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EFFECT OF SINTERING CONDITION ON PHYSIO-CHEMICAL PARAMETERS AND DRUG RELEASE CHARACTERISTICS FROM POLYMERIC MATRIX TABLET OF ATENOLOL FOR CONTROLLED RELEASE

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Keywords:

Sintering Technique, Controlled drug release, Matrix Tablet, Atenolol, Eudragit RS 100

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ABSTRACT: Sintering technique, a relatively new, convenient, economic process for making polymeric matrices for controlled release is described here. The objective of the present investigation was to prepare thermally sintered matrix tablets of Atenolol using Eudragit RS 100 as sintering polymer and to study the effect of thermal treatment on drug release; physiochemical properties of the prepared tablets. The tablets are prepared by direct compression method. The compressed fluffy matrices were subjected to thermal treatment at three different constant temperatures like 60 °C, 70°C and 80°C for two different periods like 1.5 hr and 3 hr in hot air oven. The sintering condition markedly affected the drug release characteristics of prepared matrix tablets. Drug release rate was found to be inversely related with the sintering temperature and sintering duration. Hardness of tablets was found to be increased with increasing sintering time and temperature; whereas friability was decreased with sintering. Both percent water uptake and percent erosion of sintered tablets decreased with increase in sintering condition. Based on the evaluation tests with mentioned parameters, formulation F2 Sintered at 80 °C for 3 hr was selected as optimised formulation. The drug release kinetics from formulations was best described by the Higuchi model and it followed anomalous non-Fickian diffusion mechanism. SEM analysis conformed smoother tablet surface and decrease in the porosity of sintered tablet. FTIR and DSC studies revealed that there was no evidence of interaction between the drug and polymer used in the study and no polymorphic changes in drug due to thermal sintering.

INTRODUCTION: The main objective of dosage form design should be to control the release of drug in order to reduce the dosing frequency up to an extent that daily once dose is sufficient for therapeutic effect with attainment of uniform plasma concentration at steady state.

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Among the several physical approaches employed for the design of controlled release dosage form, sintering of polymeric matrix in which a drug is dispersed is an alternative technique. Sintering is defined as the bonding of adjacent particle surface in a mass of powder, or in a compact, by the application of heat [1]. The sintering technique has been used for the fabrication of matrix tablet for sustained release and retardation of release of drug from various systems [2].

Thermal sintering, a relatively new technique in pharmaceutical sciences to retard the drug release from the dosage form, involves fusion of polymer

particles or formation of welded bond between particles by exposing the polymer matrix to the temperature above the glass transition temperature of the polymer. The entrapment of drug particles in the welded bond leads to controlled release of drug[2]. In pharmaceutical sciences exploration of sintering technique is relatively recent, but the research interest relating to this sintering technique has been continuously growing. Sintering is a simple and economic process, adds to the effectiveness of polymers to control the release of drug from formulation with relatively less quantity of polymer depending on the duration and temperature of sintering [3, 4].

In the present study Atenolol was selected as model drug which is a selective β blocker and widely prescribed in hypertension. In biopharmaceutical classification system Atenolol is included in class III category *i.e.* high aqueous solubility and low GI permeability, resulting in low oral bioavailability. Moreover because of its extensive hepatic first pass metabolism and short biological half life (6 to 7 hr), only 50% of oral dose of Atenolol is absorbed from the GIT and remaining being excreted unchanged in faeces. In conventional release systems the oral dose of Atenolol in antihypertensive treatment for adults is 50 mg, twice a daily. However, fluctuations may occur in plasma drug concentration levels, resulting either in manifestation of associated adverse effects due to systemic accumulation of drug or reduction in concentration of drug at the receptor site [5, 6]. Hence to reduce the dosing frequency and to improve the patient compliance, a daily once sustained release dosage form of Atenolol is desirable [7].

Since there are very few reports on thermally sintered matrix tablets, the objective of the present investigation was to mechanistically evaluate the effect of sintering technique in the development of polymeric matrix tablet of Atenolol for sustained release using Eudragit RS 100 as sintering polymer.

MARERIALS AND METHODS:

Materials: Atenolol and Eudragit RS 100 were procured from Yarrow chemical products, Mumbai, India. Talc and Magnesium stearate were obtained from Aurobindo Pharma Ltd, Hyderabad. All other chemicals and reagents used for the study were of analytical grade

Preparation of Tablet: The Matrix tablets were prepared by direct compression method with sintering polymer (Eudragit RS 100): drug (Atenolol) ratios of 25:75 (F1), 35:65 (F2), and 50:50 (F3); each tablet containing 100 mg of Atenolol. Talc (1% w/w) and Magnesium stearate (0.5% w/w) were added as glidant and lubricant respectively. All the measured materials were mixed using mortar and pestle initially and finally in a glass bottle by tumbling action. The mixture was then compressed in to tablets using an 8 mm biconcave punch, 16 station rotary tablet compression machine (Cadmach, Ahmedabad, India).

Sintering of Matrix Tablet: Sintering of tablets was performed using Hot air oven. The prepared fluffy matrix tablets were placed on aluminium foil and subjected to thermal treatment at three different constant temperatures like 60 °C, 70 °C and 80 °C for two different periods like 1.5 hr and 3 hr in hot air oven. The oven temperature was maintained within a degree Celsius. After the respective exposure temperature and time the tablets were removed, cooled to room temperature and stored in desiccators till further use.

Evaluation of Unsintered and Sintered Matrix Tablets of Atenolol: The unsintered and sintered matrix tablets of Atenolol of all the formulations are evaluated for various physiochemical properties like diameter, thickness, hardness, friability, drug content uniformity; percent water uptake studies, percent erosion studies and *in vitro* dissolution rate studies.

Standard Physical Tests of Unsintered and Sintered Matrix Tablets: The thickness and diameter of the tablets were determined using digital vernier callipers. The friability test was performed using Roche friabilator. Hardness of prepared tablets was measured using Stokes-Monsanto hardness tester. Uniformity of weight test and content uniformity test was carried out as per Indian Pharmacopeia.

***In vitro* Dissolution Rate Study:** [6] The *in-vitro* dissolution studies were conducted using USP XXIV dissolution apparatus-2, paddle type at a rotational speed of 50 RPM. The dissolution medium was consisted of 900 ml of 0.1N HCL for

2 hrs followed by phosphate buffer pH 6.8 for rest of the period. At predetermined time interval 5 ml of samples were withdrawn and same volume of fresh dissolution medium was replaced immediately. After suitably diluted with dissolution medium these samples were analyzed at 224 nm against reagent blank using double beam UV visible spectrophotometer.

Percent Water Uptake Study [8]: Previously weighed tablets were kept in phosphate buffer pH 6.8 for 24 hrs. After 24 hrs those wet tablets were again weighed and kept for drying. By using following formula percent water uptake was calculated.

Percent water uptake = [(Wet weight - Remaining dry weight) / Remaining dry weight] × 100

Percent Erosion Study: [8] Dissolution apparatus (paddle type, at a rotational speed of 50 RPM, 900 ml of phosphate buffer pH 6.8 at 37 °c) was used for measurement of percent erosion. Pre weighed tablets were placed in dissolution apparatus. After 24 hrs tablets were removed and kept for drying. By using following formula percent erosion was calculated.

Percent erosion= [(Initial weight - Remaining dry weight) / Initial weight] × 100

***In Vitro* Release Rate Kinetics and Mechanism: [2, 6, 9]** The *in-vitro* dissolution data obtained was fit into various pharmacokinetic models to explain the release kinetics of Atenolol from matrix tablets**.** The dissolution data obtained were plotted as cumulative percentage amount of drug released vs. time (zero order rate), log cumulative percentage amount of drug remaining vs. time (first order rate), cumulative percentage amount of drug released vs. square root of time (Higuchi model), cube root of drug percentage remaining in matrix vs. time (Hixon-Crowell).

The correlation coefficient (r) for each rate order was determined. The pharmacokinetic model with highest correlation coefficient (r) was regarded to be most fitting model for dissolution data. Further Korsmeyer and Peppas model (log cumulative percentage amount released vs. log time) was employed for determination of release mechanism from polymeric system.

According to the Korsmeyer and Peppas equation ($Mt/M_{\infty}=K_K.t^{n}$, where Mt\M∞: Fraction of drug released at time t, K_k: kinetic rate constant, n: release exponent) 'n' value is related to geometrical shape of the delivery system and characterizes the different drug release mechanism. Value of 'n' below 0.45 indicates Fickian diffusion mechanism (diffusion controlled drug release) and values of 'n' between 0.45 and 0.89 can be regarded as an indicator of non- Fickian diffusion (anomalous transport). Anomalous transport indicates that both diffusion as well as erosion was responsible for drug release. If the 'n' value=0.89, it will be non-Fickian case II transport and when 'n' value>0.89, it will be super case II transport.

Drug-Polymer-Excipient Compatibility FTIR Studies: To identify the compatibility between Drug-polymer-excipient, The Fourier transforms Infrared (FTIR) studies were performed on pure drug, drug-polymer mixture and optimised formulation, using IR spectrophotometer by potassium bromide (KBr) pellet method in the region between 4000 to 400 cm^{-1}.

Differential Scanning Calorimetric (DSC) Studies: DSC analysis for pure drug Atenolol, Eudragit RS100 and optimised formulation were done using DSC-Shimadzu 60 with TDA trend line software. Samples of 7-10 mg were heated at a scanning rate of 10 °C/min in a closed aluminium pan under dry nitrogen from50 °C to 300 °C.

Surface Morphology (SEM): Scanning electron microscopy (SEM) was used for studying the morphological changes (surface morphology) of prepared matrix tablet before and after sintering. Each sample was coated with gold palladium alloy using Jeol/EO fine coat sputter. The samples were then examined under 200X and 1000X magnification using a scanning electron microscope.

RESULTS AND DISCUSSION: In this present work sintering was carried out at three different constant temperatures like 60 °C, 70 °C and 80 °C for two different time periods like 1.5 hr and 3 hr in hot air oven. These temperature were below the melting point of Atenolol (158.95 °C, as shown in DSC studies) and above the glass transition temperature (Tg) of Eudragit RS 100 (Tg of

Eudragit RS 100 is 58.44 °C) [10]. The effects of sintering condition on physicochemical parameters of unsintered and sintered matrix tablets of Atenolol are shown in **Table 1**. The hardness of all prepared tablets was found to be in the range of 3.0-4.9 Kg/cm^2. The results indicate that as the sintering time and sintering temperature increases, hardness increases and hardness also depended on polymer content. The increase in hardness with sintering condition may be due to the fusion and firm bonding of polymer particles or formation of welded bond between particles at higher temperature. For all the formulations percentage of weight loss in friability test was found to be less than 0.8 %, which ensured that all prepared tablets are mechanically stable. It was observed that the friability of the tablets decreased with increase in sintering time. The estimated drug content was found to be in the range of 95% to 101% for all the formulations thus complying with IP limits for drug content uniformity.

TABLE 1: PHYSICOCHEMICAL PROPERTIES OF PREPARED UNSINTERED AND SINTERED MATRIX TABLETS OF ATENOLOL

Formulation Code	Parameters Evaluated				
	Hardness* (Kg/cm^2)	Friability# (%)	Drug content@ (%)	Percent water uptake**	Percent erosion**
Formulation F1					
F1 US	3.0	0.70	96.32±0.32	88±0.22	82±0.02
F1 SA	3.3	0.61	98.36±0.07	76±0.31	72±0.32
F1 SB	3.4	0.54	95.82±0.34	73±0.72	70±0.72
F1 SC	3.4	0.50	100.12±0.15	71±0.32	67±0.33
F1 SD	3.5	0.46	96.10±1.07	68±0.85	64±0.32
F1 SE	3.7	0.47	98.72±0.68	65±0.37	62±0.40
F1 SF	3.8	0.41	96.37±0.21	63±0.02	59±0.37
Formulation F2					
F2 US	3.3	0.64	95.42±0.56	81±0.22	76±0.39
F2 SA	3.9	0.51	99.07±0.03	70±0.72	68±0.15
F2 SB	4.0	0.49	97.48±0.28	68±0.32	66±0.76
F2 SC	4.1	0.45	96.36±0.70	65±0.52	65±0.62
F2 SD	4.3	0.41	98.29±0.63	63±0.09	63±0.92
F2 SE	4.3	0.38	96.32±0.30	61±0.36	60±0.30
F2 SF	4.5	0.36	97.13±0.34	59±0.62	58±0.42
Formulation F3					
F3 US	3.8	0.61	95.31±0.08	73±0.33	69±0.54
F3 SA	4.2	0.46	97.32±0.37	66±0.64	61±0.08
F3 SB	4.4	0.42	96.08±0.25	64±0.35	59±0.23
F3 SC	4.5	0.39	95.27±0.70	63±0.06	58±0.76
F3 SD	4.6	0.40	99.73±0.39	61±0.21	56±0.46
F3 SE	4.7	0.37	96.28±0.53	59±0.60	54±0.84
F3 SF	4.9	0.23	98.47±0.02	57±0.32	52±0.31

*: n=5; #: n=10; @: Mean ± S.D (n=3); **: Mean ± S.D (n=5)

***Note*: US**: Unsintered; **SA**: Sintered at 60 °C for 1.5 hr, **SB**: Sintered at 60 °C for 3 hr, **SC**: Sintered at 70 °C for 1.5 hr, **SD**: Sintered at 70 °C for 3 hr, **SE**: Sintered at 80 °Cfor 1.5 hr, **SF**: Sintered at 80 °C for 3 hr.

At the end of the dissolution period the shape of the matrix was not altered which suggest that the release of the drug is controlled by diffusion. The cumulative percent drug released from unsintered and sintered matrix tablets at 60 °C, 70 °C and 80 °C for two different periods like 1.5 hr and 3 hr are represented in **Fig. 1-3**. The controlled release of Atenolol from the thermally sintered tablets depended on concentration of polymer, temperature of sintering and time duration of sintering. From the dissolution study results it was observed that the release of drug was retarded as the concentrations of polymer increased. During *In-vitro* dissolution studies more sustained release of the drug was observed from sintered tablet matrices, compared to the unsintered tablets. As sintering temperature and duration of sintering of matrix tablets increased the time taken to attain maximum release increased correspondingly.

The unsintered Atenolol matrix tablets of formulation FI (formulation code F1US) was able

to retard the drug release up to 6 hr only, as time taken to attain maximum drug release was 6 hr. When the tablets of same formulation sintered at 60 °C for 1.5 hr and 3 hr, time taken to attain maximum release was found to be 7 hr and 8 hr respectively and for tablets of same formulation at 70 °C for 1.5 hr and 3 hr time taken to attain maximum release was found to be 9 hr and 10 hr respectively, while the corresponding values at 80 °C for 1.5 hr and 3 hr were 10 hr and 11 hr respectively.

The unsintered Atenolol matrix tablets of formulation F2 (formulation code F2US) was able to retard the drug release up to 7 hr only, as time taken to attain maximum drug release was 7 hr. When the tablets of same formulation sintered at 60 °C for 1.5 hr and 3 hr, time taken to attain maximum release was found to be 8 hr and 9 hr respectively and for tablets of same formulation at 70 °C for 1.5 hr and 3 hr time taken to attain maximum release was found to be 10 hr and 11 hr respectively, while the corresponding values at 80 °C for 1.5 hr and 3 hr were 12 hr and 14 hr respectively.

The unsintered Atenolol matrix tablets of formulation F3 (formulation code F3US) was able to retard the drug release up to 9 hr, as time taken to attain maximum drug release was 9 hr. When the tablets of same formulation sintered at 60 °C for 1.5 hr and 3 hr, time taken to attain maximum release was found to be 11 hr and 12 hr respectively and for tablets of same formulation at 70 °C for 1.5 hr and 3 hr time taken to attain maximum release was found to be 13 hr and 14 hr respectively, while the corresponding values at 80 °C for 1.5 hr and 3 hr were 14 hr and 15 hr respectively. The sintering condition markedly affected the drug release characteristics from the sintered tablets.

It was found that the drug release rate was inversely related to the sintering temperature and sintering duration. This might be due to increase in firmness of sintering which compacts the mass further and the formation of welded bond between polymer particles, which results in entrapment of drug particles in the formed matrix, leading to drug release retardation.

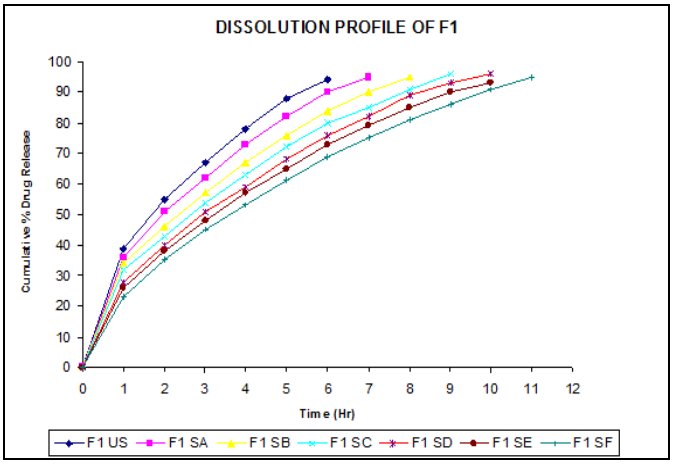

FIG. 1: DISSOLUTION PROFILES OF UNSINTERED AND THERMALLY SINTERED TABLETS OF FORMULATION F1

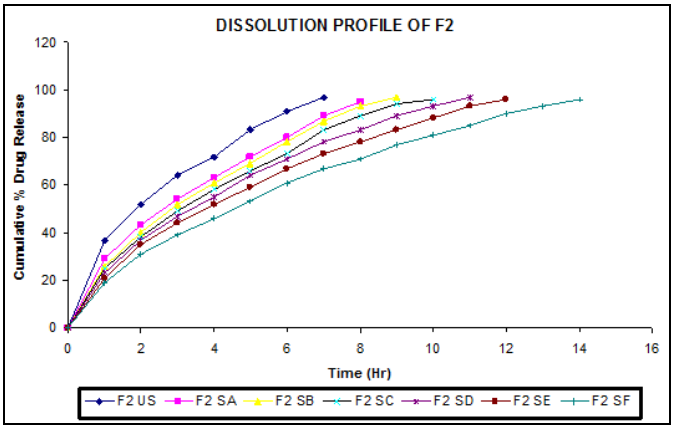

FIG. 2: DISSOLUTION PROFILES OF UNSINTERED AND THERMALLY SINTERED TABLETS OF FORMULATION F2

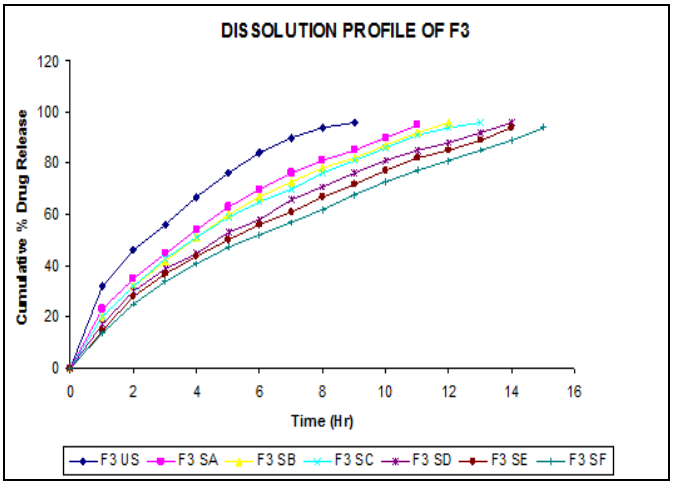

FIG. 3: DISSOLUTION PROFILES OF UNSINTERED AND THERMALLY SINTERED TABLETS OF FORMULATION F3

US: Unsintered; **SA**: Sintered at 60 °C for 1.5 hr, **SB**: Sintered at 60 °C for 3 hr, **SC**: Sintered at 70 °C for 1.5 hr, **SD**: Sintered at 70 °C for 3 hr, **SE**: Sintered at 80 °C for 1.5 hr, **SF**: Sintered at 80 °C for 3 hr.

The percent water uptake and percent erosion of tablets, both before and after sintering are shown in **Fig. 4** and **Fig. 5** respectively.

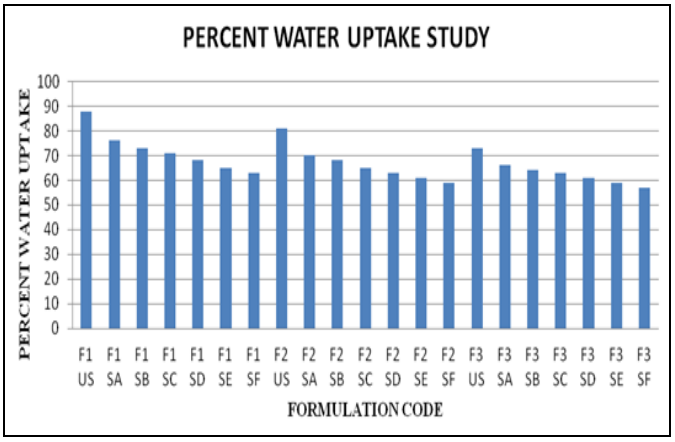

FIG. 4: PERCENT WATER UPTAKE OF UNSINTERED AND THERMALLY SINTERED MATRIX TABLETS OF ATENOLOL

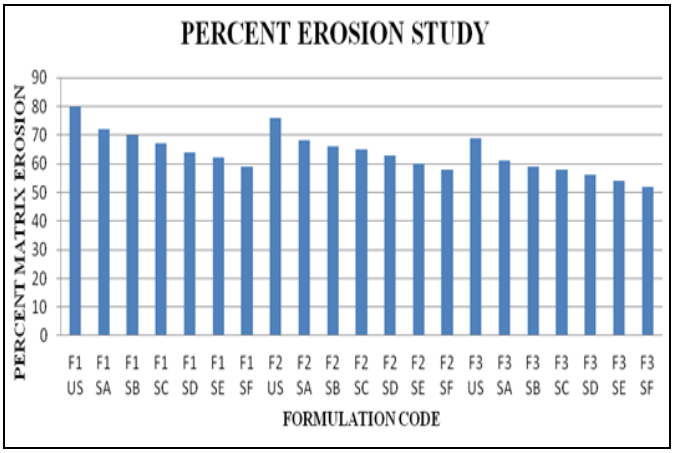

FIG. 5: PERCENT MATRIX EROSION OF UNSINTERED AND THERMALLY SINTERED MATRIX TABLETS OF ATENOLOL

The percent water uptake and percent erosion of tablets was observed to be maximum with unsintered tablets. With increase in sintering time and sintering duration both water uptake and erosion decreased, which indicates that hydrophobicity of tablets increased after sintering. This justifies the drug release retardation from sintered matrix tablet.

The results of dissolution data fitted to various kinetic models and the values of correlation coefficient (r) are presented in **Table 2**. The ranges of r values for all the formulations (both sintered and unsintered) were: zero order rate (0.9093 to 0.9676), first order rate (0.9297 to 0.9806), Higuchi model (0.9889 to 0.9996), Hixon - Crowell model (0.9854 to 0.9964) and Krosmeyer - peppas model (0.9908 to 9994). It was observed that Higuchi matrix model was found to be the best fit model for both sintered and unsintered tablets. To determine the drug release mechanism the data were subjected to Korsmeyer - Peppas equation. The release exponents 'n' values were in the range of 0.497 and 0.677 for all the formulations (both sintered and unsintered), indicating that the release of Atenolol from matrix tablets followed anomalous non-Fickian diffusion mechanism.

Among all the formulations (both unsintered and sintered) the formulation F3 SF and formulation F2 SF were able to retard the drug for longer period of 15 hr and 14 hr respectively. The formulation F2 SF (Sintered at 80 °C for 3 hr) was selected as an optimised formulation based on the higher amount of drug release, lower sintering temperature and more importantly low proportion of polymer as compared to F3 SF. For formulation F2 Sintered at 80 °C for 3 hr (F2 SF) the maximum percentage release and time to attain maximum release was found to be 96.26% and 14 hr respectively.

TABLE 2: DRUG RELEASE KINETIC STUDIES FROM UNSINTERED AND SINTERED MATRIX TABLETS OF ATENOLOL

Formulations	Zero Order (r)	First Order (r)	Higuchi (r)	Hixon Crowell (r)	Koresmeyer Peppas (r)	(n)
F1 US	0.9093	0.9771	0.9996	0.9921	0.9994	0.497
F1 SA	0.9142	0.9701	0.9994	0.9929	0.9992	0.506
F1 SB	0.9215	0.9663	0.9990	0.9924	0.9977	0.508
F1 SC	0.9248	0.9521	0.9988	0.9903	0.9975	0.514
F1 SD	0.9330	0.9628	0.9972	0.9947	0.9985	0.550
F1 SE	0.9385	0.9801	0.9967	0.9964	0.9990	0.566
F1 SF	0.9491	0.9583	0.9949	0.9937	0.9993	0.597
F2 US	0.9140	0.9335	0.9994	0.9854	0.9990	0.498
F2 SA	0.9472	0.9395	0.9956	0.9856	0.9996	0.571
F2 SB	0.9510	0.9297	0.9931	0.9871	0.9990	0.606
F2 SC	0.9467	0.9548	0.9931	0.9921	0.9983	0.598

F2 SD	0.9426	0.9394	0.9955	0.9914	0.9975	0.598
F2 SE	0.9450	0.9486	0.9956	0.9916	0.9967	0.603
F2 SF	0.9504	0.9510	0.9945	0.9926	0.9979	0.611
F3 US	0.9081	0.9808	0.9962	0.9957	0.9959	0.518
F3 SA	0.9414	0.9601	0.9952	0.9933	0.9908	0.567
F3 SB	0.9471	0.9474	0.9928	0.9918	0.9963	0.631
F3 SC	0.9408	0.9594	0.9949	0.9947	0.9954	0.611
F3 SD	0.9528	0.9472	0.9929	0.9917	0.9950	0.639
F3 SE	0.9603	0.9532	0.9911	0.9903	0.9929	0.664
F3 SF	0.9676	0.9445	0.9889	0.9872	0.9958	0.677

FTIR study was carried out to determine any possible chemical interaction. The FTIR Spectrum of pure Atenolol, Atenolol-Eudragit RS100 mixture and optimised formulation were represented in **Fig. 6** to **Fig. 8**. Pure Atenolol showed characteristic -CO-NH- at 3346 cm^{-1}, C-H stretching (alkane) at 2964 cm^{-1}, C=O stretching (amide) at 1643 cm^{-1}, -N-C=O (amide) at 1516 cm^{-1}, H_2N-C at 1417 cm^{-1}, C-O stretching (alcohols) at 1377 cm^{-1}, Aryl ether at 1244 cm^{-1} and the peak at 1178 cm^{-1} due to i-pr. The FTIR spectrum of drug-Eudragit RS 100 mixture and thermally sintered optimised formulation showed all the characteristic absorption band position of pure drug Atenolol with minor shifts. This observation indicates that there is no evidence of chemical interaction between drug and sintering polymer during manufacturing process and on sintering.

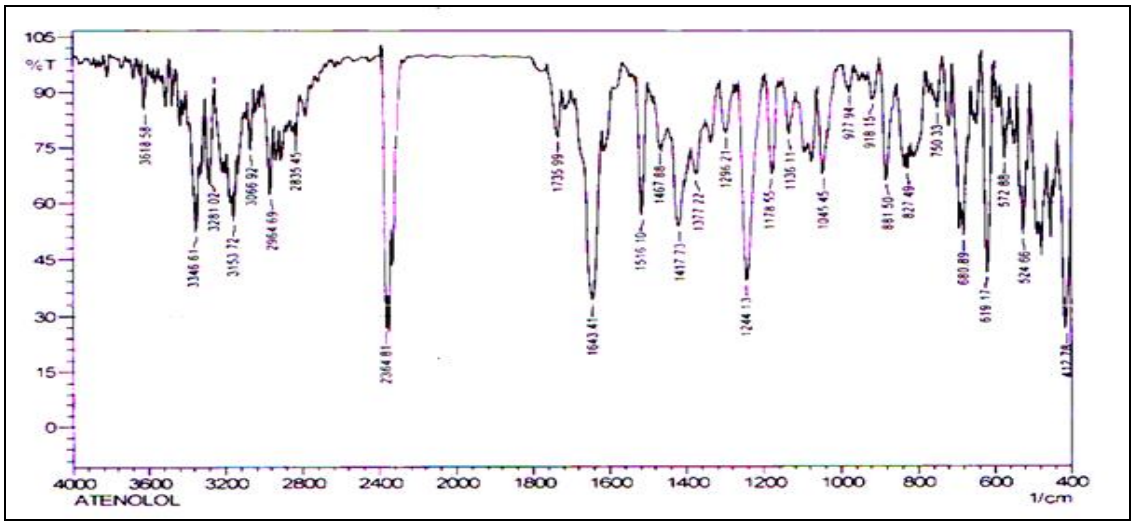

FIG. 6: FT-IR SPECTRUM OF ATENOLOL PURE DRUG

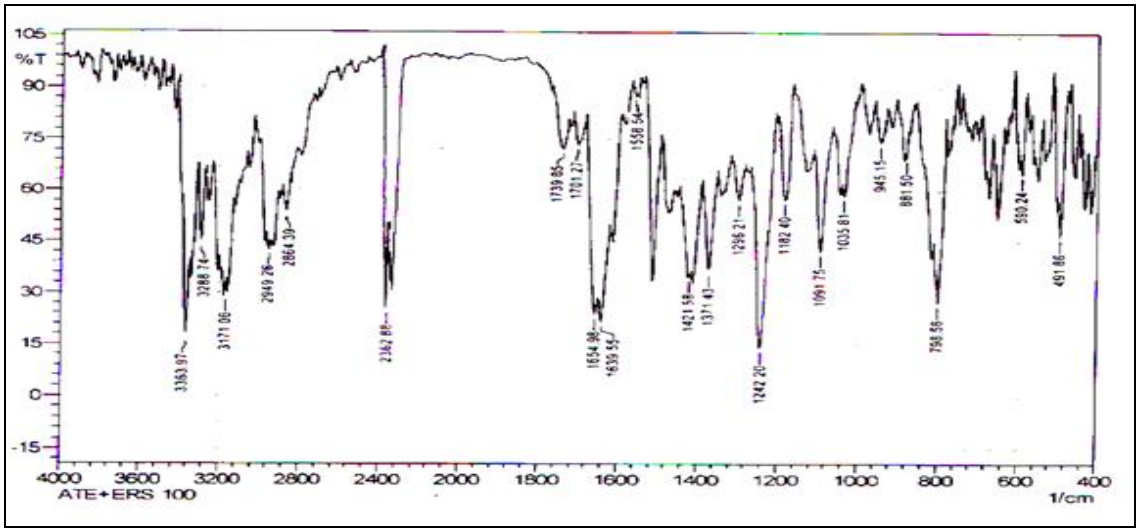

FIG. 7: FT-IR SPECTRUM OF ATENOLOL-EUDRAGIT RS100

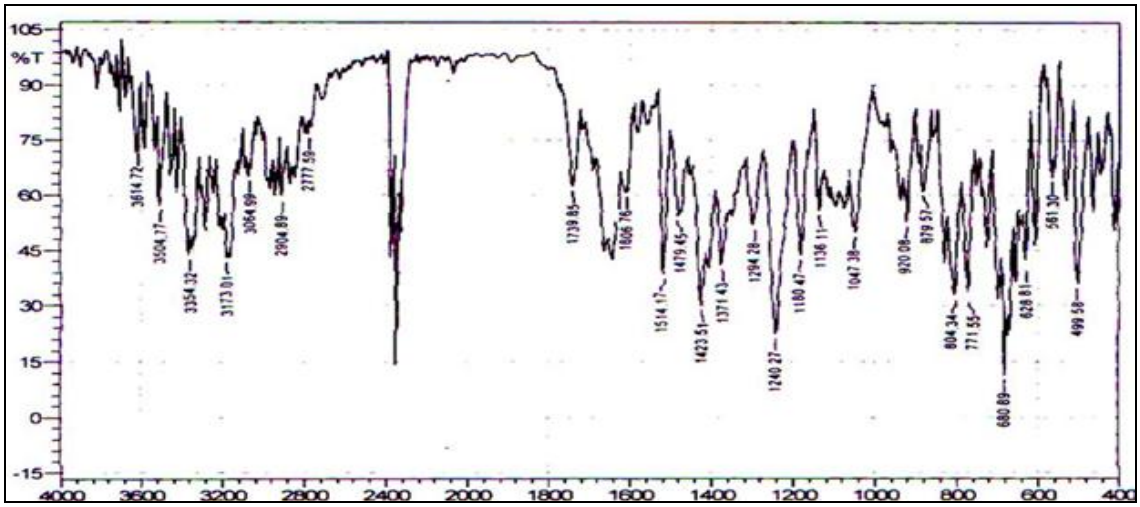

FIG. 8: FT - IR SPECTRUM OF OPTIMISED FORMULATION

DSC study was used in order to examine thermal behaviour of pure drug Atenolol and optimised formulation. Thermogram pure drug Atenolol, Eudragit RS 100 and optimised formulation was shown in **Fig. 9, 10** and **11** respectively. Pure powdered Atenolol showed a sharp endothermic melting peak at 158.95 °C. DSC thermogram of ERS100 showed a broad endotherm, may be due to the presence of residual moisture in polymers. Endothermic peak was obtained at near to 161.80 °C for the optimised formulation. The changes observed in the thermogram of DSC shows that there is no polymorphic change in the drug due to thermal sintering.

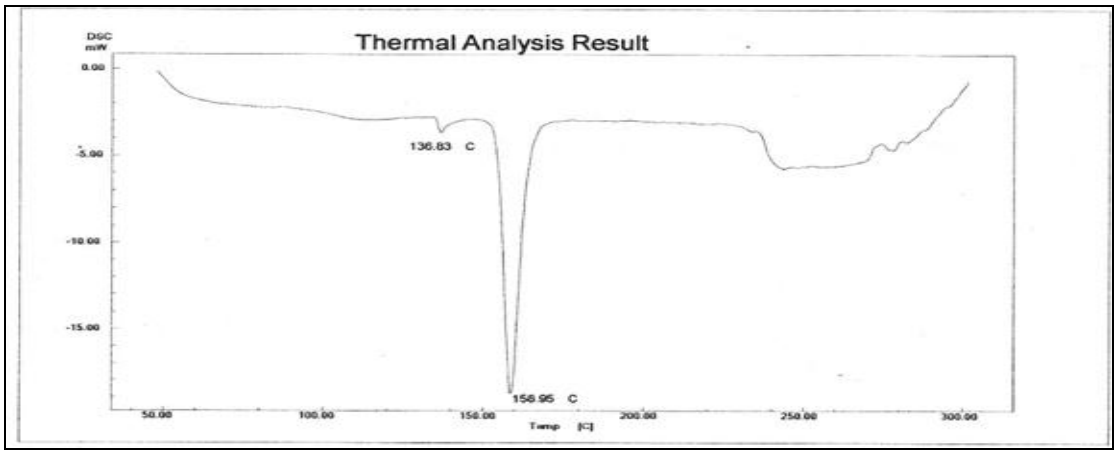

FIG. 9: DSC THERMOGRAM OF ATENOLOL PURE DRUG

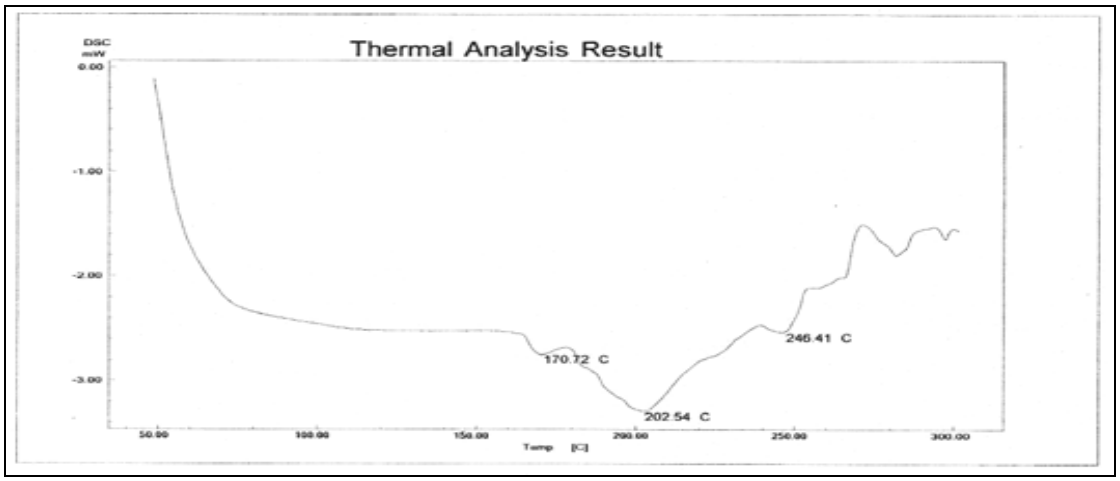

FIG. 10: DSC THERMOGRAM OF EUDRAGIT RS100

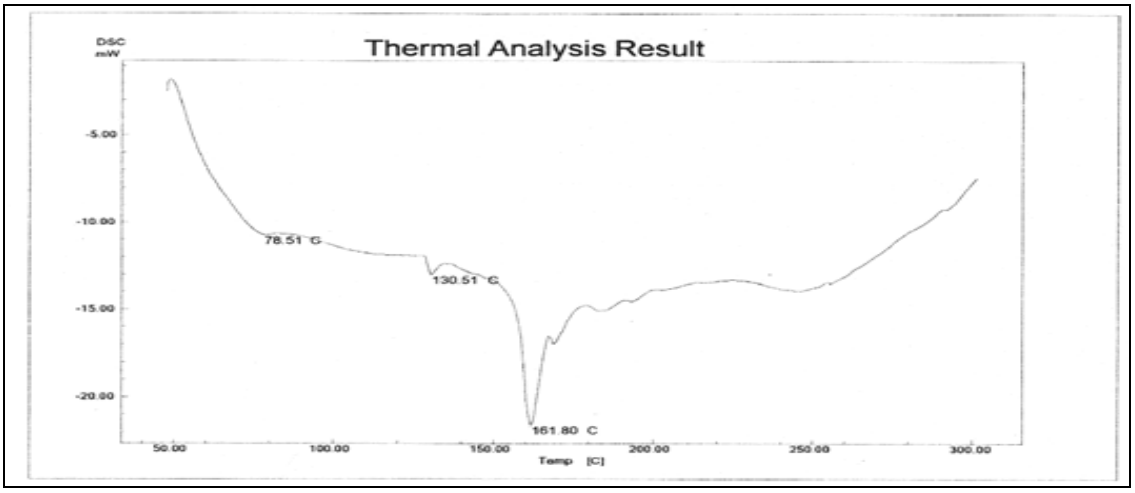

FIG. 11: DSC THERMOGRAM OF OPTIMISED FORMULATION

SEM micrographs of tablet surface of optimised formulation both before and after sintering were shown in **Fig. 12**. SEM micrographs of sintered tablet surface appeared smoother and shown that a thin film structure covers the tablet surface, which results in decrease in the porosity of sintered tablet. This might be due to the fusion of Eudragit RS 100 particle due to sintering and uniform redistribution of the polymer in pores of tablet.

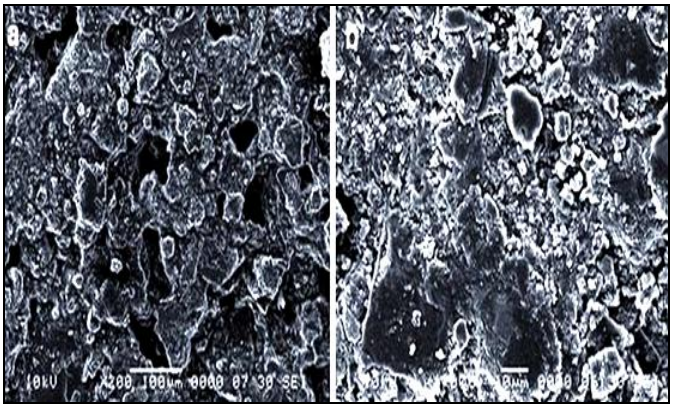

FIG. 12: SEM MICROGRAPHS OF A UNSINTERED B SINTERED TABLET SURFACE

CONCLUSION: In conclusion, sintering technique adds to the effectiveness of polymers for controlling drug release and provides a significant and expedient method for control release in oral dosage form. This new method was used to design polymeric matrix tablet of Atenolol using Eudragit RS 100 as sintering polymer and effect of sintering condition was evaluated. From the above study and data obtained experimentally it was found that the hardness of the prepared tablet increased with increase in sintering temperature and time period of sintering, where as friability of tablets was found to be decreased with sintering.

The sintering condition significantly affected the drug release characteristics from the sintered matrix tablets. Drug release rate from the prepared tablets were inversely related to the concentration of sintering polymer, sintering temperature and sintering duration. As sintering temperature and duration of sintering increased, the time taken to attain maximum release from sintered tablets also increased correspondingly. Moreover, with sintering condition both percent water uptake and percent erosion of tablets was found to be decreased, while water uptake and erosion of tablets was observed to be maximum with unsintered tablets. The thermogram of DSC shown that there is no polymorphic change in the drug due to thermal sintering. FTIR studies revealed that there is no evidence of chemical interaction between drug and sintering polymer due to sintering. SEM micrographs of sintered tablet shown that a thin film structure covers the tablet surface and tablet surface appeared to be smoother.

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