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Research Article

Development and Validation of a Novel RP-HPLC Method for Simultaneous Estimation of Budesonide and Albuterol in Bulk and Tablet Formulations

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ABSTRACT:
The concurrent assessment of albuterol and Budesonide. Kromasil was used to create the chromatogram (250mm 4.6mm, 5µ). At a flow rate of 1.0 ml/min, a mobile phase made up of OPA and acetonitrile in a 45:55 ratio was injected across the column. A constant temperature of 30°C was maintained. 244 nm was the ideal wavelength for albuterol and budesonide. The percentage RSDs for bedesonide and albuterol were found to be 0.7 and 0.2, respectively, and their retention periods were 2.473 and 3.316 minutes. Budesonide and albuterol's regression models yielded LOD and LOQ values of 0.011, 0.035, and 0.01, 0.03 correspondingly. Budesonide's regression equation is y = 145694x + 700.57, while albuterol's is y = 146661x + 1161.
Key Words: Budesonide, Albuterol, Rp Hplc, Validation.

INTRODUCTION

Asthma is a chronic lung disease affecting people of all ages. It is caused by inflammation and muscle tightening around the airways, which makes it harder to breathe. [1] People with under-treated asthma can suffer sleep disturbance, tiredness during the day, and poor concentration. Chronic obstructive pulmonary disease (COPD) and other airway disorders are treated mostly with bronchodilators. The goals of bronchodilators for COPD are to promote quality of life, lower symptoms, improve lung function, and avoid exacerbations. Most programs being developed for new bronchodilators concentrate on improving their safety profiles and increasing current objectives to once-daily dosage.[2] There is still a lot of interest in discovering new families of broncholytic medications since bronchodilators are essential in the treatment of respiratory disorders. It is possible to speculate that a once-daily drug's longer duration of bronchodilation may be linked to better and more reliable effectiveness across a variety of endpoints than a twice-daily agent. [3] There are three main types of bronchodilators: beta 2-agonists, anticholinergics and theophylline.[4] The FDA has authorised the inhalation aerosol Airsupra (albuterol and budesonide) to treat or prevent bronchoconstriction as needed and to lower the risk of asthma attacks in individuals with asthma who are 18 years of age or older. Budesonide, a corticosteroid, and albuterol, a beta-2 adrenergic agonist, are combined to form Airsupra. [5] Significant morbidity is linked to untreated asthma. Fast-acting bronchodilators can quickly alleviate the symptoms of asthma, but they don't address the underlying inflammation when used as a rescue medication. As a rescue medication, combining an inhaled corticosteroid, such budesonide, with a short-acting beta2-agonist, like albuterol (salbutamol), in a single inhaler may help manage inflammation and bronchoconstriction while lowering the likelihood of asthma flare-ups. [6]

Albuterol is Chemically written as 4-[2-(tert-butylamino)-1-hydroxyethyl]-2-(hydroxymethyl) phenol[7] and Budesonide (1S,2S,4R,8S,9S,11S,12S,13R)-11-hydroxy-8-(2-hydroxyacetyl)-9,13-dimethyl-6-propyl-5,7-dioxapentacyclo [10.8.0.0^{2,9}.0^{4,8}.0^{13,18}] icosa-14,17-dien-16-one. [8]

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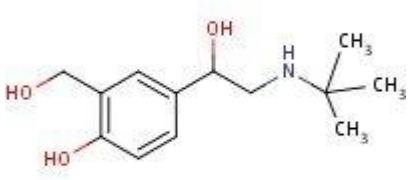


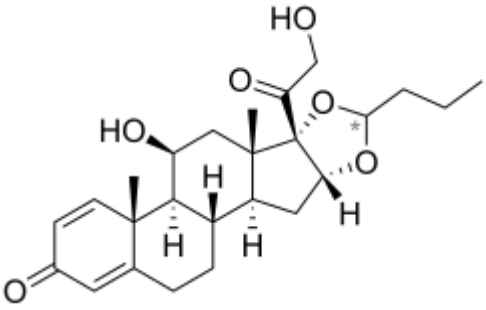


Figure 1: structure of Budesonide **Figure 2: Structure of Albuterol**

Extensive literature research has unearthed a multitude of recorded analytical procedures, including the discovery of more economically efficient ways. Nevertheless, there is currently no documented approach for calculating stability studies. Hence, a reliable and cost-effective approach is suggested for assessing the stability of Budesonide, Albuterol, and their medicinal dose form using RP-HPLC.[9-11] must be validated and developed as per ICH guidelines

Materials and Methods: Spectrum pharma Research Solution provide with Budesonide and Albuterol pure drugs (API) gift samples and Combination Budesonide and Albuterol tablets (Airsupra) received from local market. The chemicals and buffers utilized in this estimation were obtained from Rankem, an Indian supplier.

Instrumentation: The development and method validation were conducted using a WATERS HPLC, specifically the model 2695 SYSTEM, equipped with a Photo diode array detector. The system also included an automated sample injector and the Empower 2 software.

Objective: In order to fulfill ICH standards, we need to design and test an HPLC technique that can detect Albuterol and Budesonide in pharmaceutical formulations at the same time.

Table 1: Chromatographic Conditions

Mobile phase	0.1% OPA and Acetonitrile (45:55 v/v)
Flow rate	1 ml/min
Column	Kromosil C18 (4.6 x 150mm, 5µm)
Detector wave length	244 nm
Column temperature	30°C
Injection volume	10mL
Run time	4.0 min
Buffer	Ortho-phosphoric acid

Preparation of Standard stock solutions: Accurately weighed 2 mg of Budesonide, 2.25 mg of Albuterol and transferred to 50 ml volumetric flask separately. 3/4 th of diluents was added to both flasks and sonicated for 10 minutes. Flasks were made up with diluents and labeled as Standard stock solution 1 and 2. (40µg/ml of Budesonide and 45µg/ml of Albuterol).then from it 1 ml of stock sol was spiked and was add in a 10 ml vf and made up till mark with diluent. (4µg/ml Budesonide and 4.5µg/ml of Albuterol).

Preparation of Sample stock solutions: The contents of inhalation aerosol delivered by 2 actuations (90mcg of Albuterol and 80µg of budesonide each) were collected in 10 ml volumetric flask. Then 8ml diluent was added, sonicated for 25 min and made up to mark. Then the sample was filtered using 0.45 µm filters using (Millipore, Milford, PVDF) (16µg/ml Budesonide and 18µg/ml of Albuterol). from it 2.5 ml of stock sol was spiked and was add in a 10 ml vf and made up till mark with diluent. (16µg/ml Budesonide and 18µg/ml of Albuterol).

System suitability parameters: Budesonide (4 ppm) and Albuterol (4.5 ppm) standard solutions were prepared, injected six times, and metrics such as peak tailing, resolution, and USP plate count were measured in order to evaluate the system suitability parameters. The region of six standard injection results should have an RSD of no more than 2%.

Specificity: Checking of the interference in the optimized method. We should not find interfering peaks in blank and placebo at retention times of these drugs in this method. So, this method was said to be specific.

Table 2: System suitability results

S.no	Budesonide			Albuterol			
Inj	RT (min)	USP Plate Count	Tailing	RT (min)	USP Plate Count	Tailing	Resolution
1	2.478	7284	1.37	3.312	8801	1.26	6.3
2	2.481	7360	1.33	3.315	8801	1.32	6.2
3	2.481	7177	1.34	3.315	8014	1.28	6.2
4	2.482	6944	1.34	3.315	8459	1.27	6.2
5	2.483	7837	1.32	3.317	8035	1.28	6.2
6	2.483	7465	1.34	3.317	8014	1.29	6.2

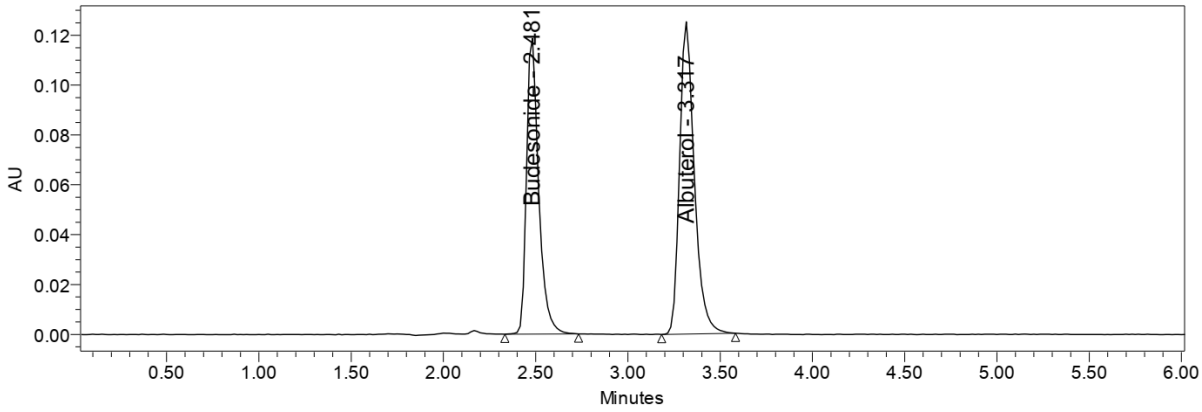


Figure 3: system suitability Chromatogram

Table 3: Specificity data

Sample name	Retention time	Area	Plate count	Tailing	Resolution
Budesonide	2.473	567209	7611.2	1.3	
Albuterol	3.316	642005	8642.2	1.2	6.6

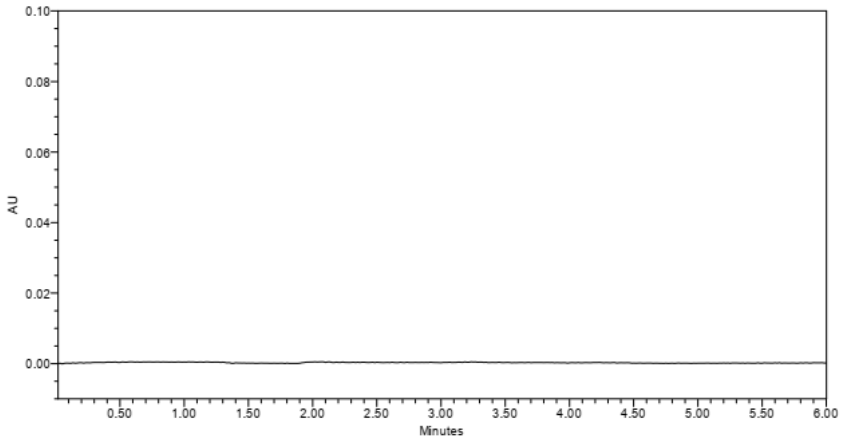


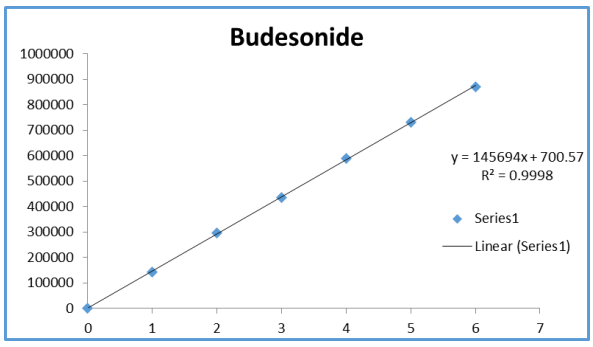
Figure.4 Specificity of Budesonide and Albuterol

Linearity:

Calibration data is given in table 4 and regression data in table 5 and calibration curve in figure 6, 7

Table 4: Calibration data of Budesonide and Albuterol

Budesonide		Albuterol	
Conc (µg/mL)	**Peak area**	**Conc(µg/mL)**	**Peak area**
0	0	0	0
1	142510	1.125	165579
2	296026	2.25	333698
3	435470	3.375	490960
4	589984	4.5	665822
5	730968	5.625	831965
6	869518	6.75	984979



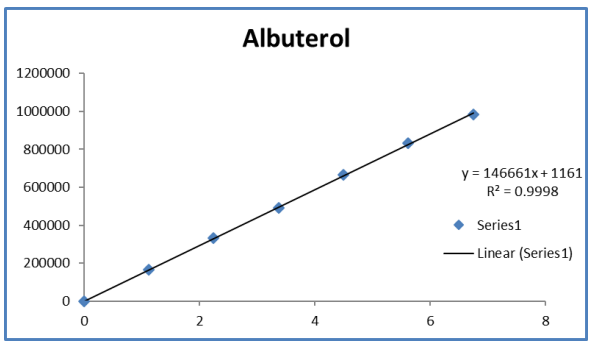


Figure 6 Calibration curve of Budesonide

Figure 7 Calibration curve of Albuterol

Table 5: regression data

Parameter	Budesonide	Albuterol
Conc range (µg/mL)	1-6 µg/ml	1.125 – 6.75 µg/ml
Regression Equation	y = 145694x + 700.57	y = 146661x + 1161
Co-relation	0.999	0.999

Accuracy:

Recovery data shown in table 6

Table 6: recovery data of Budesonide and Albuterol

	Budesonide			Albuterol		
% Level	**Amount Spiked (µg/mL)**	**Amount recovered (µg/mL)**	**% Recovery**	**Amount Spiked (µg/mL)**	**Amount recovered (µg/mL)**	**% Recovery**
50%	2	1.99	99.58	2.25	2.23	99.20
	2	1.99	99.45	2.25	2.24	99.52
	2	1.99	99.75	2.25	2.23	99.23
100%	4	3.99	99.66	4.5	4.48	99.45
	4	3.98	99.48	4.5	4.51	100.29
	4	4.00	100.00	4.5	4.48	99.55
150%	6	5.98	99.69	6.75	6.70	99.25
	6	5.99	99.84	6.75	6.72	99.51
	6	6.01	100.11	6.75	6.70	99.33
% recovery	**99.73**			**99.48**		

System precision was performed and the data was shown in table 8

Table 7: System precision of Budesonide and Albuterol

S. No	Area of Budesonide	Area of Albuterol
1.	588606	664676
2.	588778	668527
3.	590302	667158
4.	596310	665226
5.	597179	668544
6.	596745	665979
Mean	592987	666685
S.D	4167.9	1657.5
%RSD	0.7	0.2

The % RSD for the peak areas of Budesonide and Albuterol obtained from six replicate injections of standard solution was within the limit.

Method Precision: The precision of the method was determined by analyzing a sample of Budesonide and Albuterol and shown in table 8.

Table 8: method Precision

S. No	Area of Budesonide	Area of Albuterol
1.	587400	665316
2.	592185	668299
3.	589095	666025
4.	593411	664928
5.	595456	667312
6.	593487	664684
Mean	591839	666094
S.D	3020.7	1435.5
%RSD	0.5	0.2

From the above results, the % RSD of method precision study was within the limit for Budesonide and Albuterol.

Robustness: Robustness conditions like Flow minus (0.9ml/min), Flow plus (1.0ml/min), mobile phase minus (40B:60A), mobile phase plus (50B:50A), temperature minus (27°C) and temperature plus(33°C) was maintained and samples were injected in duplicate manner. System suitability parameters were not much affected and all the parameters were passed. %RSD was within the limit.

Table 9: Robustness data for Budesonide and Albuterol.

Condition	%RSD of Budesonide	%RSD of Albuterol
Flow rate (-) 0.9ml/min	0.3	0.1
Flow rate (+) 1.0ml/min	0.1	0.9
Mobile phase (-) 60B:40A	0.2	0.6
Mobile phase (+) 50B:50A	0.6	0.3
Temperature (-) 27°C	0.3	0.2
Temperature (+) 33°C	0.4	0.4

Sensitivity:

Table 10: sensitivity of Budesonide and Albuterol

Molecule	LOD	LOQ
Budesonide	0.011 µg/ml	0.035 µg/ml
Albuterol	0.01 µg/ml	0.3 µg/ml

Force Degradation Studies: table 11 shows degradation conditions and table 10 shows the obtained degraded data and purity plot chromatogram in figure 8, 9.

Table 11: degradation conditions

Stress condition	Solvent	Temp(^{0}C)	Exposed time
Acid	2N HCL	60^0c	30 mins
Base	2N NAOH	60^0c	30 mins
Oxdation	20% H_2O_2	60^0c	30 mins
Thermal	Diluent	105^0c	6 hours
Photolytic	Diluent	-	-
Hydrolytic	Water	60^0c	

Table 12: degradation data

Type of degradation	Budesonide			Albuterol		
	area	%recovered	% degraded	area	%recovered	% degraded
Acid	556786	93.71	6.29	626015	93.71	6.29
Base	558911	94.07	5.93	633698	94.86	5.14
Peroxide	564344	94.98	5.02	638963	95.65	4.35
Thermal	573053	96.45	3.55	645868	96.68	3.32
Uv	581592	97.88	2.12	648405	97.06	2.94
Water	592131	99.66	0.34	663944	99.39	0.61

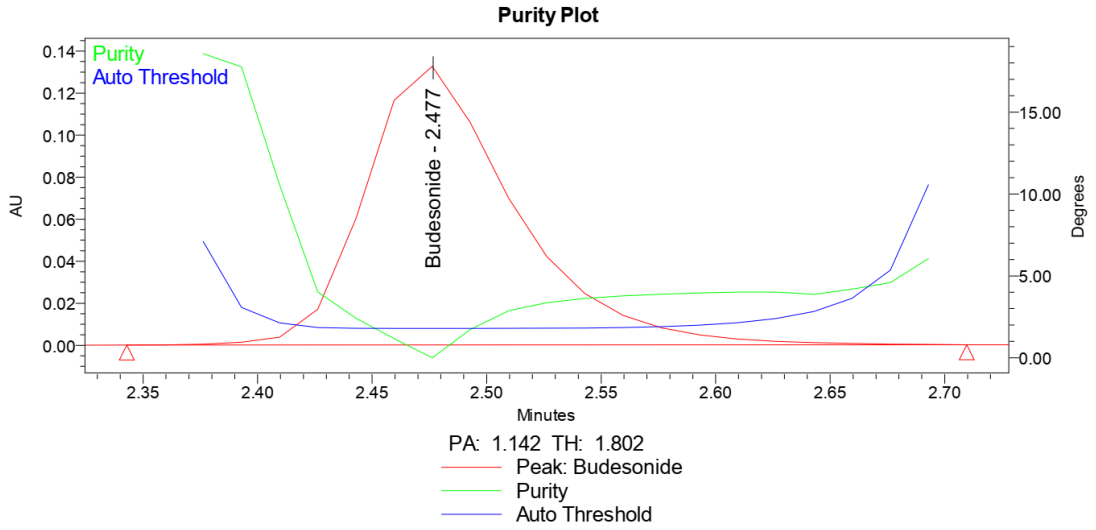


Figure 8: Purity plots for Acid Condition for Budesonide

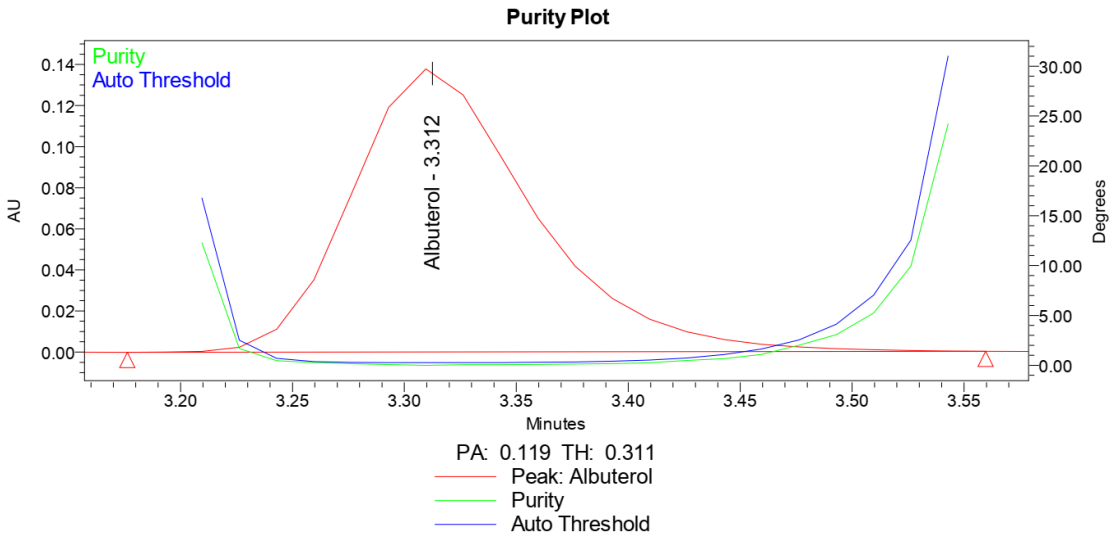


Figure 9: Purity plots for Acid Condition for Albuterol

Assay: Airsupra inhaler, bearing the label claim Budesonide 90mcg, Albuterol 8mcg. Assay was performed with the above formulation. Average % Assay for Budesonide and Albuterol obtained was 99.61% and 99.71% respectively.

Table 13: assay data

	Budesonide			Albuterol		
S.no	**Std Area**	**Sample area**	**% Assay**	**Std Area**	**Sample area**	**% Assay**
1	588606	587400	**98.86**	664676	665316	**99.60**
2	588778	592185	**99.67**	668527	668299	**100.04**
3	590302	589095	**99.15**	667158	666025	**99.70**
4	596310	593411	**99.87**	665226	664928	**99.54**
5	597179	595456	**100.22**	668544	667312	**99.89**
6	596745	593487	**99.88**	665979	664684	**99.50**
Avg	592987	591839	**99.61**	666685	666094	**99.71**
Stdev	4167.9	3020.7	**0.51**	1657.5	1435.5	**0.2**
%RSD	0.7	0.5	**0.51**	0.2	0.2	**0.2**

Assay was calculated by the formula:

$$\% \text{ Assay} = \frac{AT}{AS} \times \frac{WS}{100} \times \frac{1}{10} \times \frac{100}{1} \times \frac{10}{1} \times \frac{P}{100} \times \frac{FV}{L.C} \times 100$$

AT	Average Peak area of sample in test solution
AS	Mean peak area of sample in standard solution
WS	Weight of drug working standard taken in mg
P	Assay of drug working standard in % on dried basis
L.C	Label Claim

Figure 10 formula

CONCLUSION:

The study's results will help a lot with checking the quality of affordable medications that contain Budesonide and Albuterol. This might be because the study used a simple way to prepare the samples, which only needed a short analysis time and a small amount of mobile phase. After testing two medicines together in a single dose, the data showed that the newly developed analysis method was very close to being 100% effective.

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REFERENCES:

1. WHO: Asthama
2. Garbo Mak, Nicola A Hanania, New bronchodilators, Current Opinion in Pharmacology, Volume 12, Issue 3, June 2012, Pages 238-245.
3. Maria Gabriella Matera, Clive P. Page, Mario Cazzola, Novel bronchodilators for the treatment of chronic obstructive pulmonary disease, Trends in Pharmacological Sciences, Volume 32, Issue 8, August 2011, Pages 495-506.
4. Cleveland Clinic: Bronchodilator
5. FDA approves drug combination treatment for adults with asthma
6. Bradley E Chipps, Frank C Albers, Laurence Reilly, Eva Johnsson, Christy Cappelletti, Alberto Papi, Efficacy and safety of as-needed albuterol/budesonide versus albuterol in adults and children aged ≥4 years with moderate-to-severe asthma: rationale and design of the randomised, double-blind, active-controlled MANDALA study, BMJ open Respiratory research, Volume 8, Issue 1, 2021.
7. https://go.drugbank.com/drugs/DB01001
8. https://go.drugbank.com/drugs/DB01222
9. Fadi L Alkhateeb, Ian Wilson, Margaret Maziarz, Paul Rainville, Ultra high-performance liquid chromatography method development for separation of formoterol, budesonide, and related substances using an analytical quality by design approach, J Pharm Biomed Anal, 2021 Jan 30:193:113729. doi: 10.1016/j.jpba.2020.113729. Epub 2020 Oct 29.

10. Satyajit V. Erram, Cindy B. Fanska, Muhammad Asif, Determination of albuterol sulfate and its related substances in albuterol sulfate inhalation solution, 0.5% by RP-HPLC, Journal of Pharmaceutical and Biomedical Analysis, Volume 40, Issue 4, 3 March 2006, Pages 864-874.
11. J Varshosaz, J Emami, N Tavakoli, M Minaiyan, N Rahmani, F Ahmadi, F Dorkoosh, Development and validation of a rapid HPLC method for simultaneous analysis of budesonide and its novel synthesized hemiesters in colon specific formulations, Res Pharm Sci. 2011 Jul-Dec;6(2):107–116.