

**FORMULATION AND CHARACTERIZATION OF FAST DISSOLVING TABLET OF
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ABSTRACT

The present study was aimed at the formulation and evaluation of fast-dissolving tablets of Eslicarbazepine acetate to enhance patient compliance and achieve rapid drug release. Six formulations (F1–F6) were prepared using superdisintegrants such as sodium starch glycolate and croscarmellose sodium by the direct compression method. Pre-compression parameters, including bulk density, tapped density, Carr's index, and Hausner's ratio, indicated good flow properties of all powder blends. Post-compression evaluation revealed acceptable hardness (3.4–3.7 kg/cm²), friability (<1%), uniform weight variation, and drug content within the pharmacopeial limits (96.45–99.02%). The disintegration time varied between 60–86 seconds, with formulation F3 showing the fastest disintegration (60 ± 3 sec). In-vitro drug release studies demonstrated that F3 released 98.12% of the drug within 10 minutes, following Higuchi kinetics with a regression coefficient ($r^2 = 0.9783$). The results suggest that F3, containing 30 mg sodium starch glycolate, is the optimized formulation providing rapid disintegration and enhanced drug release, making it a promising candidate for improving therapeutic efficacy in the management of epilepsy.

Keywords: Eslicarbazepine acetate, Fast dissolving tablets, Superdisintegrants, Sodium starch glycolate, Croscarmellose sodium, In-vitro drug release, Higuchi kinetics.

INTRODUCTION

Oral drug delivery is regarded as the most widely accepted and convenient route of administration owing to its non-invasiveness, cost-effectiveness, and high patient compliance. However, conventional tablets and capsules often present difficulties for pediatric, geriatric, and dysphagic patients, leading to poor adherence to therapy^{1,2}. To overcome these limitations, fast dissolving tablets (FDTs), also termed orally disintegrating tablets (ODTs), were introduced. These formulations are designed to rapidly disintegrate or dissolve on the tongue within seconds without the need for water, thereby enhancing patient convenience and ensuring faster drug action^{3,4}. The European Pharmacopoeia

defines ODTs as tablets that should disintegrate within three minutes, highlighting the importance of rapid breakdown for therapeutic effectiveness ⁵.

The efficiency of FDTs largely depends on the selection of suitable superdisintegrants, which facilitate tablet breakup through mechanisms such as swelling, wicking, and deformation. Commonly employed superdisintegrants include sodium starch glycolate (SSG), croscarmellose sodium (CCS), and crospovidone. Among these, SSG swells extensively upon contact with water, promoting rapid tablet disintegration even at low concentrations, while CCS acts through combined swelling and wicking action, resulting in superior disintegration efficiency ^{6,7}. The choice and concentration of these excipients are critical for balancing rapid disintegration with mechanical strength of the tablets.

Eslicarbazepine acetate (ESL) is a novel, once-daily antiepileptic drug belonging to the dibenzazepine family. It is a prodrug that undergoes rapid first-pass hydrolysis to its active metabolite, eslicarbazepine (S-licarbazepine), which exerts therapeutic action by blocking voltage-gated sodium channels and reducing sustained repetitive neuronal firing ^{8,9}. ESL has demonstrated favorable pharmacokinetics, including near-complete absorption, peak plasma concentrations within 1–4 hours, low protein binding (<40%), and a terminal half-life of 10–20 hours, supporting its once-daily dosing regimen ^{10,11}. Despite these advantages, ESL is classified as a Biopharmaceutics Classification System (BCS) Class II drug due to its poor aqueous solubility (<1 mg/mL), which can limit dissolution rate and delay therapeutic onset ^{12,13}.

Therefore, developing fast dissolving tablets of eslicarbazepine acetate presents a promising strategy to overcome solubility-related limitations and improve therapeutic efficiency. By incorporating suitable superdisintegrants via direct compression—a simple, cost-effective, and scalable manufacturing technique—rapid disintegration and dissolution can be achieved, leading to faster onset of action. This is particularly advantageous for epileptic patients requiring immediate therapeutic relief, as well as pediatric and geriatric populations with swallowing difficulties ^{5,14}.

The present study was thus designed to formulate and characterize fast dissolving tablets of eslicarbazepine acetate using superdisintegrants such as sodium starch glycolate and croscarmellose sodium. Pre- and post-compression parameters, along with in-vitro drug release and kinetic modeling, were evaluated to identify an optimized formulation with improved performance characteristics and potential clinical applicability.

Material and Methods

Material

Eslicarbazepine acetate was obtained as a gift sample from Pharmaceutical Company. Analytical grade solvents such as methanol, ethanol, hydrochloride, and chloroform were procured from S. D. Fine Chem. Ltd., Mumbai and Chem Pure Pvt. Ltd. To enhance palatability and disintegration, citric acid (Qualigens Fine Chemicals, Mumbai) was used. Various excipients essential for tablet formulation and performance were incorporated, including HPMC (Ozone International, Mumbai) as a polymer, sodium starch glycolate, croscarmellose sodium, and crospovidone (Loba Chemie Pvt. Ltd., Mumbai) as superdisintegrants, microcrystalline cellulose (Loba Chemie) as a diluent, and talc along with magnesium stearate (Loba Chemie) as glidant and lubricant, respectively. All materials were of pharmaceutical or analytical grade and used as received.

Methods

Preparation of tablets of Eslicarbazepine acetate

Fast dissolving tablets containing Eslicarbazepine acetate (10 mg) were formulated using the direct compression method. To enhance disintegration properties, varying concentrations of two superdisintegrants croscarmellose sodium (Ac-Di-Sol) and crospovidone were incorporated at levels of 10 mg, 15 mg, and 20 mg, respectively, in different formulations for the purpose of optimization (Okuda *et al.*, 2011). All ingredients were accurately weighed and initially mixed in geometric proportion using a clean and dry mortar and pestle. The powder mixture was then passed through sieve no. 60 to ensure uniform particle size and homogeneity.

In the final blending stage, magnesium stearate (6 mg) was added as a lubricant, talc (5 mg) as a glidant, and microcrystalline cellulose (64 mg, 59 mg, and 54 mg depending on the formulation) was included as a diluent/bulking agent. The final blend was thoroughly mixed to ensure uniform distribution of all excipients. The prepared blend was evaluated for pre-compression parameters, including angle of repose, bulk density, tapped density, Carr's index, and Hausner's ratio, to assess flow properties and compressibility.

Following satisfactory pre-compression evaluation, the blends were compressed into tablets using 8 mm flat-faced punches on a Rimek Mini Press 16-station rotary tablet compression machine.

A total of six formulations were prepared, each containing one type of superdisintegrant in three different concentrations. Each tablet weighing 300 mg was obtained. Composition of tablets is mentioned in Table no 1.

Table 1: Composition of fast dissolving tablets of Eslicarbazepine acetate

Ingredients (mg)	Formulation code					
	F1	F2	F3	F4	F5	F6
Eslicarbazepine acetate	200	200	200	200	200	200
Sodium Starch glycolate	20	25	30	-	-	-
Croscarmellose sodium	—	—	—	20	25	30
Microcrystalline cellulose	64	59	54	64	59	54
Talc	5	5	5	5	5	5
Magnesium stearate	6	6	6	6	6	6
Citric acid	5	5	5	5	5	5
Total weight	300	300	300	300	300	300

Evaluation of precompression parameter

Angle of repose (θ): The frictional forces in a loose powder or granules can be measured by the angle of repose. This is the maximum angle possible between the surface of a pile of powder or granules and the horizontal plane ¹⁴.

$$\tan \theta = h/r$$

$$\theta = \tan^{-1} (h/r)$$

Where, θ is the angle of repose, h is the height, r is the radius.

The granules were allowed to flow through the funnel fixed to a stand at definite height. The angle of repose was then calculated by measuring the height and radius of the heap of granules formed.

Bulk density: Both loose bulk density (LBD) and tapped bulk density (TBD) were determined ¹⁵. Accurately weighed amount of granules taken in a 50 ml capacity measuring cylinder was tapped for 100 times on a plane hard wooden surface and estimated the LBD and TBD, calculated by using following formulas.

$$\text{LBD (Loose Bulk Density)} = \frac{\text{Mass of Powder}}{\text{Volume of Packing}}$$

$$\text{TBD (Tapped Bulk Density)} = \frac{\text{Mass of Powder}}{\text{Tapped Volume of Packing}}$$

Compressibility index: Percent compressibility of powder mix was determined by Carr's compressibility index, calculated by using following formula:-

$$\text{Carr's Index \%} = \frac{\text{TBD} - \text{LBD}}{\text{TBD}} \times 100$$

Hausners ratio: It is determined by comparing tapped density to the bulk density by using following equation:-

$$\text{Housner's ratio} = \frac{\text{Tapped bulk density}}{\text{loose Bulk density}}$$

Hausner's ratio value <1.25 shows better flow properties

Evaluation of post compression Parameter

Shape and colour of tablets

Uncoated tablets were examined under a lens for the shape of the tablet and colour was observed by keeping the tablets in light ¹⁶.

Thickness test

Three tablets were picked from each formulation randomly and thickness was measured individually ¹⁷. It is expressed in mm and standard deviation was also calculated. The tablet thickness was measured using dial-caliper (Mitutoyo, Japan).

Weight variation test

Twenty tablets were selected randomly from each formulation and average weight was determined ¹⁸. The tablets were weighed individually and compared with average weight.

Hardness test

The hardness of tablet was measured by Pfizer hardness tester and results were expressed in Kg/cm² ¹⁹.

Friability test

For this, 20 tablets were taken from each formulation and the friability was determined using Roche friabilator. The equipment was run for 4min at 25 revolutions per minute. The tablets were taken out, dedusted and reweighed and % friability was calculated ²⁰. The friability was determined as the mass loss in percent according to Equation:-

$$\% \text{Friability} = \frac{\text{Loss in weight}}{\text{Initial weight}} \times 100$$

The test complies if tablets not loss more than 1% of their weight.

Uniformity of drug content

The test is mandatory for tablets with 10 mg or less weight of active ingredient ²¹. Ten randomly selected tablets from each formulation (F1 to F6) were finely powdered and Drug equivalent to 10mg of drug dissolved in 10 ml phosphate buffer pH 6.8) sonicate it for 20 minutes, till the entire drug

leached out from complex, then the solution was filtered through whatman filter paper No. 41. From this Solution take 1 ml and Diluted up to 100 ml with 0.1 N HCl and the drug content was determined spectrophotometrically at 233nm.

***In vitro* dissolution rate studies**

The prepared tablets were evaluated for *in vitro* drug release. The drug release studies were carried out using USP XXII paddle type Dissolution test apparatus. The dissolution study was carried out in 900 ml dissolution medium which was stirred at 50rpm maintained at $37 \pm 0.2^\circ\text{C}$. The scheme of using the simulated fluids at different timing was as follows:

A tablet placed in dissolution media (900 ml) at $37 \pm 0.2^\circ\text{C}$. Samples were withdrawn at different time interval and compensated with same amount of fresh dissolution medium. Volume of sample withdrawn was made up to 10ml 0.1 N HCl. The samples withdrawn were assayed spectrophotometrically at 233nm using UV visible spectrophotometer.

Results and Discussion

The present study focused on the development of fast-dissolving tablets (FDTs) of **Eslicarbazepine acetate**, an antiepileptic drug with limited aqueous solubility and bioavailability. FDTs were formulated using **superdisintegrants** such as sodium starch glycolate (SSG) and croscarmellose sodium (CCS) in varying concentrations (Table 1). These excipients are widely employed in tablet formulations to enhance the disintegration process and thus improve drug dissolution and onset of therapeutic action ^{1,21}.

The **pre-compression parameters** (Table 2) indicated good flow properties of the powder blend. The bulk density values ranged from 0.365 to 0.395 g/ml, while tapped density values varied between 0.482 and 0.495 g/ml. Carr's Index values were within 19.88–24.27%, and Hausner's ratios were less than 1.32, confirming fair to good flow characteristics suitable for direct compression ²². These results suggested that the powder mixtures had adequate packing ability and compressibility, minimizing weight variation during tablet compression ²³.

The **post-compression evaluation** (Table 3) revealed that all formulations possessed acceptable mechanical strength with hardness values ranging from 3.4 to 3.7 kg/cm², which is ideal for FDTs as very high hardness can prolong disintegration. Friability values were below 1% in all formulations, indicating good mechanical resistance. Drug content uniformity ranged between 96.45% and 99.02%, which lies within the pharmacopeial limits (95–105%), thereby ensuring dose uniformity.

The **disintegration time** (Table 4) varied across formulations depending on the type and concentration of superdisintegrant. Among all, F3 exhibited the shortest disintegration time of **60 ± 3 seconds**, which

can be attributed to the higher concentration of sodium starch glycolate (30 mg) that promotes rapid swelling and wicking action. In contrast, formulations with lower concentrations or alternative superdisintegrants demonstrated relatively higher disintegration times. This confirms the crucial role of disintegrant concentration in designing fast-dissolving systems ²⁴.

The **in-vitro dissolution studies** (Table 5) further supported these findings. The optimized formulation F3 showed rapid drug release, with nearly **82.25% released within 5 minutes** and **98.12% within 10 minutes**. The faster dissolution of F3 compared to other formulations was likely due to the combined effect of rapid disintegration and increased surface area available for dissolution ²⁵.

The **drug release kinetics** (Table 6) demonstrated that F3 followed the Higuchi model ($r^2 = 0.9783$) more closely than zero-order ($r^2 = 0.9407$) and first-order ($r^2 = 0.9745$) kinetics. This suggests that drug release was primarily governed by a diffusion-controlled mechanism, a common phenomenon in fast-dissolving formulations where the drug is released rapidly as the tablet matrix disperses ²⁶.

The study established that the choice of superdisintegrant plays a pivotal role in the performance of Eslicarbazepine acetate FDTs. Among all formulations, F3 emerged as the **optimized formulation** owing to its desirable pre- and post-compression characteristics, minimal disintegration time, and rapid drug release profile. These findings align with earlier reports where sodium starch glycolate at optimal concentrations demonstrated superior disintegration efficiency in fast-dissolving formulations ^{27,28}.

Table 2: Results of pre-compression parameters of Eslicarbazepine acetate

Formulation code	Parameters			
	Loose Bulk density(gm/ml)	Tapped bulk density(gm/ml)	Carr's Index (%)	Hausner's Ratio
F1	0.385	0.495	22.22	1.286
F2	0.395	0.493	19.88	1.248
F3	0.374	0.489	23.52	1.307
F4	0.365	0.482	24.27	1.321
F5	0.375	0.486	22.84	1.296
F6	0.377	0.483	21.95	1.281

Table 3: Results of post-compression parameters of all formulations

F. Code	Hardness test (kg/cm ²)	Friability (%)	Weight variation (%)	Thickness (mm)	Drug content (%)
F1	3.4±0.3	0.885±0.015	302±6	1.32±0.08	98.78±0.12
F2	3.6±0.2	0.745±0.020	305±3	1.36±0.09	98.65±0.22
F3	3.5±0.4	0.669±0.022	302±4	1.35±0.08	99.02±0.15
F4	3.7±0.2	0.812±0.016	298±5	1.34±0.07	97.15±0.16
F5	3.6±0.3	0.753±0.014	300±3	1.32±0.06	97.65±0.13
F6	3.4±0.3	0.852±0.032	304±2	1.30±0.03	96.45±0.19

Table 4: Results of disintegration time parameters of all formulations

Formulation code	Disintegration Time (Sec.) Mean ± SD
F1	85±5
F2	73±7
F3	60±3
F4	86±6
F5	78±3
F6	76±4

*Average of three determinations (n=3)

Table 5: *In-vitro* drug release data for optimized formulation F3

Time (min)	Square Root of Time(h) ^{1/2}	Log Time	Cumulative*% Drug Release	Log Cumulative % Drug Release	Cumulative % Drug Remaining	Log Cumulative % Drug Remaining
1	1	0.000	49.98	1.699	50.02	1.699
3	1.732	0.477	63.32	1.802	36.68	1.564
5	2.236	0.699	82.25	1.915	17.75	1.249
10	3.162	1.000	98.12	1.992	1.88	0.274

Table 6: Regression analysis data

Batch	Zero Order	First Order	Higuchi
		r^2	
F3	0.9407	0.9745	0.9783

Conclusion

The present study successfully demonstrated the formulation and evaluation of fast-dissolving tablets of Eslicarbazepine acetate using superdisintegrants such as sodium starch glycolate and croscarmellose sodium. All prepared formulations exhibited good pre-compression and post-compression parameters within pharmacopeial limits, ensuring adequate flowability, mechanical strength, and uniformity. Among the developed batches, formulation F3 showed the most desirable characteristics, including the shortest disintegration time (60 ± 3 seconds) and the highest drug release (98.12% within 10 minutes). The in-vitro release profile of the optimized formulation followed Higuchi kinetics, indicating diffusion-controlled drug release. Thus, the study concludes that incorporation of sodium starch glycolate at an appropriate concentration significantly enhances the disintegration and dissolution behavior of Eslicarbazepine acetate tablets, making them suitable as a fast-dissolving dosage form. This optimized formulation may improve patient compliance and therapeutic efficacy in the management of epilepsy, particularly in populations with swallowing difficulties.

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