DHR International Journal Of Pharmaceutical Sciences (DHR-IJPS)
ISSN: 2278-8328, *Vol. 5, Issue 3, 2014*
Available online *http://www.doublehelixresearch.com/DHRIJPS*

Original Article

Comparative Study of Four Different Brands of Lisinopril Available In Karachi

Safila Naveed*, Huma Dilshad and Fakhra Khalid

Faculty of Pharmacy of Pharmacy, Jinnah University for Women, Karachi, Pakistan
*Corresponding Author: Safila Naveed

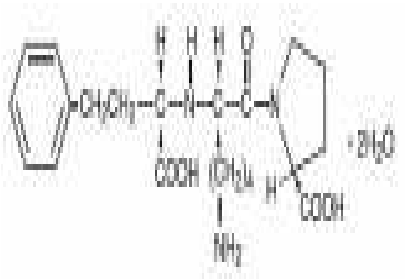
Abstract

Lisinopril is the orally active inhibitor of angiotensin-converting enzyme. It blocks conversion of angiotensin I to angiotensin II and used for hyper tension as a potent vasodilator. Lisinopril used to lower hyper tension and available in several brands in the market. The aim of this study to establish pharmaceutical equivalence among the brands available in Karachi, Pakistan. Four different brands of Lisinopril tablets (10 mg) were included in study. Six quality control parameters: weight variation test, hardness test, thickness, friability, disintegration test and dissolution test were carried out specified by British and United state Pharmacopoeia BP/USP . Hardness value requirement was complied by all brands .Disintegration time for all brands was within 15 minutes complying the BP/USP standards. All brands of lisinopril showed more than 80 % drug release within forty five 45 minutes. The study suggest that all the brands of lisinopril are available in Karachi meet the specification for quality control analysis.

Key words: Lisinopril, formulations, comparative study.

Introduction

Lisinopril is an oral long acting ACE inhibitor and has a synthetic peptide derivative which is chemically represented by (S) – 1 – [N2 – (1 – Carboxy – 3 – phenyl propyl) – L – lysyl} – L – proline dehydrate with empirical formula of C21H31N3O5.2H2O having molecular weight of 441.53. [1]Its chemical structure is;



It is used as a fundamental medicines in the treatment of Hypertension which is the most commonly disease nowadays. Lisinopril is mostly used in the following diseases includes:

- Mild to moderate hypertension (Essential Hypertension).
- Symptomatic & asymptomatic left ventricular systolic dysfunction
- Post myocardial infarction
- Renal failure & diabetic nephropathy. [2]

Lisinopril administered orally in a daily dose of 2.5 to 40mg. The bioavailability is between 25-30% & needed 6 hours to reach the maximum plasma concentration. It is not metabolized by the liver & is strongly binds to plasma protein. The absorbed drug is eliminated in urine as an unchanged drug. The rate of absorption of this drug does not affected in presence of foods. ACE inhibitor is used with diuretic in combination because diuretic activates the renin-angiotensin system due to which loss of potassium level occur. So ACE inhibitor maintained the level of potassium in body. [3]Used as a conjunctive treatment with diuretic & Beta-blocker or Calcium channel blocker in patients with CHF. It is more effective drug in white younger patients as compared to black patients. [4]

Lisinopril tablets work by the following mechanism of action;It inhibits the ACE inhibitor that catalyzes the conversion of angiotensin-I to angiotensin-II (vasoconstrictor peptide). This vasoconstrictor substance stimulates the aldosterone secretion by adrenal cortex. Due to this, the renin-angiotensin-aldosterone system suppresses which results in decrease plasma angiotensin II which leads to decrease vasopressor activity & also decrease aldosterone secretion. [5]

- Lisinopril also inactivates the bradykinin (a vasodilator) causes vasodilation and decrease aldosterone secretion thus improves endothelial function & reduced left ventricular mass leading to cardio protective effect. [5]In those patients which have a decreased renal function & proteinuria may slow the rate of disease progression by altering intraglomerular pressure & reduce the mediators of glomerular & tubular hypertrophy resulting in decrease systemic blood pressure of the human body. [5]Angioedema may occur if patient has acute dyspnea.[6].Literature survey reveals that there are many methods have been develop and validated for lisinopril and there interaction studies but no such type of study has been found[7-13].

MATERIALS & METHODOLOGY

The significantly use of Lisinopril needs to monitor the quality of different brands available in market.

The aim of the study is to evaluate the various physico-chemical parameters of different brands of lisinopril tablets were assessed by the evaluation of official & non-official standards like weight variation, hardness, thickness, friability, disintegration and dissolution with the specifications of USP.

MATERIALS

Four different brands of Lisinopril tablets were purchased from the market in Karachi & check the Batch Number and Manufacturing/Expiry date. All brands randomly marked as LIS-01, LIS-02, and LIS-03 & LIS-04. The labeled active ingredient is 5mg of Lisinopril. The reagent i.e. utilized includes Hydrochloric Acid 0.1N.

METHODS

- Weight Variation Test:-

Twenty tablets from each brand are randomly selected and weighed individually by using an AD Electronic weighing balance (FX-400) & average weight for each brand was conducted as per official specification and record the results.

- Hardness Test:-

The Ten Tables from each brands randomly selected was determined by using Hardness tester (MH-1 Tablet Hardness Tester) & obtained the hardness value of each tablet in kg. Finally the average hardness was calculated and record the results.

- Thickness Test:-

The Thickness of ten tablets from each brand was measured by using Vernier caliper and calculates the average thickness of each brand and also records the results.

- Friability Test:-

Ten tablets from each brand selected & weigh them individually (initial weight) & transfer the tablets to friabilator (FB-1004) at 25 rpm for four minutes (100 revolutions). Then tablets were again weighed (final weight) & compare them with their initial weights & percent of friability was conducted as per specification and record the results.

- Disintegration Test:-

The disintegration test was performed on 6 tablets of each brand by using disintegration Curio apparatus (DS-0702). Select the 6 tablets from each brand and put them in an each tube of basket rack then kept it in a 800ml beaker of water medium at 37^0C and then record the disintegration time i.e. the time was taken when no minute particles of ant tablet was left on the mesh.

- Dissolution Test:-

The dissolution test on tablets from each brand was carried out using Tablet Dissolution Apparatus Basket Type (GDT-7L from Galvano Scientific).

In this method, place the volume of dissolution medium containing 900ml HCL 0.1N in a beaker and equilibrate the medium at 37^0C. Then put the tablet of each brand in a beaker and operate the

apparatus at 50rpm on different time interval i.e. 0minute, 15minute, 30minute and 45minute. At the end of time interval, inject the 10ml volume of a sample at specified intervals and analyzed the sample by using UV Visible spectrophotometer at 215nm and note the absorbance of each of the withdrawn sample and calculate the concentration of drug in the samples as per Lisinopril monograph.

GENERAL TABLE:-

No.	NAME OF THE PRODUCT	SERIAL No.	CODE No.	BATCH No.
1.	ZESTRIL	LIS-01*	012350	0335
2.	TRUPRIL	LIS-02	022022	063T25
3.	NOVATEC	LIS-03	012852	D148
4.	LAME 5	LIS-04	026225	13007

WEIGHT VARIATION:-

TABLE 1:-

No.	Serial No.	Batch No.	Average weight (mg)	S.D	Upper limit (UCL)(X+3S)	Lower limit (LCL)(X-3S)
1.	LIS-01*	0335	105.3	1.688974	110.366922	100.233078
2.	LIS-02	063T25	97.8	3.503382	108.310146	87.289854
3.	LIS-03	D148	103.6	2.112619	109.937857	97.262143
4.	LIS-04	13007	139.3	3.088178	148.564534	130.035466

TABLE 2:-

LIS-01*

Tablet	Weight (mg)	Mean	Standard Deviation	Upper Class Limit	Lower Class Limit	Comment
1	103	105.3	1.688974	110.366922	100.233078	OK
2	103	105.3	1.688974	110.366922	100.233078	OK
3	108	105.3	1.688974	110.366922	100.233078	OK
4	105	105.3	1.688974	110.366922	100.233078	OK
5	105	105.3	1.688974	110.366922	100.233078	OK
6	106	105.3	1.688974	110.366922	100.233078	OK
7	106	105.3	1.688974	110.366922	100.233078	OK

8	103	105.3	1.688974	110.366922	100.233078	OK
9	108	105.3	1.688974	110.366922	100.233078	OK
10	103	105.3	1.688974	110.366922	100.233078	OK
11	106	105.3	1.688974	110.366922	100.233078	OK
12	104	105.3	1.688974	110.366922	100.233078	OK
13	103	105.3	1.688974	110.366922	100.233078	OK
14	105	105.3	1.688974	110.366922	100.233078	OK
15	106	105.3	1.688974	110.366922	100.233078	OK
16	107	105.3	1.688974	110.366922	100.233078	OK
17	106	105.3	1.688974	110.366922	100.233078	OK
18	105	105.3	1.688974	110.366922	100.233078	OK
19	107	105.3	1.688974	110.366922	100.233078	OK
20	107	105.3	1.688974	110.366922	100.233078	OK

LIS-02

Tablet	Weight (mg)	Mean	Standard Deviation	Upper Class Limit	Lower Class Limit	Comment
1	95	97.8	3.503382	108.310146	87.289854	OK
2	97	97.8	3.503382	108.310146	87.289854	OK
3	110	97.8	3.503382	108.310146	87.289854	OK
4	91	97.8	3.503382	108.310146	87.289854	OK
5	99	97.8	3.503382	108.310146	87.289854	OK
6	98	97.8	3.503382	108.310146	87.289854	OK
7	95	97.8	3.503382	108.310146	87.289854	OK
8	99	97.8	3.503382	108.310146	87.289854	OK
9	98	97.8	3.503382	108.310146	87.289854	OK
10	99	97.8	3.503382	108.310146	87.289854	OK

11	99	97.8	3.503382	108.310146	87.289854	OK
12	99	97.8	3.503382	108.310146	87.289854	OK
13	97	97.8	3.503382	108.310146	87.289854	OK
14	98	97.8	3.503382	108.310146	87.289854	OK
15	97	97.8	3.503382	108.310146	87.289854	OK
16	98	97.8	3.503382	108.310146	87.289854	OK
17	96	97.8	3.503382	108.310146	87.289854	OK
18	99	97.8	3.503382	108.310146	87.289854	OK
19	95	97.8	3.503382	108.310146	87.289854	OK
20	97	97.8	3.503382	108.310146	87.289854	OK

LIS-03

Tablet	Weight (mg)	Mean	Standard Deviation	Upper Class Limit	Lower Class Limit	Comment
1	107	103.6	2.112619	109.937857	97.262143	OK
2	105	103.6	2.112619	109.937857	97.262143	OK
3	106	103.6	2.112619	109.937857	97.262143	OK
4	101	103.6	2.112619	109.937857	97.262143	OK
5	102	103.6	2.112619	109.937857	97.262143	OK
6	101	103.6	2.112619	109.937857	97.262143	OK
7	104	103.6	2.112619	109.937857	97.262143	OK
8	107	103.6	2.112619	109.937857	97.262143	OK
9	104	103.6	2.112619	109.937857	97.262143	OK
10	103	103.6	2.112619	109.937857	97.262143	OK
11	103	103.6	2.112619	109.937857	97.262143	OK
12	103	103.6	2.112619	109.937857	97.262143	OK

13	107	103.6	2.112619	109.937857	97.262143	OK
14	106	103.6	2.112619	109.937857	97.262143	OK
15	102	103.6	2.112619	109.937857	97.262143	OK
16	101	103.6	2.112619	109.937857	97.262143	OK
17	102	103.6	2.112619	109.937857	97.262143	OK
18	101	103.6	2.112619	109.937857	97.262143	OK
19	104	103.6	2.112619	109.937857	97.262143	OK
20	103	103.6	2.112619	109.937857	97.262143	OK

LIS-04

Tablet	Weight (mg)	Mean	Standard Deviation	Upper Class Limit	Lower Class Limit	Comment
1	148	139.3	3.088178	148.564534	130.035466	OK
2	150	139.3	3.088178	148.564534	130.035466	OK
3	150	139.3	3.088178	148.564534	130.035466	OK
4	151	139.3	3.088178	148.564534	130.035466	OK
5	144	139.3	3.088178	148.564534	130.035466	OK
6	147	139.3	3.088178	148.564534	130.035466	OK
7	150	139.3	3.088178	148.564534	130.035466	OK
8	142	139.3	3.088178	148.564534	130.035466	OK
9	150	139.3	3.088178	148.564534	130.035466	OK
10	150	139.3	3.088178	148.564534	130.035466	OK
11	145	139.3	3.088178	148.564534	130.035466	OK
12	150	139.3	3.088178	148.564534	130.035466	OK
13	149	139.3	3.088178	148.564534	130.035466	OK
14	144	139.3	3.088178	148.564534	130.035466	OK
15	148	139.3	3.088178	148.564534	130.035466	OK
16	144	139.3	3.088178	148.564534	130.035466	OK
17	143	139.3	3.088178	148.564534	130.035466	OK

18	144	139.3	3.088178	148.564534	130.035466	OK
19	144	139.3	3.088178	148.564534	130.035466	OK
20	143	139.3	3.088178	148.564534	130.035466	OK

TABLE 3:-

Serial No.	Code No	Batch No	Results in gm.	Official Specs.	Official Deviation Limit
LIS-01*	012350	0335	0.1053	±7.5%	Within limit
LIS-02	022022	063T25	0.0978	±7.5%	Within limit
LIS-03	012852	D148	0.1036	±7.5%	Within limit
LIS-04	026225	13007	0.1393	±7.5%	Within limit

HARDNESS:-

TABLE 1:-

Serial No.	Code No.	Batch No.	Average Hardness (Kg)	S.D	Upper Limit(UCL)(X+3S)	Lower Limit(LCL)(X-3S)
LIS-01*	012350	0335	3.915	0.517	5.466	2.364
LIS-02	022022	063T25	6.859	0.478	8.293	5.425
LIS-03	012852	D148	7.895	0.956	10.76	5.027
LIS-04	026225	13007	4.108	0.636	6.016	2.20

TABLE 2:-

LIS-01*	TAB1	TAB2	TAB3	TAB4	TAB5	TAB6	TAB7	TAB8	TAB9	TAB10
HARDNESS (Kg)	3.34	3.37	4.63	4.13	3.26	4.64	4.37	3.87	3.87	3.67
MEAN	3.915	3.915	3.915	3.915	3.915	3.915	3.915	3.915	3.915	3.915
SD	0.517	0.517	0.517	0.517	0.517	0.517	0.517	0.517	0.517	0.517
X+3S	5.466	5.466	5.466	5.466	5.466	5.466	5.466	5.466	5.466	5.466
X-3S	2.364	2.364	2.364	2.364	2.364	2.364	2.364	2.364	2.364	2.364

LIS-02	TAB1	TAB2	TAB3	TAB4	TAB5	TAB6	TAB7	TAB8	TAB9	TAB10
HARDNESS (Kg)	7.75	7.16	7.15	7.26	6.56	7.04	6.32	6.55	6.37	6.43
MEAN	6.859	6.859	6.859	6.859	6.859	6.859	6.859	6.859	6.859	6.859
SD	0.478	0.478	0.478	0.478	0.478	0.478	0.478	0.478	0.478	0.478
X+3S	8.293	8.293	8.293	8.293	8.293	8.293	8.293	8.293	8.293	8.293
X-3S	5.425	5.425	5.425	5.425	5.425	5.425	5.425	5.425	5.425	5.425

LIS-03	TAB1	TAB2	TAB3	TAB4	TAB5	TAB6	TAB7	TAB8	TAB9	TAB10
HARDNESS (Kg)	7.67	8.87	8.67	6.95	6.59	7.50	9.42	8.75	7.14	7.39
MEAN	7.895	7.895	7.895	7.895	7.895	7.895	7.895	7.895	7.895	7.895
SD	0.956	0.956	0.956	0.956	0.956	0.956	0.956	0.956	0.956	0.956
X+3S	10.76	10.76	10.76	10.76	10.76	10.76	10.76	10.76	10.76	10.76
X-3S	5.027	5.027	5.027	5.027	5.027	5.027	5.027	5.027	5.027	5.027

LIS-04	TAB1	TAB2	TAB3	TAB4	TAB5	TAB6	TAB7	TAB8	TAB9	TAB10
HARDNESS (Kg)	3.67	3.29	4.37	3.38	3.79	3.62	4.36	5.06	4.77	4.77
MEAN	4.108	4.108	4.108	4.108	4.108	4.108	4.108	4.108	4.108	4.108
SD	0.636	0.636	0.636	0.636	0.636	0.636	0.636	0.636	0.636	0.636
X+3S	6.016	6.016	6.016	6.016	6.016	6.016	6.016	6.016	6.016	6.016
X-3S	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20

THICKNESS:-

TABLE1:-

Serial No.	Code No.	Batch No.	Average Thickness (mm)	S.D	Upper Limit(UCL)(X+3S)	Lower Limit(LCL)(X-3S)
LIS-01*	012350	0335	0.253	0.010593	0.284779	0.221221
LIS-02	022022	063T25	0.233	0.00483	0.24749	0.21851
LIS-03	012852	D148	0.207	0.00483	0.22149	0.19251
LIS-04	026225	13007	0.344	0.006992	0.364976	0.323024

TABLE 2:-

LIS-01*	TAB1	TAB2	TAB3	TAB4	TAB5	TAB6	TAB7	TAB8	TAB9	TAB10
THICKNESS (mm)	0.27	0.27	0.26	0.25	0.25	0.25	0.24	0.25	0.25	0.24
MEAN	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253
SD	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105
X+3S	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284
X-3S	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221

LIS-02	TAB1	TAB2	TAB3	TAB4	TAB5	TAB6	TAB7	TAB8	TAB9	TAB10
THICKNESS (mm)	0.23	0.23	0.24	0.23	0.24	0.23	0.23	0.23	0.23	0.24
MEAN	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233
SD	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
X+3S	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247
X-3S	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218

LIS-03	TAB1	TAB2	TAB3	TAB4	TAB5	TAB6	TAB7	TAB8	TAB9	TAB10
THICKNESS (mm)	0.21	0.20	0.21	0.20	0.21	0.21	0.20	0.21	0.21	0.21
MEAN	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207
SD	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
X+3S	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221
X-3S	0.1925	0.1925	0.1925	0.1925	0.1925	0.1925	0.1925	0.1925	0.1925	0.1925

FRIABILITY:-

Serial No.	Code No.	Batch No.	Initial weight (gm.)	Final Weight (gm.)	Friability %	Official Limits	Comments
LIS-01*	012350	0335	1.053	1.052	0.0949	Not more than 1%	Within specified limit
LIS-02	022022	063T25	0.972	0.969	0.308	Not more than 1%	Within specified limit
LIS-03	012852	D148	1.053	1.051	0.189	Not more than 1%	Within specified limit

	TAB1	TAB2	TAB3	TAB4	TAB5	TAB6	TAB7	TAB8	TAB9	TAB10
THICKNESS (mm)	0.35	0.33	0.34	0.34	0.35	0.35	0.34	0.35	0.34	0.35
MEAN	0.344	0.344	0.344	0.344	0.344	0.344	0.344	0.344	0.344	0.344
SD	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069
X+3S	0.3649	0.3649	0.3649	0.3649	0.3649	0.3649	0.3649	0.3649	0.3649	0.3649
X-3S	0.3230	0.3230	0.3230	0.3230	0.3230	0.3230	0.3230	0.3230	0.3230	0.3230

LIS-04	026225	13007	1.470	1.468	0.136	Not more than 1%	Within specified limit

DISINTEGRATION:-

TABLE 1:-

GENERAL TABLE

Serial No.	Code No.	Batch No.	Disintegration Time	Official Limits	Comments
LIS-01*	012350	0335	9mint 58sec	Not more than 15min	Within specified limit
LIS-02	022022	063T25	12mint	Not more than 15min	Within specified limit
LIS-03	012852	D148	7mint	Not more than 15min	Within specified limit
LIS-04	026225	13007	9mint 30sec	Not more than 15min	Within specified limit

DISSOLUTION:-

TABLE 1:-

ABSORBANCE AT DIFFERENT TIME INTERVAL AT 215 WAVELENGTHS:-

No.	Serial No.	Absorbance of drug at 215nm			
		0min	15min	30min	45min
1	LIS-01*	0.225	0.320	0.420	0.421
2	LIS-02	0.202	0.309	0.409	0.410
3	LIS-03	0.185	0.300	0.402	0.403
4	LIS-04	0.195	0.295	0.408	0.409

TABLE 2:- OFFICIAL LIMITS AT 215nm

No.	Serial No	Batch No	% Dissolution at 30min	Official Specs.	Deviation Limit
1.	LIS-02	063T25	97.380%	Not less than 80%	Within specified limit
2.	LIS-03	D148	95.714%	Not less than 80%	Within specified limit
3.	LIS-04	13007	97.142%	Not less than 80%	Within specified limit

RESULTS AND DISCUSSION:-

The results of the invitro quality control parameters of four different brands of Lisinopril 5mg tablets were performed and three brands i.e. LIS-02, LIS-03, LIS-04 were compared with the brand of multi-national considered as standard i.e. LIS-01*. The physico-chemical parameters like weight variation, disintegration, friability and dissolution have official standard to assess the quality of tablets.

- Weight variation of "Table-1" have different brands of Lisinopril tablets, average weight and standard deviation. For comparison and accuracy of tablets, we use standard deviation against the weight of tablets. The brand 2 (LIS-02) has high standard deviation as compared to other brands of Lisinopril but all the brands I.e. LIS-01, LIS-02, LIS-03 & LIS-04 complies within the official specifications i.e. shown in Table-3 which states that none of the brands deviated by up to ±7.5% from the mean value.
- The hardness and thickness of 10 tablets from each brand was measured and calculate their standard deviation and average hardness and thickness of each brand were noted in Table 1 of hardness and thickness respectively. The average hardness and thickness of all brands found to be in the limit of 3.91 to 7.85 kg and 0.20 to 0.34mm respectively. The brand 2 i.e. LIS-02 has low value of standard deviation and brand 3 i.e. LIS-03 has high value of standard deviation of hardness. The brand 2 & 3 (LIS-02 & LIS-03) have low value of standard deviation but LIS-01 has high value of standard deviation that is considered as standard.
- The friability of the tablets should not be more than 1% i.e. official limit. All the brands of Lisinopril tablets are found in limits. Brand LIS-01 has minimum friability of 0.0949% while brand LIS-03 has maximum friability of 0.189% but both are within the limit.
- The disintegration test of the all brands of Lisinopril tablets complies within the official specification i.e. showed in Table 1 because in BP un-coated tablets should be disintegrate within 15 minutes but in USP both un-coated and film coated tablets should be disintegrate within 30 minutes.
- The result of dissolution test of all the brands of Lisinopril i.e. shown in Table 1 complies within the official specification and passed the test as per monograph in BP and USP which states that the amount of drug release (Active ingredient) in solution should not be less than 80% of the labeled amount at 30minutes.

  In this study, we concluded that all the four brands of Lisinopril shows remarkable results and also in range in all of the Physico-chemical comparison of different brands of the Lisinopril.

Reference:-

1. NAGHAM A. JASIMa, ADLA A. SALOMI* and FADHIL M. ABIDa Int. J. Chem. Sci.: 8(4), 2010, 2808-2814.
2. Krisztina Takacs-Novak, Katalin Deak, Szabolcs Beni, Gergely Volgyi ADMET & DMPK 1(2) (2013) 6-16; doi: 10.5599/admet.1.2.3

http://pub.iapchem.org/ojs/index.php/admet/article/view/3/7.Received: January 7th, 2013; Revised: February 1st, 2013; Published: February 15th, 2013.

3. M.Inam Danish "Medical Diagnosis and Management" edition 2012, page. No. 43.
4. Stephen J.Mcphee A.Papadakis "Current Medical Diagnosis and Treatment" Mc Grew Hill LANGE, 2011 VOl 01, Fifteen Edition, Page.No.435.
5. Peter Hamilton & David Hui, Second edition 2006; Drugs and Drugs: A Practical guide to the safe use of common drugs in adults ISBN 1-55195-200-9, from page # 46. British National Formulary, September 2011, Page.No.116.
6. Sultana N, Arayne MS and Safila Naveed (2011) Validated Method for the Simultaneous Determination of Lisinopril, Pravastatin, Atorvastatin and Rosuvastatin in API, Formulations and Human Serum by RP-HPLC Chinese Journal of Chemistry 29, 1216-1220.DOI: 10.1002/cjoc.201190226.
7. Safila Naveed, Sultana N and Arayne MS (2012) Simultaneous Determination of Lisinopril and H_2 Antagonists in Bulk, Pharmaceutical Dosage Forms and Human Serum by RP-HPLC 4542-4548 (7) DOI 10.1007/s00044-011-9939-z.
8. Sultana N, Arayne MS, Siddiqui R and Safila Naveed (2012) RP-HPLC Method for the Simultaneous Determination of Lisinopril and NSAIDs In Bulk, Formulations and Human Serum. American Journal of Analytical Chemistry) 3, 147-152 doi:10.4236/ajac.2012.32021 Published Online February 2012 (http://www.SciRP.org/journal/ajac).
9. Arayne MS, Sultana N, Arman Tabassum Saeeda Nadir Ali and Safila Naveed (2012). Simultaneous LC Determination of Rosuvastatin, Lisinopril, Captopril, and Enalapril in API, Pharmaceutical Dosage Formulations, and Human Serum Medicinal Chemistry Research 21:4542-4548 DOI 10.1007/s00044-012-9997-x http://link.springer.com/article/10.1007%2Fs00044-012-9997-x#page-1
10. Sultana N, Naveed Safila, Arayne MS (2013) Direct Determination of Four ACE-Inhibitors Lisinopril, Enalapril, Captopril and Fosinopril in Pharmaceuticals and Serum by HPLC. J Chromat Separation Techniq 4: 179.5pg doi:10.4172/2157-7064.1000179
11. Arayne MS, Safila Naveed , Sultana N (2013) RP-HPLC Method for the Determination of isinopril in Active Pharmaceutical Ingredients, Dosage Forms and Human Serum. 3: 832. doi: 10.4172/scientificreports.832 Modern Chemistry & Applications
12. Safila Naveed, Najma Sultana, and Saeed Arayne M (2014) Facile and Manifest RPHPLC Method for the Determination of Captpril, Lisiopril , Enalpril and Diclofenac sodium: Its Applications in

Dosage formulations and in human serum Can J App Sci; Issue 2; Vol. 4: 40-50; ISSN 1925-7430; Available online http://www.cjasci.com http://cajaps.files.wordpress.com/2014/04/safila.pdf