption at the wavelength of 237 nm. Sample concentration was determined using the linear regression equation of the calibration curve obtained by standard amlodipine besylate solution of 3.22 - 16.12 µg/mL concentration. The percentage of cumulative drug release of each tablet was determined by the following equation:

$$\text{Calculation of Release}(\%) = \frac{\text{Sample concentration} \times 500 \times 100}{5 \times 1000}$$

2.11. Test for Content (Assay)

3 tablets of Amlodipine besylate were weighted and taken into a 50 mL volumetric flask. 2 mL of distilled water was added into the volumetric flask and swirled to disintegrate the tablets; it was made up to mark with methanol. The solution was then filtered through Whatman no.1 filter paper. 1 mL of this solution was taken into a 25 mL volumetric flask and diluted up to mark with methanol. The absorbance of each solution was measured at 237 nm. Using the standard amlodipine besylate solution of known concentration, the amount of amlodipine in

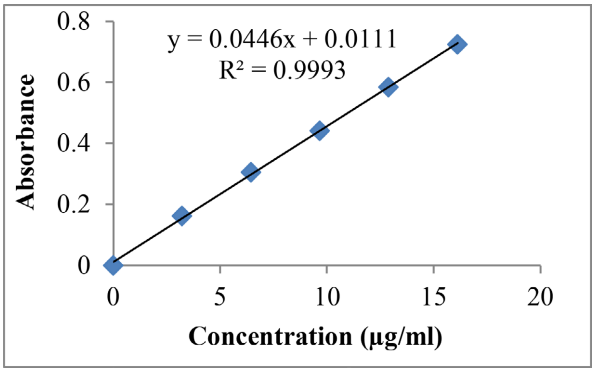

Figure 2. Standard curve of amlodipine.

each brand was determined.

2.12. Comparison of Dissolution Profiles

As a model independent approach, here two adjustment factors, namely difference factor (f_1) and similarity factor (f_2), were applied to the dissolution data to compare the dissolution profile of a pair of pharmaceutical products; f_1 values between 0 and 15, and f_2 values between 50 and 100 were used to define the pharmaceutical equivalence of two dissolution profiles [15].

$$\text{Difference factor,} \quad f_1 = \left\{\left[\sum_1^n \left|R_t - T_t\right|\right] \Big/ \sum_1^n R_t\right\} \cdot 100$$

$$\text{Similarity factor,} \quad f_2 = 50 \cdot \log\left\{\left[1 + (1/n)\sum_1^n \left(R_t - T_t\right)^2\right]^{-0.5} \cdot 100\right\}$$

where n is the number of dissolution sample times, R_t is the mean percent dissolved at each time point for the reference and T_t is the mean percent dissolved at each time point for the test dissolution profile.

Statistical analysis:

Statistical analysis of the assay, disintegration and dissolution (30-min time point) data was performed by applying a one-way analysis of variance. The mean, standard deviation (SD) and %RSD were calculated using Microsoft Excel 2010 (Microsoft Corporation). The data were presented as mean ± SD or mean ± %RSD, as applicable.

3. Results and Discussions

3.1. Weight Variation

According to BP, for tablets weighing ≤ 130 mg, the percentage difference allowed is ±10% and for tablets weighing 130 - 324 mg, it is ±7.5%. All brands of amlodipine besylate were within the standard limit and as such, all the brands passed the uniformity of weight test (Table 1). Among all the brands ALT_1 showed minimal deviations from the mean weight (1.22) and brand AST_4 showed maximum deviation (4.91).

3.2. Hardness Test

The hardness of the different brands of Amlodipine besylate tablets was found to be between 2.29 kg/cm^2 - 9.52 kg/cm^2. Only one brand, AMT_2 exhibited hardness of more than 4 kg (Table 1). The low hardness value may be the result of the improper amount of binder and lubricant. Besides mixing time of lubricants, moisture content of the excipients and non-uniform size distribution of granules may also result in low hardness of tablets.

3.3. Thickness

Thickness of the tablets of all the brands of Amlodipine besylate was in the acceptable range as they lie within ± 5% variation (Table 1). The results revealed that the tablet's thickness ranged between 2.03 mm to 3.67 mm. These differenc-

es between generics in thickness are probably the consequence of differences in the added adjuvants according to each company's formulation or differences in the coating layer applied in the different products.

3.4. Friability Test

One of the very effective tests indicating the compactness of the tablet's core and coat is the friability test. High friability (*i.e.*, low capacity to withstand friction) means that the drug is more likely to withstand mechanical erosion, which may cause loss of the active drug and thus compromise its efficacy. Results of this test as shown in Table 1 revealed that all tablets understudy met the USP specification, as the maximum mean weight loss from the samples taken was not more than 1.0%. So, the low hardness value can be compensated as all the brands met the standard specifications of friability.

3.5. Loss on Drying

Brands ALT_1, AMT_2, AMT_3 and AST_4 showed 4.45%, 4.75%, 6.17% and 5.27% of loss on drying, respectively. Brand AMT_3 showed maximum moisture content which is consistent with its lowest hardness value result (Table 1).

3.6. Disintegration Time Test

The physical assay on disintegration is related to the capacity of solid pharmaceutical forms to release their active ingredients, because before their solubilization the tablets must disintegrate into small particles, increasing the contact surface with the dissolution medium and favoring absorption and bioavailability of the drug. All the tested brands disintegrated within 30 minutes and thus conformed with regard to their disintegration time. ALT_1 had the fastest disintegration time, 23 sec. whereas AMT_3 had the slowest disintegration time, 3 min 3 sec. The conformity of the brands of tablets to the standard specification for disintegration time can be explained for the appropriate use of disintegrating agent by the manufacturers. However, variations in disintegration time from brand to brand were observed in the study (Table 2).

3.7. *In-Vitro* Drug Release

Percent of drug release for brands ALT_1, AMT_2, AMT_3 and AST_4 was 95.34%, 92.33%, 84.29% and 92.49%, respectively (Table 1). All the brands of Amlodipine besylate met the official standard (Figure 3).

Dissolution studies give an idea of the amount of drug available for the absorption after oral administration. Drugs with poor dissolution profiles will not be available in the body system or target organ/tissue to elicit therapeutic effect. Moreover for a BCS Class I drug of high solubility and high permeability like amlodipine, a good dissolution rate will ultimately ensure permeability and systemic absorption of the drug. Pharmaceutical equivalence between drugs can be determined from the dissolution result and it must be performed to ensure

Table 1. Evaluation of different brands of Amlodipine besylate.

Parameters	Brand ALT_1	Brand AMT_2	Brand AMT_3	Brand AST_4	Standard Specifications	Remarks
Description & Packaging	Round, white, Alu Alu	Octahedral, White, Alu PVC	Round, White, Alu PVC	Round, Orange, Alu PVC	-	-
Average Weight (mg) Mean ± SD	70.15 ± 1.22	137.28 ± 2.20	160.23 ± 3.74	168.25 ± 4.91	–	–
Weight Variation (%)	(−) 2.21 to (+) 3.78	(−) 3.56 to (+) 1.83	(−) 3.82 to (+) 5.47	(−) 7.34 to (+) 5.02	± 10% (≤ 130 mg) ± 7.5% (130 - 324 mg).	Comply
Hardness Test (kg) Mean ± SD	3.60 ± 0.48	9.52 ± 1.85	2.29 ± 0.15	3.12 ± 0.72	–	–
Friability Test (%)	0.007	0.08	0.02	0.006	0.5% to 1%	Comply
Thickness Test (%)	(−) 1.12 to (+) 1.80	(−) 2.76 to (+) 2.34	(−) 4.57 to (+) 2.92	(−) 0.99 to (+) 0.94	± 5%	Comply
Loss on Drying	4.45%	4.75%	6.17%	5.27%	–	–
Disintegration Time	23 sec	36 sec	3 min 3 sec	2 min 43 sec	Within 30 minutes	Comply
% Dissolved in 30 min.	95.34%	92.33%	84.29%	92.49%	Minimum 75% in 30 min	Comply
Assay (%) ± SD	105.15 ± 0.34	104.15 ± 0.22	103.89 ± 1.05	105.53 ± 1.77	90% – 110%	Comply

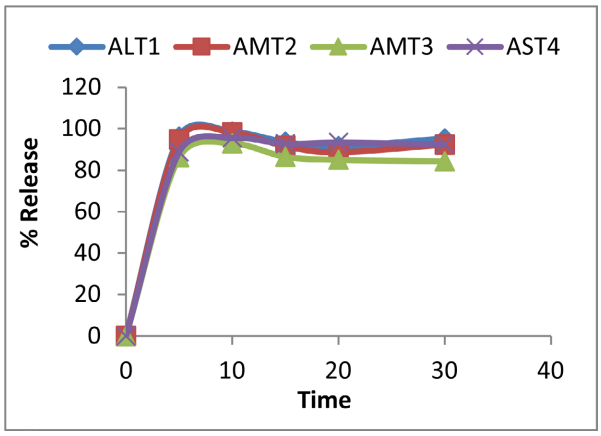

Figure 3. Percent of drug release of different brands of amlodipine besylate.

bioequivalence of Amlodipine besylate. The four brands that we tested showed more than 75% dissolution rate within 30 minutes and did comply with the specification.

3.8. Test for Content (Assay)

According to USP, amlodipine besylate tablets must contain not less than 90.0%

and not more than 110.0% of the labeled amount of amlodipine ($C_{20}H_{25}N_2O_5Cl$) [14]. The results of dosage assays presented in Table 1 showed that the average content of amlodipine besylate among the analyzed drugs ranged from 103.89% to 105.53% and thus complied with the USP standard of drug content (90% - 110%). Brand AST_4 showed a maximum percent of drug content, 105.53% and brand AMT_3 showed a minimum percent of drug content, 103.89% (Table 1).

3.9. Comparison of Dissolution Profiles to Establish Pharmaceutical Equivalence

Comparison of therapeutic performances of different medicinal products containing the same active substance is a critical mean of assessing the possibility of alternative usage between the innovator and any essentially similar medicinal products. Difference factor (f_1) and similarity factor (f_2) were applied to the release rate and the data obtained showed that the tested brands of amlodipine besylate were pharmaceutically equivalent and can be used as alternatives to any of the brands with insignificant differences in their qualities (Table 2). ALT_1 was considered the benchmark for better average drug release and its highest market share. Pharmaceutical equivalency of AMT_2 is the closest to that of the benchmark brand ALT_1 whereas AST_4 is the furthest to that of ALT_1.

The low hardness value for brand ALT_1 can be omitted as it has the lowest average weight of 70.15 mg and also showed acceptable friability.

All in all, the pharmaceutical quality of the tested generic brands can be regarded as acceptable according to the above quality control tests. The tested generic products met the pharmacopoeial criteria for in vitro drug dissolution and drug content. The tested generic products are pharmaceutically equivalent and

Table 2. f_1 (Difference) and f_2 (similarity) factors—reference (ALT_1) vs. test products (AMT_2, AMT_3 and AMT_4).

Time (min)	ALT_1	AMT_2	AMT_3	AST_4
0	0	0	0	0
5	96.136	94.833	86.202	88.794
10	98.527	98.171	92.872	95.636
15	93.651	91.628	86.5	92.809
20	91.491	88.659	84.984	93.345
30	95.341	92.333	84.287	92.496
Remarks	Comply	Comply	Comply	Comply
Factor				
f_1		2.004	8.48	3.32
f_2	Benchmark	81.30	53.83	69.95
Remarks		Ph. Eq.[a]	Ph. Eq.[a]	Ph. Eq.[a]

[a]Pharmaceutically Equivalent.

therefore interchangeable. The efficacy associated with the use of the generic formulations would be comparable to the innovator brand.

4. Conclusion

The pharmaceutical sector of Bangladesh had to travel a long way to achieve the present prestigious position in both domestic and international markets. By now, 97% of the country's demand for medicines is produced locally and approximately 30 pharmaceutical companies are exporting different finished dosage forms to both regulated and non-regulated countries [16]. The rapid growth of the pharmaceutical sector of our country and its effect on our economy has made constant surveillance of the quality of different pharmaceutical products by the controlling authority, research organizations, manufacturers and so on, more indispensable. In this work, the quality of different brands of amlodipine besylate tablets available in the Bangladesh drug market has been evaluated. The findings indicated that most of the marketed brands of amlodipine besylate met the pharmacopoeial standards. All tested brands were found to be pharmaceutically equivalent, which suggested that they can be used as alternatives by the healthcare practitioner and thus fulfill the requirements of quality medication for the people of Bangladesh.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Levi, L., Walker, G. and Pugsley, L. (1964) Quality Control of Pharmaceuticals. *The Canadian Medical Association Journal*, **91**, 781-785.

[2] Harris, J., Stevens, P. and Morris, J. (2009) Keeping It Real: Combating the Spread of Fake Drugs in Poor Countries. International Policy Network, London.

[3] Apurba, S.A., *et al.* (2011) In Vitro Evaluation of the Pharmaceutical Equivalence of Phenoxymethylpenicillin Tablet Formulations Available in Bangladesh. *Journal of Pharmacy Research*, **4**, 1445-1447.

[4] Cutler, S.J. (2006) Cardiovascular Agents. In: Jr. Beale, J.M., Block, J.H., Eds., *Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry*. Lippincott Williams & Wilkins, New York, 617-665.

[5] Kaynak, M.S., Bogacz, A., Stelmasinski, M. and Sahin, S. (2011) Bioavailability File: Amlodipine. *FABAD Journal of Pharmaceutical Sciences*, **36**, 207-222.

[6] Mahwish, F., Nighat, R., Sana, G., Fakhsheena, A., Lubna, G. and Saeed, A.S. (2014) Assessment of Pharmaceutical Quality Control and Equivalence of Various Brands

of Amlodipine Besylate (5 Mg) Tablets Available in The Pakistani Market Under Biowaiver Conditions. *International Journal of Pharmacy and Pharmaceutical Sciences*, **6**, 909-913.

[7] Hussein, A.A. and Mustafa, A.M. (2015) A Comparative Pharmaceutical Evaluation of Amlodipine (5mg). *University of Khartoum Engineering Journal*, **5**, 26-29.

[8] Thapa, P., Manandhar, N. and Pandeya, S. (2018) In-Vitro Evaluation of Amlodipine Tablets Available in Nepalese Market. *Journal of Nepal Chemical Society*, **39**, 46-52. https://doi.org/10.3126/jncs.v39i0.27027

[9] Arnold, C.I., Amarachi, P.E. and Effiong, M.E. (2020) Quality Evaluation and UV Spectrophotometric Assay of Ten Brands of Amlodipine Tablets Marketed in Uyo, Nigeria. *Journal of Pharmacy & Bioresources*, **17**, 60-65. https://doi.org/10.4314/jpb.v17i1.10

[10] Asim, N., Mohammed, A.B., Bassam, A.A., Rami, A.A., Turki, S.W., Abdulrahman, I.A., *et al.* (2021) Evaluation of In Vitro Equivalence of Commonly Available Generic Brands of Amlodipine Tablets in Saudi Arabia Under Biowaiver Conditions. *Dissolution Technologies*, **28**, 1-12. https://doi.org/10.14227/DT280221PGC1

[11] Alshargabi, A. (2021) In Vitro Assessment of Physicochemical Parameters of Five Generics Amlodipine Besylate Tablets Marketed in Yemen. *International Journal of Pharmacy and Pharmaceutical Sciences*, **13**, 15-19. https://doi.org/10.22159/ijpps.2021v13i11.42898

[12] Karmoker, J.R., Joydhar, P., Sarkar, S. and Rahman, M. (2016) Comparative In Vitro Evaluation of Various Commercial Brands of Amlodipine Besylate Tablets Marketed in Bangladesh. *Asian Journal of Pharmaceutical and Health Sciences*, **6**, 1384-1389.

[13] Bankers, G.S. and Anderson, N.R. (1987) Tablets. In: Lachman, L., Lieberman, H.A., Kanig, J.L., Eds., *The Theory and Practice of Industrial Pharmacy*, Varghese Publishing House, Bombay, 296-302.

[14] United States Pharmacopeia and National Formulary (USP 29-NF 34). United States Pharmacopeia Convention, Rockville, MD, p. 3017, 2011.

[15] Prior, A., Frutos, P. and Correa, C.P. (2013) Comparison of Dissolution Profiles: Current Guidelines. *International Journal of Drug Delivery*, **5**, 99-109.

[16] Jesmin, S. (2016) Future Prospects and Barriers of Pharmaceutical Industries in Bangladesh. *Biomedical and Pharmacology Journal*, **19**, 53-57. https://doi.org/10.3329/bpj.v19i1.29239