

### **Fabrication, Formulation and Evaluation of Doxofylline Sustained-Release Tablets**

#### **ABSTRACT**

**Aim-** The present investigation was done for the purpose to fabricate, manufacturing, and evaluating Doxofylline sustained action tablets by using different concentrations of Chitosan and Guar Gum.

**Place and Duration of Study-** This work is done in Post graduate laboratory of SND College of Pharmacy, Yeola, Dist Nashik, Maharashtra, India.

**Method-** Factorial design was used to prepare Doxofylline sustained-release tablet. Doxofylline sustained-release tablets were prepared employing different concentrations of Chitosan, Guar Gum, Lactose, and Magnesium Stearate in different combinations by direct compression technique. Total 9 formulations were designed, formulated and evaluated for the hardness, thickness, friability, % drug content and *in-vitro* drug release.

**Results-** A study of the release of drug by *in-vitro* found that F8 is found to be best efficient formulation which consisting of both Chitosan and Guar Gum, delayed the release of drug up to 24 hours and performs excellent release of drug in starting hours of drug release in the body. The drug released from F8 formulation indicates the kinetic model of First Order, by anomalous diffusion. Different studies of stability were performed based on ICH guidelines. The formulation F8 at 40°C±2 /75 % ±5 RH shows no major change relegated to assay and drug release pattern which indicate stable prepared formulation.

**Conclusion-** This study conclude that by using natural polymer better drug release is observed in above study. Doxofylline in combination with chitosan and guar gum shows good release and better dissolution rate as compare with single polymer. This formulation has better scope in future for further release studies.

**Keywords:** Chitosan; Doxofylline; Guar gum; HPLC; Sustained-release

## 1. INTRODUCTION

Most of the traditional oral measurement structures like tablets and capsules are detailed to deliver the dynamic medication following oral organization, to get quick and complete foundational drug assimilation. Such prompt delivery items bring about moderately fast medication retention and beginning of going with pharmacodynamics impacts. In any case, after retention of the medication from the structure of the measurement is finished, plasma drug fixations decrease as per the medication's pharmacokinetic profile [1]. At long last, plasma drug fixations fall underneath **the base successful plasma focus**, bringing about loss of remedial movement. Before this point is reached, another portion is normally given if a supported restorative impact is wanted. An option in contrast to overseeing another portion is to utilize a dosing structure that will give supported medication discharge, and accordingly keep up plasma drug fixations, past the thing is regularly seen utilizing quick delivery measurement structures. As of late, different adjusted delivery drug items were created for controlling the delivery pace of medication, additionally, become ideal opportunity to drug discharge. An adjusted delivery is characterized to person for which the medication discharge qualities of time course and additionally area is picked to achieve helpful or comfort targets not offered by customary dose structures like balms, or fast-dissolving dose forms [2] [7].

### **Sustained-release drug delivery**

Sustained-release drug delivery can show predetermine release by maintaining sustained medication activity at a specified rate while minimizing undesired side effects by keeping a reasonably same, efficacy level of drug in the body [6] [8]. Local effect of the drug-related to diseased tissue by keeping the controlled release system in space. Different carriers and particles are used to transfer the drug to the target organ. Many oldest dosage forms namely suspension, emulsion, tablet capsule, and suppositories, etc. have a few drawbacks, like drug having a short half-life need repeated drug administration, which increases the like hood of skipping a dose of a drug resulting in fewer patient compliance [5] [9]. Drug's steady-state level cannot be maintained in the body because of peak-valley due to absorption and elimination of the drug from the body and this would lead to underdose or overdose, as uniform drug amount increases or decrease above the range of therapeutic. When an overdose occurs, changing drug levels may precipitate undesirable consequences, especially if the substance has a small therapeutic index [3].

### **Merits of Sustained-release Dosage Form**

Sustained-release dosage form gives a long-term therapeutic effect by continuously releasing the drug. It reduces frequent dosing of drugs and gives **prolong the action** [11]. It provides patient compliance. It does not require any special storage conditions and handling precautions. Drugs having nauseous taste and smell can be given by the above formulation. It reduces local side effects by reducing the total amount of drugs. The more stable dosage form as compared to others [4].

### **Types of Sustained Action Systems**

#### **A) Diffusion Controlled System**

**I. Reservoir Storage System:** The inner raw part of the drug is covered by polymer material. Drug release is dependent upon the nature of the membrane. It is possible to release the drug by Zero Order by this system. Those molecules which have high molecular weight have low delivery by using this type of device.

**II. Matrix Devices:** This consists of an appropriate combination of a drug molecule with a polymer matrix. Those compounds having high molecular weight can be easily delivered by this device.

#### **B) Dissolution Controlled Release System**

**I. Matrix Release System:** Drugs are surrounded by a slowly dissolving polymer membrane. The drug also got protection from other things.

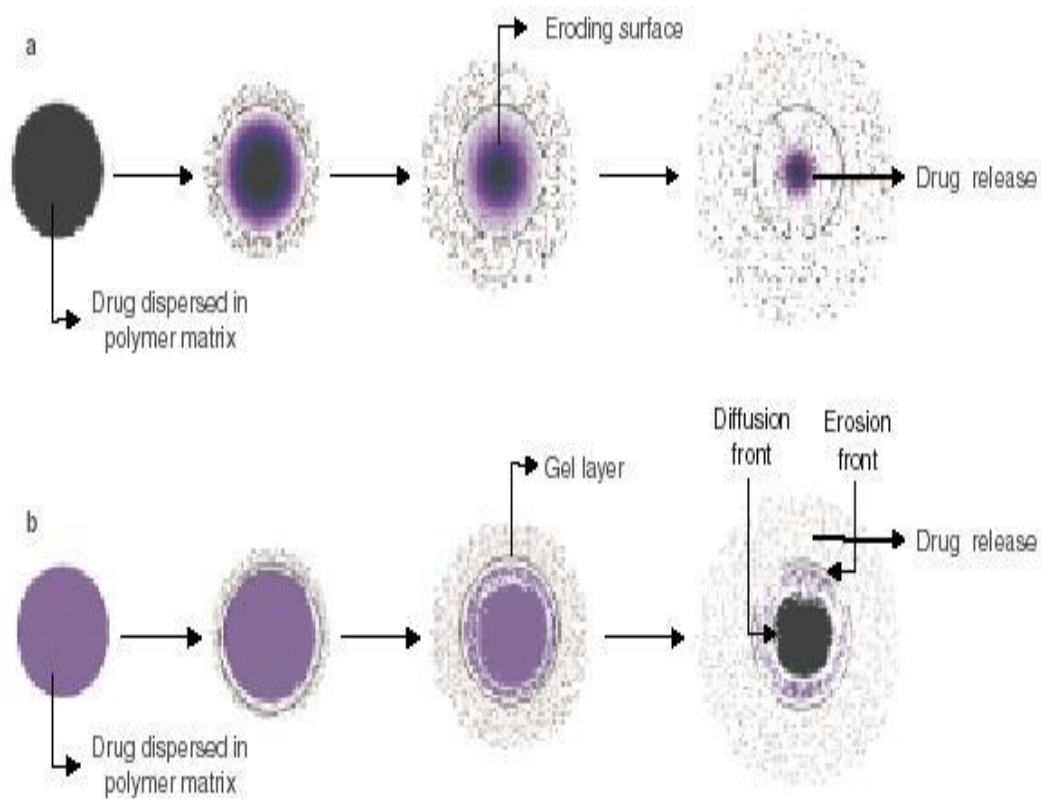
**II. Encapsulation Dissolution Control:** Similar to microencapsulation by coating seeds, granules, and particles.

**C) Diffusion and Dissolution Controlled System:** Used for those drugs which have high doses and low half-life. The drug is uniformly mixed with matrix and release drug either swelling, hydrolysis, or using enzymatic attack. By imbibing mechanism or by addition of hydrogen or by enzyme action [12] [13].

### **Drug Removal Mechanism by Matrix Tablet**

In a biodegradable matrix system, drug release is determined by polymer erosion from the matrix surface; whereas in hydrophilic matrices gel layer is formed and it depends upon time-release functions. The thickness of the layer of gel will determine the diffusion path length of drug molecules. As soon as swelling continues gel becomes thick and it results in slow drug release from polymer; but, because of regular hydration polymer gets disintegrated from the

matrix surface which results in reducing the depilation area and increasing the rate of dissolution in the same system.



*Figure 1.* Hypothetical Diagram shows release of drug from diffusion controlled drug delivery system. In which there is homogenous mixture of polymer matrix (a) and hydrophilic, swellable polymer matrix (b).

### **Kinetics for Drug Release-Suitable Model for Drug release Data**

Once a newer formulation enters the market from the manufacturer, it is mandatory to crosscheck that its dissolution is in a good manner. Different research and development laboratory and industry keep their eyes on drugs dissolution studies. Drug dissolution from the dosage form is studied by the different kinetic models. in which the mixed quantity of drug ( $Q$ ) is a work of test time,  $t$  or  $Q=f(t)$ . Few scientific meanings of the  $Q(t)$  function are rarely used, such as zero order, first order, Hixson–Crowell, Higuchi, Korsmeyer–Peppas models.

### **Zero Order Kinetics**

Drug released in the same amount from any pharmaceutical formulation by the particular slot of time and this one is the best technique for removal of the drug to reach long pharmacological effect, this is elaborated by the given formula-

$$Q_t = Q_0 + K_0t$$

Where  $Q_t$  means the quantity of drug release from the formulation in time  $t$ .

$Q_0$  is starting quantity of drug in a liquid.

$K_0$  is Constant for Zero Order Release.

The drug release values are plotted on a graph in the form of the cumulative amount of release of drug Vs time. Mostly used for many new modified release dosage forms and matrix tablets or patches dosage forms.

### **First Order Kinetics**

Such a type is widely used for the absorption and elimination of many drugs.

$$\text{Log } Q_t = \text{Log } Q_0 + (K_1/2.303)t$$

In the above equation,  $Q_t$  denotes the amount of drug release within time  $t$ ,  $Q_0$  is starting quantity of drug release from formulation,  $K_1$  is the first-order release constant.

The above-obtained data were plotted on a graph as Log cumulative % of drug remaining Vs time which shows a straight line with the slope as  $-K/2.303$ .

This formula is utilized for drug absorption in pharmaceutical dosage form, those containing water-soluble drugs in porous form.

### **Higuchi Model**

Only one model describes the release of drugs from the matrix system. Model **depend** depends on the various hypothesis that the concentration of drug initially is higher than its solubility. Diffusion of the drug takes place in only one direction. Higuchi explains the release of drugs depends upon scientist Fick's First Law square root dependent.

$$F_t = Q = KH/t$$

Where  $KH$  is Higuchi Dissolution constant.

### **Hixson-Crowell model**

Hixson and Crowell (1931) noted that the area of the granular side of particles is proportional to the cubic root of its volume which is derived by the equation described in the following manner.

$$W_0^{1/3} - W_t^{1/3} = Kst$$

### Mechanism of Drug Release

To determine the drug release mechanism resulting from swelling (due to hydration) and gradual matrix erosion, the first 60% of drug release data can be fitted into the Korsmeyer–Peppas model, which is frequently used to describe drug release behavior from polymeric systems when the mechanism is unknown or when multiple types of release phenomena are present.

$$\text{Log} (M_t / M_\infty) = \text{Log} KKP + n \text{Log} t$$

Where,  $M_t$  Quantity of drug release at specific time  $t$ ,  $M_\infty$  quantity of drug removes at the infinite time;  $KKP$  drug release rate constant related to physical and mechanical properties of the tablet, and  $n$  is the release exponent indicative of the mechanism of drug release [10].

Table 1. Drug release Kinetic

Model Name	Relation	System following the Model	Where, $f_t =$ Amount of Drug removed from the system at Time $t$ .
First Order	$\text{Log} Q_t = \text{Log} Q_0 + (K/2.303)t$	Drugs that are soluble in water	KH,
Zero Order	$Q_t = Q_0 - K_0t$	Beneath the Skin system and Osmotic systems	
Higuchi	$F_t = Q = KH/t$	Matrix Formulation	
Hixon- Crowell	$W_0^{1/3} - W_t^{1/3} = Kst$	Erodible isometric matrices	

$K_0$ , and  $K_s$  = constant of the Drug release rate of a particular model

$Q_0$  = Remaining quantity of drug to be released at zero order

$Q_t$  = Quantity of drug remain to release at time  $t$

$W_0$  = Starting Quantity drug present in the matrix;

$W_t$  = Quantity of released at time  $t$

### Advantages of Doxofylline SR over Theophylline SR:

- Sustained bronchodilation for 24 hours including controlling of inflammatory cytokines release.
- More selective inhibition of phosphodiesterase activities than theophylline reduces the affinity with A1 and A2 Adenosine Receptors.
- Long action even prevents nocturnal asthma attacks.

- Devoid of cardiovascular, central nervous, and gastrointestinal side effects.
- Asthma is a chronic disease, once-daily dosing will increase patient's compliance [14].

## 2. MATERIALS AND METHODS

### 2.1 Preparation of PH 6.8 Phosphate Buffer

### 2.2 Formation of the standard graph

### 2.3 Preparation of Doxofylline Coe Tablet

Table 2. Formula for Doxofylline Tablet

Drug with Additives	F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8	F-9
	Mg/Tablet								
Doxofylline	800	800	800	800	800	800	800	800	800
Chitosan	20	20	20	30	30	30	40	40	40
Guar Gum	20	30	40	40	30	20	20	30	40
Lactose	45	35	25	15	25	35	25	15	05
Talc Powder	10	10	10	10	10	10	10	10	10
Magnesium Stearate	5	5	5	5	5	5	5	5	5
Alcohol	Q.S.	Q.S.	Q.S.	Q.S.	Q.S.	Q.S.	Q.S.	Q.S.	Q.S.
Final Weight	900	900	900	900	900	900	900	900	900

### 2.4 Evaluation parameter of material undergo compression

- 2.4.1 Angle of Repose
- 2.4.2 Determination of Bulk Density and Tapped Density
- 2.4.3 Compressibility Index (Carr's Index)
- 2.4.4 Hauser's Ratio

### 2.5 Evaluation parameter of martial undergone compression

- 2.5.1 Weight Variation in Tablet
- 2.5.2 Tablet Thickness
- 2.5.3 Hardness of Tablet
- 2.5.4 Friability of Tablet
- 2.5.5 Content of Active Drug in tablet
- 2.5.6 Drug Release Study (*In-vitro*)
- 2.5.7 Kinetics of Dissolution Data
- 2.5.8 Drug Release Mechanism

## 3. RESULT AND DISCUSSION

### 3.1 Organoleptic Properties

The properties of Doxofylline showed similar results reported in IP. It is concluded that Doxofylline is in a pure state.

Table 3. Observation of Organoleptic Properties of Doxofylline

Identification Test	Reported Standards	Result of Sample Obtained
Appearance	Crystalline Powder	Crystalline Powder
Colour	White Colour Powder	White Colour Powder
Odor	Odorless	Odorless

Table 4. Melting Point

Sr.No.	Parameter	Drug
1	Melting Point (Sample)	144 <sup>0</sup> C – 146 <sup>0</sup> C
2	Melting Point (Reference)	142 <sup>0</sup> C – 146 <sup>0</sup> C

### 3.2 API Characterization

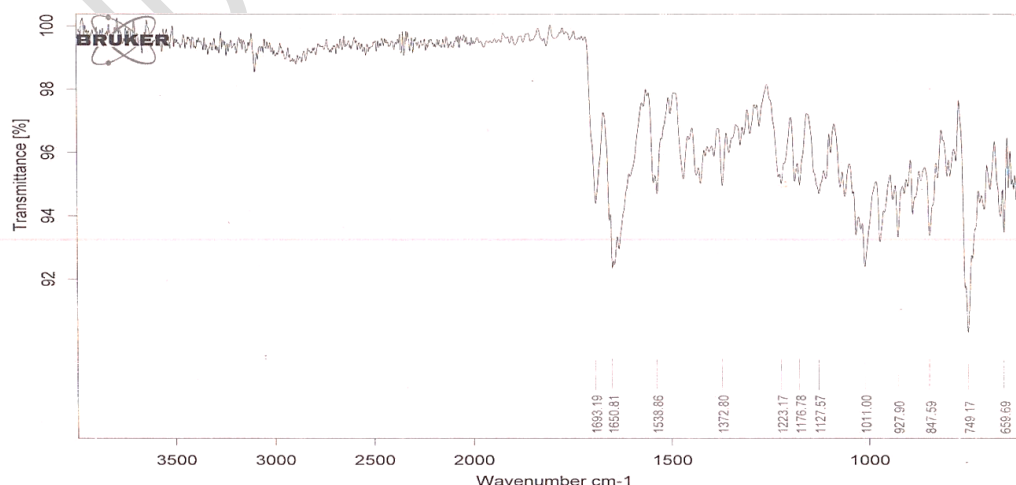
The drug must be tested for various physicochemical tests which are listed in table 5.

Table 5. Physical Properties of Drug

Sr.No.	Parameter	Result
1	Bulk Density	0.562 gm/ml
2	Tapped Density	0.624 gm/ml
3	Compressibility Index	11.03%
4	Hauser's Ratio	1.110
5	Angle of Repose	28 <sup>0</sup>

Drug complies with all specifications based on the above result and concluded that drug has very good flow properties.

### 3.3 Infrared Spectra of Doxofylline



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Figure 2. IR Graph of Drug Doxofylline

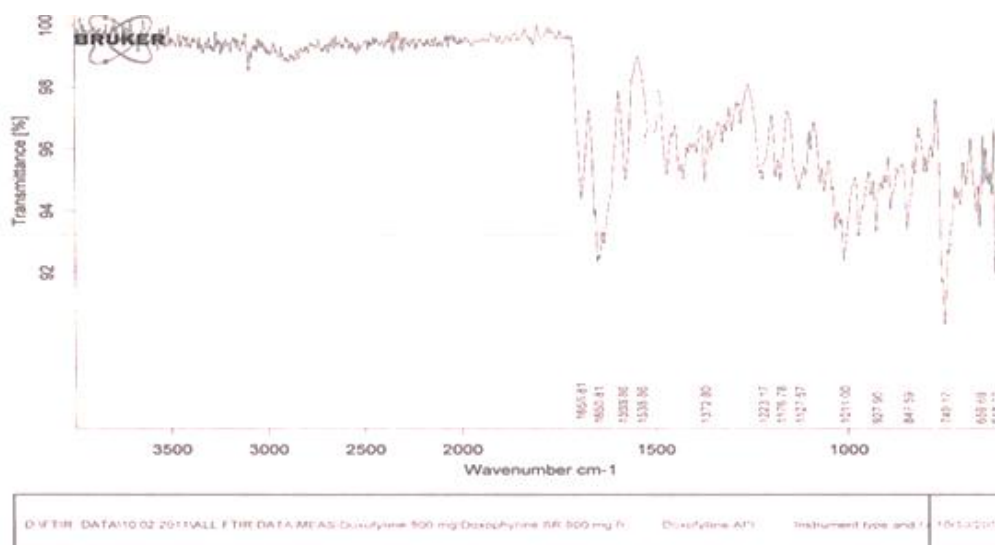


Figure 3. IR Graph of Drug Doxofylline + Polymer

Table 6. Interpretation of IR Bands of Doxofylline

Groups	Std. Freq. (cm <sup>-1</sup> )	Observed Freq. (cm <sup>-1</sup> )
C-H Stretch	3130-3070	3110.10
C-H Stretch	1090-1010	1011.00
C-H Stretch	1700-1690	1693.19
C-H Stretch	1680-1620	1650.81
C-O-C	1140-1070	1127.57

Table 7: Interpretation of IR Bands of Doxofylline + Polymer

Groups	Std. Freq. (cm <sup>-1</sup> )	Observed Freq. (cm <sup>-1</sup> )
C=N Stretch	1500-1600	1595.20
C=C Stretch	1680-1620	1656.10
C-H Stretch	1400-1500	1430.00

### 3.4 Differential Scanning Calorimetry (DSC):

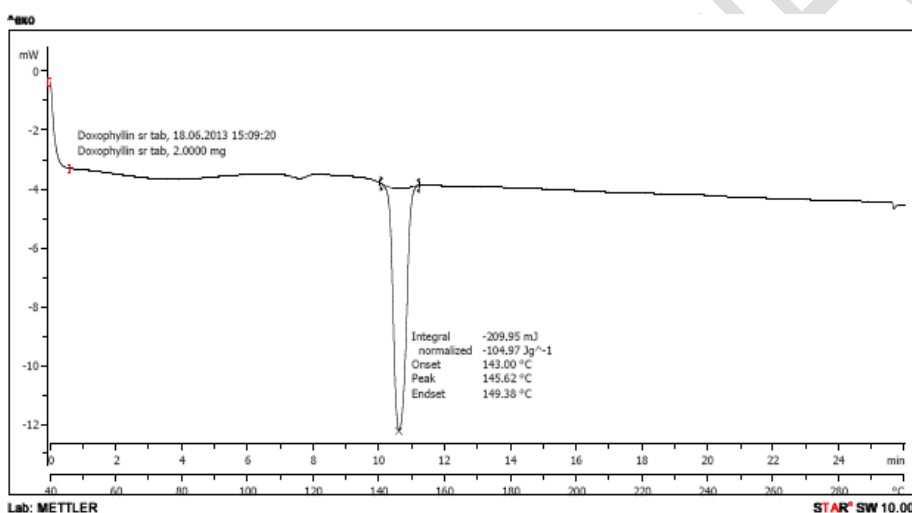
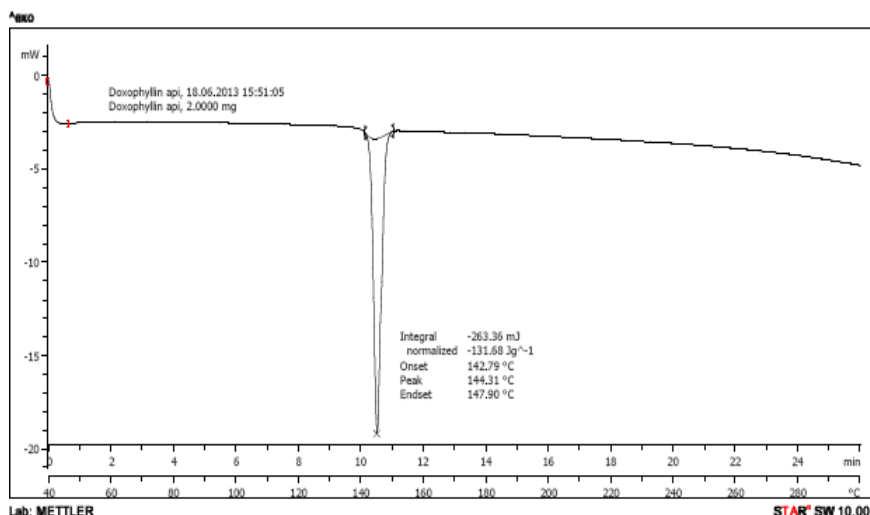


Figure 4. DSC of Physical Mixture

The above graph indicates that DSC data confirmed the API and all other additives are compatible with one another.

### 3.5 Solubility:

Table 8. Solubility Data of Doxofylline

Sr. No.	Water	Drug Dissolved(mg/ml)
1	Water	0.014
2	0.1 N HCL	0.025
3	Phosphate Buffer of PH 6.8	0.018

According to the above results, 0.1N HCL shows more solubility than other media for that 0.1N HCL used further study.

### 3.6 Calibration Curve of API in 0.1N HCL:

Table 9. Drug Absorbance in 0.1 N HCL

Quantity of Drug ( $\mu\text{g/ml}$ )	Absorbance (nm)
9	0.3044
13	0.4767
18	0.6916
22	0.8457
26	0.9791

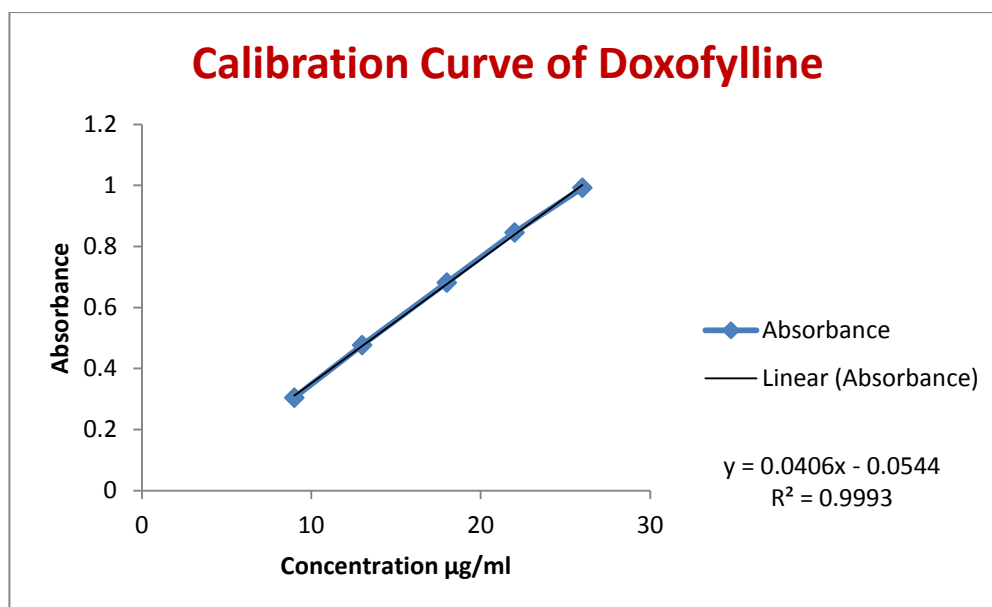


Figure 5. Calibration Curve of Doxofylline by UV

**Observation:**

From the Calibration curve Line Equation is given as

$$Y = 0.04x - 0.044$$

The value of  $R^2$  is 0.999 by obtaining the result it has been concluded that API Obeyed Beer-Lambert's Law.

**UV Spectrum of Doxofylline**

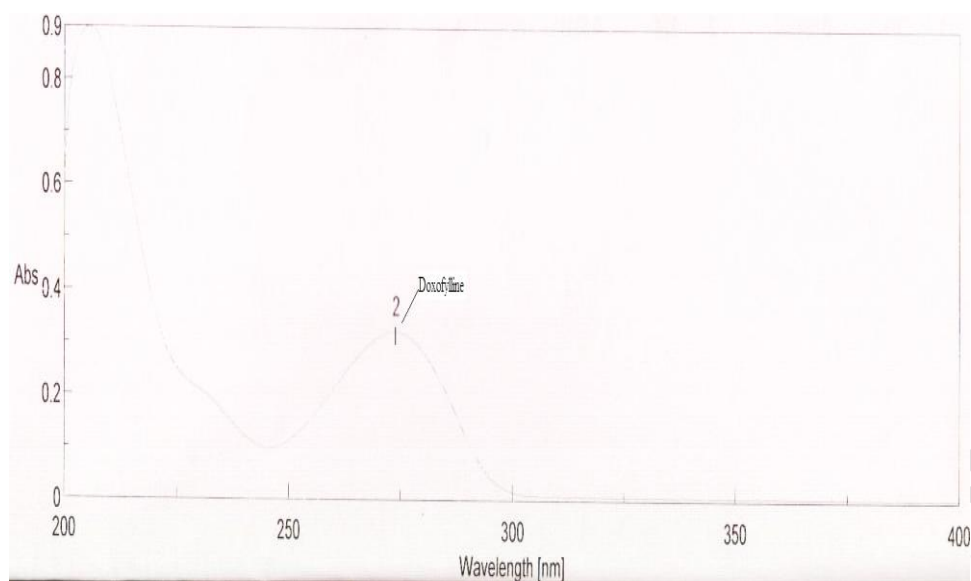


Figure 6. UV Spectra of Doxofylline

Doxofylline spectrum ( $\lambda_{max}$ ) was found at 274 nm.

### 3.7 API Potency calculation:

Assay = 99.13%    LOD: 0.17%

The quantity depends upon 100% w/w assay.

$$\frac{\text{Strength} \times 100 \times 100}{(\text{Assay Depends on Loss in LOD}) \times (100 \% \text{ LOD})} = 805.6 \text{ mg.}$$

$$\frac{800 \times 100 \times 100}{(99.13) \times (100 - 0.17\%)}$$

Dispensing of Doxofylline was done based on potency calculation.

### Analytical method:

As per IP assay on a dried basis was found to be 99.3 %.

### 3.8 Drug-Excipient compatibility study data:

Table 10. Drug Absorbance in 0.1 N HCL

Sr. No.	Physical Admixture	Drug Excipient Ratio	Initial Description	Observation 40°C/75%RH		
				1 <sup>st</sup> Week	2 <sup>nd</sup> Week	4 <sup>th</sup> Week
1	Doxofylline API	Plain API	White	No	No	No
			Powder	Change	Change	Change
2	Doxofylline + Chitosan	1:1	White	No	No	No

3	Doxofylline + Guar Gum	1:1	Powder White	Change No	Change No	Change No
4	Doxofylline + Lactose	1:1	Powder White	Change No	Change No	Change No
5	Doxofylline + Purified Talc	1:1	Powder White	Change No	Change No	Change No
6	Doxofylline + Mg Stearate	1:1	Powder White	Change No	Change No	Change No
7	Doxofylline + Alcohol	1:1	Powder White	Change No	Change No	Change No
			Powder	Change	Change	Change

### 3.9 In-process results:

#### In process Evaluation of in compression blend

Table 11. Evaluation of Blend before Compression

Batch No.	Bulk Density (mg/ml)	Tapped Density (mg/ml)	Compressibility Index (%)	Hauser's Ratio	LOD %
F1	0.495	0.590	19.19	1.191	1.23
F2	0.469	0.533	13.64	1.136	1.04
F3	0.458	0.521	13.75	1.137	0.97
F4	0.468	0.545	16.45	1.164	1.16
F5	0.464	0.527	13.57	1.135	0.81
F6	0.576	0.679	17.40	1.178	----
F7	0.558	0.681	22.04	1.223	----
F8	0.632	0.790	25.00	1.250	----
F9	0.561	0.676	20.49	1.204	----

All the above values are means  $\pm$  SD (n=3)

Above all formulation shows good flow properties.

#### In-process Evaluation of Tablet

##### IPQC Test

Table 12. In Process Evaluation of Tablet

Batch No.	Average Weight(mg) (n= 10)	Thickness (mm) (n= 5)	Hardness (N) (n= 5)	Friability (%)
F1	899 $\pm$ 2.05	5.28 $\pm$ 0.008	186 $\pm$ 1.34	0.240

F2	901±2.83	5.29±0.114	195±1.22	0.177
F3	898±2.31	5.28±0.013	177±1.87	0.119
F4	899±2.95	5.30±0.011	197±1.30	0.175
F5	897±2.22	5.28±0.013	189±1.51	0.118
F6	1046±2.60	6.00±0.013	293±1.64	0.329
F7	1045±2.53	6.05±0.012	298±1.30	0.468
F8	1048±1.59	6.01±0.016	289±1.30	0.400
F9	1046±2.37	6.04±0.023	296±1.87	0.334

All the above values are means ± SD (n=3)

Above all batches has passed all parameters like thickness, Variation in weight, Hardness of Tablet, Friability shows it within the limit.

### 3.10 Dissolution Results of Formulations:

Table 13. Comparative Dissolution Profile for F1-F9 Formulation

Formula Code	% Drug Release ( In Hours )									
	Percent drug release at the time (hrs)									
	1	2	4	6	8	10	12	16	18	24
F1	8.47 ±0.25	15.14 ±0.21	22.92 ±1.32	33.12 ±2.26	47.82 ±2.78	53.42 ±2.96	61.15 ±4.61	73.21 ±1.02	84.70 ±2.78	91.60 ±2.3
F2	8.80 ±1.56	15.24 ±1.50	20.85 ±2.04	34.24 ±1.63	40.70 ±4.3	53.88 ±1.74	66.79 ±2.93	75.08 ±2.20	84.26 ±4.30	90.50 ±2.20
F3	9.34 ±3.02	21.34 ±3.02	30.54 ±1.06	48.07 ±3.05	57.30 ±3.05	64.88 ±2.40	70.35 ±2.03	78.97 ±2.0	86.36 ±3.05	95.38 ±2.01
F4	9.56 ±2.94	19.01 ±2.42	23.74 ±1.00	29.57 ±2.03	39.11 ±1.00	48.19 ±1.92	53.84 ±1.09	61.10 ±1.2	78.04 ±1.00	94.16 ±2.20
F5	9.08 ±4.01	18.84 ±4.01	28.78 ±3.29	34.40 ±3.45	40.54 ±1.13	51.36 ±1.8	70.70 ±2.93	74.09 ±2.322	84.26 ±2.30	97.48 ±2.30
F6	8.16 ±1.98	15.62 ±1.98	19.60 ±2.92	24.26 ±0.94	33.10 ±1.3	45.03 ±3.00	65.23 ±3.01	72.83 ±1.20	83.91 ±1.30	98.08 ±1.31
F7	9.02 ±1.34	14.21 ±1.21	20.89 ±2.34	28.91 ±3.20	34.16 8±1.2	48.88 ±2.35	57.93 ±1.13	71.93 ±2.10	78.60 ±1.20	98.93 ±1.10
F8	09.00 ±2.12	13.55 ±2.03	20.90 2.20	24.75 ±2.21	36.66 ±3.23	45.42 ±1.13	54.17 ±2.10	69.93 ±2.500	76.93 ±3.24	99.35 ±2.15
F9	9.24 ±2.32	16.38 ±2.20	21.60 ±2.12	26.3 ±1.26	35.83 ±1.40	46.18 ±2.23	56.33 ±3.21	72.48 ±1.6	81.64 ±1.41	98.87 ±3.20

All the above values are means  $\pm$  SD (n=3)

**Drug Release for F1- F9 Formulation**

UNDER PEER REVIEW

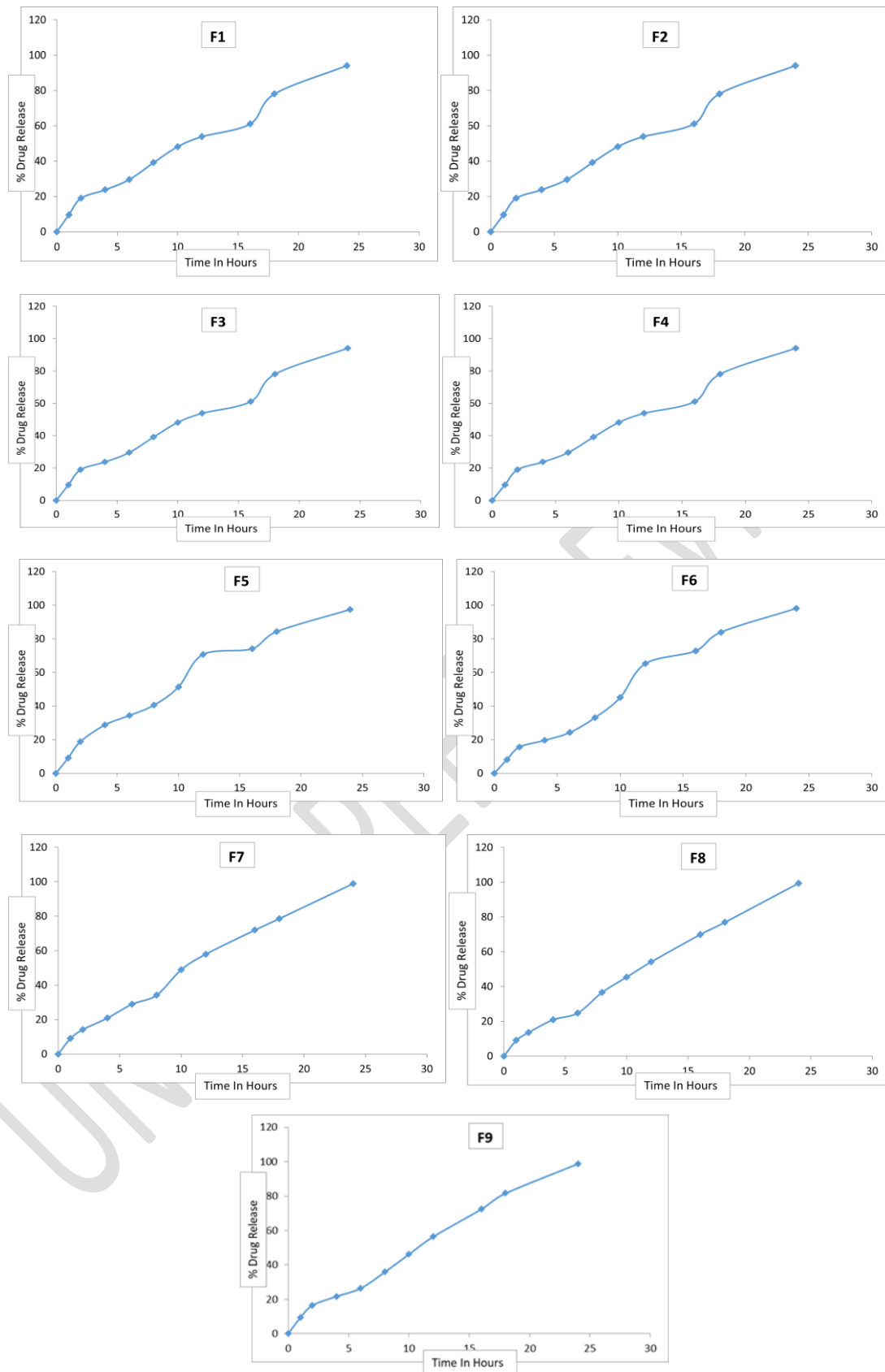


Figure 7. % Drug Release for F1- F9 Formulation

### Drug Release Kinetics

Data received by studying drug release, above parameters were followed zero-order, first-order, Higuchi, Koser Mayer's for the establishment of the release of drug mechanism and Drug release Kinetic of prepared tablet formulation. A regression coefficient ( $r^2$ ) indicated the proper model for the formulation and is the important criteria for the selection of the model.

To find the drug release mechanism above data is analyzed by Zero Order Kinetic, First Order Kinetic, Higuchi's, and Korsmeyer equations.

Table 14. Dissolution model for F1- F9 Formulation for  $R^2$  Value

Sr. No.	Zero Order Model	First – Order Model	Higuchi Model	Kosmeyer Model Papa's Model	Hixon and Crowel Model
1	0.9727	0.9616	0.9688	0.7836	0.9931
2	0.9528	0.9779	0.9578	0.7836	0.9854
3	0.9196	0.9756	0.9844	0.7836	0.9934
4	0.9821	0.8756	0.9525	0.7836	0.9481
5	0.9661	0.8900	0.9660	0.7836	0.9699
6	0.9769	0.8234	0.9185	0.7836	0.9407
7	0.9920	0.7717	0.9424	0.7836	0.9207
8	0.9960	0.7203	0.9341	0.7836	0.8915
9	0.9922	0.7736	0.9332	0.7836	0.9190

The most suitable and fitted model was found to be Zero Order Kinetic Model.

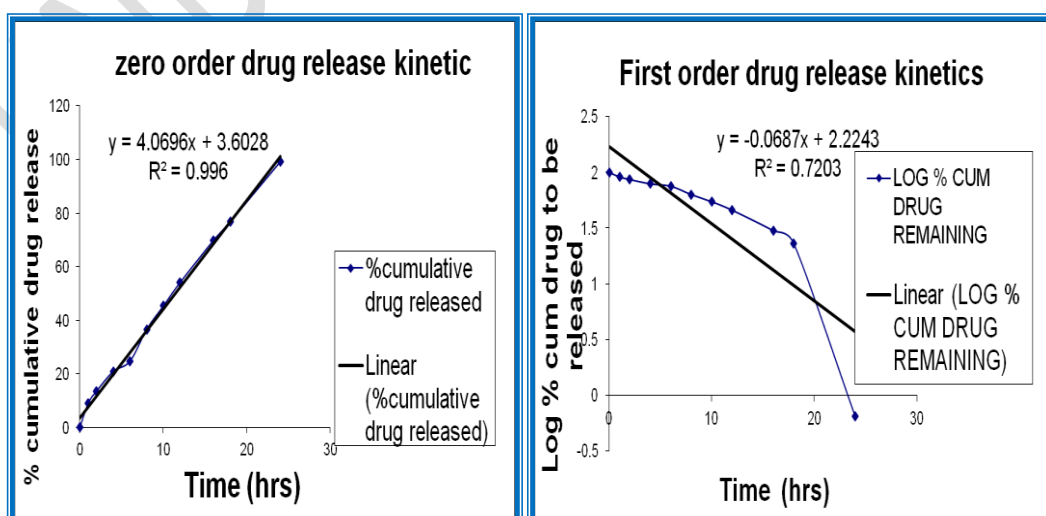


Fig 8

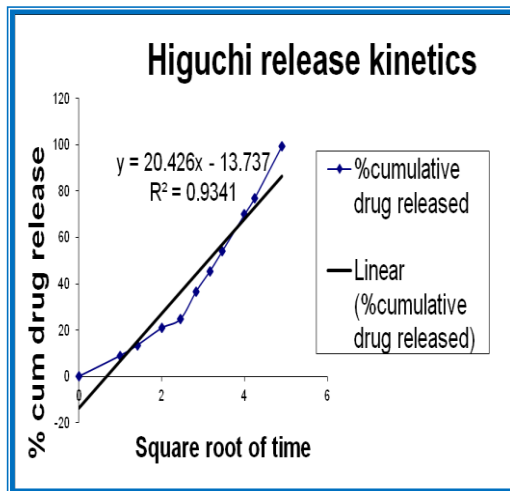


Fig 9

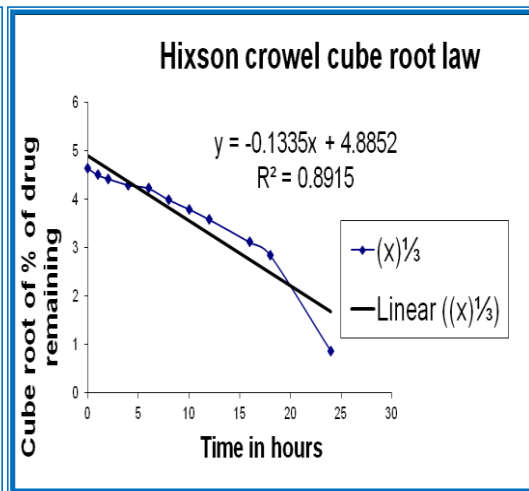


Fig 10

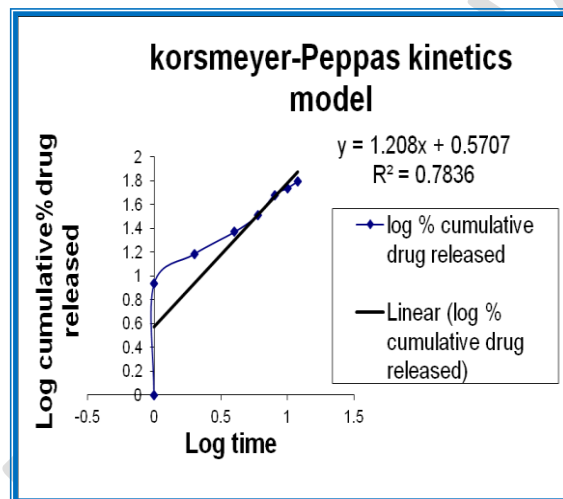


Fig 11

Fig 12

#### 4. CONCLUSION

In this way, Doxofylline sustained-release tablets were prepared and developed, by using different combinations of natural polymers like Chitosan and Guar Gum (release retarding polymers). Doxofylline is broadly utilized in the treatment of patients suffering from COPD (Chronic Obstructive Pulmonary Disease). Sustained-release tablets of Doxofylline are rarely available in the market hence we have selected the drug for formulation. The tablet containing Doxofylline were prepared by wet granulation technique. From the physical evaluation, FTIR, in which stretching vibrations are observed, C=C at 1650  $\text{cm}^{-1}$ , C-O-C at 1127  $\text{cm}^{-1}$ , C-N at 1011  $\text{cm}^{-1}$ , UV shows spectrum ( $\lambda_{\text{max}}$ ) at 274 nm, and DSC studies show

Sharp Peak at 1440c, hence the identified drug is Doxofylline. By studying stability, and DSC study we observed that API and additives are compatible with each other. There should not be any interaction between API and additives. We observed the melting point of the above formulation in the range of 144<sup>0</sup>C to 148<sup>0</sup>C. Tablets were prepared by using chitosan and guar gum as natural polymer using the wet granulation method of tablet manufacturing. We have also added lactose as diluents, alcohol as a binding solution and talc as a lubricant, and magnesium stearate as a glidant. Prepared tablets were evaluated using parameters such as physicochemical parameters like Hardness of the tablet, friability, average weight of the tablet, the thickness of tablet, and drug content, all these indicate that prepared tablets were physically and mechanically stable **also comply all the necessary parameters as per pharmacopeia.** From the dissolution studies formulation, No F8 showed 99% drug release that complies with IP. The stability testing of formulation No F8 at 40°C±2 /75 % ±5 RH revealed no specific changes related to assay and release of drug pattern which indicates the stability of the prepared formulation. Used polymers Guar Gum and Chitosan **show** good release as that of synthetic polymer. At last, it has been concluded that the method used for manufacturing of above formulation meets all the stated specifications as well as quality parameters. This technique will produce reproducibility and robustness in the prepared formulation.

## **5. FUTURE SCOPE**

The above research work has several scopes in the future for developing new drug formulations and study of different natural polymers as we have used in the above project. Also, different methods were used for formulation instead of wet granulation. There are different ways to treat chronic pulmonary obstructive disease and asthma **therefore various formulations are also made in the future for the betterment and curing of this disease.**

Certain future scopes like bioequivalence study of various formulations, manufacture and develop new techniques for release pattern of the drug by using a combination of polymers and advanced new drug delivery can be used for the above project.

## **CONSENT**

It is not applicable.

## **ETHICAL APPROVAL**

It is not applicable.

### **STUDY SIGNIFICANCE**

The study highlights the release of the drug more slowly into the bloodstream due to use of polymers, which provides the ability to maintain a constant level of medicament in the body.

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### **COMPETING INTERESTS DISCLAIMER:**

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the

advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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