RESEARCH ARTICLE

Enhanced Solubility and Dissolution Rate of Aceclofenac using Freeze Drying Technique

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ABSTRACT

The purpose of this investigation was to determine whether lyophilization or freeze-drying Aceclofenac could improve the solubility of the medicine, making it more easily dissolved into tablets. The drug aceclofenac is classified as a biopharmaceutical classification system (BCS) class II medicine. The lyophilization process was facilitated by the addition of SLS as an adjuvant, which has the potential to enhance the dissolving rate. Aceclofenac was swiftly released from fast-dissolving tablets by including an appropriate ratio of PVP K-30. Aceclofenac from a lyophilized sample dissolved at a much faster pace than plain aceclofenac *in-vitro*. The amount of polymer had an effect on the dissolving rate. The dissolving efficiency of the drug and polymer is enhanced at a 1:2 ratio. Therefore, aceclofenac can be effectively dissolved using the lyophilization procedure.

Keywords: Fast dissolving tablet, Freeze drying, Solid dispersion, Solubility, Dissolution.

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INTRODUCTION

Solubility, defined as the degree to which a solute dissolves in a solvent to produce a homogenous solution, is an important property to take into account when aiming to achieve the desired concentration of medication in the systemic circulation and the expected pharmacological response.[1] One of the biggest challenges in developing new chemical entities or generics is their low water solubility. Water is nearly insoluble for almost 40% of innovative chemical entities (NCEs) created by the pharmaceutical sector. Formulation scientists face a significant obstacle in solubility[2] in the site of absorption and must have a solution of any medicine that is to be absorbed. To improve the solubility of pharmaceuticals that aren't very soluble, researchers employ a wide range of strategies. Many more examples include physical and chemical modifications to drugs, engineering of crystals, production of salts, solid dispersion, usage of surfactants, complexation, and countless more. The method to improve solubility is decided by the drug's characteristics, the site of absorption, and the attributes sought for the dosage form, freeze-drying, or lyophilization, is a technique. The procedure begins with the sample being frozen in order to dry it, and then continues with the extraction of any remaining moisture. Primary drying, which involves sublimation, and secondary drying, which involves desorption, are the two stages in the process of moisture removal.[3-5] A technique known as freeze-drying or lyophilization relies heavily on the sublimation phenomena.[6,7] When water goes straight from its solid to its vapor form, skipping the liquid phase entirely, this process is known as sublimation. Water can sublimate at temperatures as low as 0.0099°C and pressures as low as 4.579 mm Hg. In order to freeze-dry a sample, the liquid must first be frozen, and then it must be placed in a vacuum and slightly heated until it sublimes, becoming a dried sample. Lyophilization and freeze drying rely on the water vapor concentration gradient between the drying front and condenser to drive the elimination of all solvents, including water.[8-10]

One example of a phenylacetic acid derivative is aceclofenac, which is a member of a class of drugs known as NSAIDs. Light and hydrolytic stress (neutral, acidic, and alkaline) cause its degradation; it is a prodrug of diclofenac. When solid, the chemical is unaffected by heat, photolytic stress, or oxidative stress. Almost insoluble in water, it dissolves completely in acetone and is very soluble in ethanol (96%). The solid has a white crystal structure. It goes through

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hepatic first-pass metabolism after oral administration and is absorbed at a rate of 15%. Aceclofenac has low bioavailability because of its little solubility and first-pass metabolism. There is a 25-liter distribution volume and a 4-hour elimination half-life. When compared to naproxen and phenylbutazone, the pharmacodynamic profile is better, but it is comparable to diclofenac and indomethacin. Oral, rectal, and injectable forms of aceclofenac are all on the market.[11]

There are three primary ways in which drugs can be made more soluble in solid dispersions: first, by coming into direct contact with the hydrophilic carrier, which increases their wettability; second, by decreasing the particle size, which increases their surface area; and third, by converting them from a crystalline to an amorphous state, which is more soluble. The chosen model medication, aceclofenac, has a low bioavailability of 15% and is only slightly soluble in water (0.079 mg/mL).[12] Therefore, the goal is to increase the drug's solubility in water by means of the lyophilization process. When used orally, the nonsteroidal anti-inflammatory drug aceclofenac has a low rate of absorption due to its low water solubility.[13] The oral administration of drugs is associated with certain unwanted side effects, such as gastrointestinal discomfort, hence there is a significant deal of interest in developing unique formulations to increase oral mucosa drug absorption. The drug enters the bloodstream *via* this site of absorption instead of the gastrointestinal tract or the liver's first-pass metabolism.[14]

MATERIAL AND METHODS

Materials

Aceclofenac was a gift sample from Amoli Organics Pvt Ltd Vapi Gujrat. PVP K 30 was purchased from SDFCL Hyderabad. Croscarmellose sodium and aspartame as purchased from Research Lab Pvt Ltd Mumbai, Maharashtra.

Methods

Preformulation studies

The initial and most important stage in developing a dosage form is preformulation testing. The term "formulation" refers to the physicochemical characterization of a compound's solids and solution properties that occurs before the actual formulation of a stable and biopharmaceuticals-suitable drug dosage form. This includes all investigations conducted on a novel medicinal compound.[15]

Characterization of drug candidate

A medication must be characterized in order to be identified, its purity must be confirmed, and its physicochemical qualities must be determined in order to aid in the development of a specific dosage form. The aceclofenac sample was examined using a battery of tests, including identification, solubility, melting point, ultraviolet (UV), fourier transform infrared (FTIR), and dynamic scattering calorimetry (DSC) analyses.[16]

Organoleptic parameter

Color and smell were examined in the aceclofenac sample.

- *Melting point determination*

One way to identify and gauge a drug's purity is by measuring its melting point. The capillary method was used to determine aceclofenac's melting point using melting point equipment. A previously sealed glass capillary tube was filled with fine aceclofenac powder. After attaching a thermometer to the capillary tube, it was placed into the melting point device. A thermometer was dipped into the liquid paraffin device to determine the temperature at which the medication began to melt.[17]

- *Loss on drying*

Using a digital weighing scale (Shimadzu BL2200H), 1 gram of aceclofenac was measured in a petri dish. The weight of the dish and the aceclofenac were also measured. The petri dish containing the aceclofenac was heated in a laboratory hosp 230 oven to 105°C for 2 hours. After cooling, the weight of the plate and aceclofenac were measured again, and the limit of detection (LoD) was determined using the following formula.[18]

LoD = Initial weight–final weight/Initial weight x 100

FTIR spectroscopy

Spectral analysis was performed on the recorded infrared spectrum sample. The IR (Brucker alpha) instrument was used to evaluate the dried drug sample. When it comes to identifying chemicals, infrared spectroscopy is a crucial analytical tool. FTIR was used to examine the drug-polymer interaction. The FTIR spectra were captured for the substance in its pure form. A range of 400–4000 cm^{-1} was scanned.[19]

UV-vis spectrophotometric method for aceclofenac

- *Determination of λ_{max}*

Using a UV spectrophotometer (UV-, Shimadzu, 1800) in a mixture of ethanol, phosphate buffer (pH 6.8), and distilled water, standard Aceclofenac solution was scanned from 200 to 400 nm.

- *Calibration curve of aceclofenac in ethanol*

In 100 mL of ethanol (1000 µg per mL) was used to dissolve 100 mg of aceclofenac. A total of 1-mL of this solution and added 100 mL to get the final volume. The resulting solution was used as a stock solution, and it was diluted with ethanol to make subsequent solutions with strengths ranging from 5 to 30 µg/mL. At a wavelength of 276 nm, the solutions mentioned above were examined using a UV Spectrophotometer (UV-, Shimadzu, 1800).

Assay of aceclofenac

- *Determine by UV-vis spectrophotometer*

In 100 mL of ethanol (1000 µg per mL) was used to dissolve 100 mg of aceclofenac. The volume was increased to 10 mL by withdrawing 1-mL of this solution. A further 1-mL of this solution was removed, and the volume was increased to 100 mL. At a wavelength of 276 nm, the solutions mentioned above were examined using a UV Spectrophotometer (UV-, Shimadzu, 1800). Aceclofenac's absorbance and slope were used to find the concentration.

• *Solubility study*

In 20 mL of a variety of solutions (distilled water, ethanol, and phosphate buffer at pH 6.8) were added to 50 mL glass vials containing an excess of aceclofenac. The samples were subjected to sonication for 10 minutes at room temperature before being shaken for 24 hours at 37 ± 0.1°C using a mechanical shaker. Glass vials were left at 37°C for 24 hours to equilibrate. After the solution was diluted to an appropriate concentration, the supernatant was filtered through Whatman filter paper. The amount of medication dissolved was then measured using spectrophotometry (UV-, Shimadzu, 1800) at 276 nm. In order to choose an appropriate dissolution media for *in-vitro* drug release investigations, this study was also conducted. We repeated all solubility tests six times.

• *Compatibility study*

Each drug and the drug:excipient (1:1) mixture were subjected to a 14-day compatibility evaluation in a sealed glass container at 55°C. Prior to adding the drug and ingredients to the glass vials, each one was analyzed using an infrared (IR) graph. After 14 days at 55°C and 75% RH, the vials were checked for any changes in color, gas formation, caking, or liquefaction. Finally, after 14 days, the IR of each vial was examined.

Selection of carriers or optimization of carriers

• *Physical mixtures*

A homogenous mixture was achieved by combining Aceclofenac and PVP K 30 with PEG 6000 and mannitol in 1:1 and 1:2 weight/volume ratios (Table 1) for 10 minutes in a mortar. Before further examination, the combinations were placed in airtight containers after being sieved *via* a 60-mesh sieve.

• *Freeze-dried (lyophilized) solid dispersions*

We used the freeze-drying process to create each SD preparation with a unique ratio of aceclofenac and PVP K 30, PEG 6000, and mannitol in 1:1 and 1:2 weight/weight (Table 2) With use of a magnetic stirrer, aceclofenac was weighed and mixed with a 5% ethanolic solution of PVP K 30, PEG 6000, and mannitol in 1:1 and 1:2 weight/weight ratios, respectively. Next, fill the beaker up to one-third of its contents with the sample. After that For 24 hours, the sample was placed in a freezer (Freezer Unicryo) and frozen to -20°C. Then, it was lyophilized in a freeze dryer (Bio Era clout) at -49°C under a vacuum of 23 Pa. After being freeze-dried, the material was passed through a 60-mesh sieve and kept in sealed containers until it was time for additional testing.

Analysis of solid dispersions (PM and Lyophilized)

• *Solubility study*

Twenty milliliters of distilled water was added to 50 mL glass vials that already had an excess of solid dispersion. After sonicating the samples for 10 minutes at ambient temperature, the capped glass vials were subjected to a mechanical shaker set at 37 ± 0.1°C for 24 hours. The glass vials were left at 37°C for 24 hours to equilibrate. Spectrophotometric analysis was performed at 276 nm after appropriate dilution using a UV-, Shimadzu, 1800, and the supernatant solution was subsequently filtered through Whatman filter paper to determine drug concentration. In order to choose an appropriate dissolution media for *In-vitro* drug release investigations, this study was also conducted. We repeated all solubility tests six times.

• *FTIR spectra*

FTIR was used to examine the drug-polymer interaction. Using FTIR spectra of PVP K30, pure medication, PM, and lyophilized solid dispersion were recorded. The range of detection was 400 to 4000 cm^{-1}.

Manufacturing process

• *Preparation of solid dispersion by freeze drying of aceclofenac and selected carrier*

Using the freeze-drying process, a variety of SD preparations were made, each containing a different ratio of aceclofenac and PVP K30. The ratios ranged from 1:1 to 1:2 w/w. A 5% ethanolic solution of PVP K 30 was mixed with weighed aceclofenac in 1:1 and 1:2 weight/weight ratios while being agitated with a magnetic stirrer. Next, fill the beaker up to one-third of its contents with the sample. After that for 24 hours, the sample was placed in a freezer (Freezer Unicryo) and frozen to -20˚C. Then, it was lyophilized in a freeze dryer (Bio Era clout) at -49˚C under a vacuum of 23 Pa. After being freeze-dried, the material was passed through a 60-mesh sieve and kept in sealed containers until it was time for additional testing.[20]

• *Formulation of orodispersible tablet by direct compression*

Aceclofenac orodispersible tablets were made by compressing the drug directly using a rotating tablet compression machine. As shown in Tables 3 and 4, the excipients were mixed with the aceclofenac and PVP K 30 solid dispersions in a ratio of 1:1 and 1:2, respectively. The formulations' constituents were all passed through sieve #60, with the exception of the lubricant and glidant. The first step in creating a consistent powder blend was to mix the solid dispersion with the sodium lauryl sulfate, croscarmellose sodium, aspartame, talc, and microcrystalline cellulose in a mortar and pestle. Lastly, magnesium stearate was added and stirred for one to two minutes. The last mixture was tested and then compressed into tablets using a Jaguar JMD 4 to 8 rotary tablet compression machine with a 10-mL flat die and punches. All of the formulations maintained a consistent tablet weight of 350 mg. Tablets evaluated for various parameters.

• *Evaluation parameter*

These include the pre-compression and post-compression characterization of tablets.

• *Precompression study*

These include the density, angle of repose, hausner's ratio and compressibility index.

• *Bulk density*

Two grams of powder was transferred to a 10-mL measuring tube. Without removing the cylinder, we measured the powder's

Table 1: Ratios of solid dispersion

Solid dispersion	*Ratio (%w/w)*
Aceclofenac + PVP K 30	1:1
	1:2
Aceclofenac + PEG 6000	1:1
	1:2
Aceclofenac + Mannitol	1:1
	1:2

volume and used the following equation to determine its bulk density:

Bulk density = Mass of powder/Bulk volume

- *Tapped density*

Two grams of powder was transferred to a 10-mL measuring tube. The cylinder was thereafter tapped a certain number of times (100 times) until the volume of the powder bed reached the lowest level. The following calculation was used to compute the tap density and record the final volume:

Tapped density = Mass of powder/Tapped volume

- *Compressibility index*

The formula that was used to determine the compressibility of the powder was

% compressibility = Tapped density – bulk density/Tapped density x 100

- *Hausner's ratio*

In order to determine the powder's Hausner ratio, the following formula was used:

Hausner's Ratio = Tapped density/Bulk density

- *Angle of repose*

A clamp was used to hold a funnel such that its stem was 1.5 cm above the graph paper, which was laid flat on a surface. With the funnel's opening blocked, 5 grams of powder was carefully measured and poured into it. Until the conical pile's apex is flush with the funnel's tip, the powder was permitted to flow by removing the obstruction. By using a ruler to measure the average of six diameters generated by the powder pile and the height of the pile (h), we were able to establish the angle of repose.

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

Where; h = height of pile,
r = radius of the base of pile,
θ = angle of repose.

Based on the results obtained from the above mentioned characterizations the formulation was developed. The results for all API characterizations were discussed in result and discussion.

Table 2: Compatibility study data

Physical mixture	*Observation*			
	Color change	*Cake formation*	*Liquefaction*	*Gas formation*
Aceclofenac + PVP K30	NO	NO	NO	NO
Aceclofenac + PEG 6000	NO	NO	NO	NO
Aceclofenac + Mannitol	NO	NO	NO	NO
Aceclofenac + Croscarmellose sodium	NO	NO	NO	NO
Aceclofenac + SLS	NO	NO	NO	NO
Aceclofenac + Aspartame	NO	NO	NO	NO
Aceclofenac + Talc	NO	NO	NO	NO
Aceclofenac + Magnesium Stearate	NO	NO	NO	NO
Aceclofenac + MCC	NO	NO	NO	NO

Table 3: Batches of formulations containing solid dispersion in 1:1 ratio

Code ingredients (mg)	*A1*	*A2*	*A3*	*A4*
Aceclofenac	100	100	100	100
PVP K 30	100	100	100	100
Croscarmellose sodium	30	20	10	0
SLS	6	6	6	6
Aspartame	3	3	3	3
Talc	6	6	6	6
Mg sterate	1.4	1.4	1.4	1.4
MCC	103	113	123	133
Total weight	350	350	350	350

Table 4: Batches of formulations containing solid dispersion in 1:2 ratios

Code Ingredients (mg)	B1	B2	B3	B4
Aceclofenac	100	100	100	100
PVP K 30	200	200	200	200
Croscarmellose sodium	30	20	10	0
SLS	6	6	6	6
Aspartame	3	3	3	3
Talc	6	6	6	6
Mg.Sterate	1.4	1.4	1.4	1.4
MCC	3	13	23	33
Total weight	350	350	350	350

Table 5 : Organoleptic properties of aceclofenac

Description	*Standard*	*Observed*
Color	Off-white to white powder	Off-white to white powder
Odor	Odorless	Odorless
Taste	Bitter	Bitter

Post-compression studies of tablets

- *General appearance*

Tablets must have a certain "elegance" and "visual identity" in order to be well-received by consumers. Size, form, color, smell, taste, surface texture, consistency, and the legibility of any identifying markings on the tablet are all part of it.

- *Hardness*

An absolute minimum hardness of 11.3 N (1.12 Kg/cm^2) was necessary for the successful manufacture of sublingual tablets. A hardness tester was used to assess the crushing strength of each formulation of Monsanto tablets, which were selected at random from all of the tablets. The tablet was found to have fully broken in half when it was placed diagonally between the tester's plungers and the pressure was measured in Kg/cm^2.

- *Thickness*

It is measured with the help of Vernier Callipers. Keep the thickness within a 50% range of a reference value.

- *Friability*

The mechanical strength of the tablets was tested after determining their friability using the Roche friabilator. The amount by which the test tablets' weight decreased after being dusted and reweighed is a percentage that represents their friability.

Table 6: Reported IR frequencies of aceclofenac

S. No.	*Peak assignments*	*Practical values*
		Frequency (cm^{-1})
1.	N-H Stretching	3319
2.	O-H Stretching	2940
3.	C-O Stretching	1740
4.	C=C Stretching	1548.19
5.	C-N aromatic amine	1272
6.	O-H Stretching	952
7.	N-H Bending	744

Table 7: Assay of aceclofenac

Parameter	*Observed % Purity*	*Standard*
Aceclofenac	97.5%	95–105%

Table 8: Solubility of aceclofenac in different solvents

Medium	*Solubility (mg/mL)*
Distilled water	0.079
Phosphate buffer 6.8	0.095
Ethanol	10

$$\%\ friability = \frac{\text{Initial wt. of tablets} - \text{Final wt. of tablets}}{\text{Initial wt. of tablets}} \times 100$$

If the tablet's total weight is less than or equal to 650 mg, then you should collect a full sample of around 6.5 mg. Ten complete tablets should be sampled for tablets whose unit weight exceeds 650 mg. Before testing, make sure the tablet is well dedusted. Before placing the tablet in the drum, make sure you accurately weigh the sample tablet. After 100 rotations, take the tablets out of the drum. Before correctly weighing the tablets, make sure to remove any loose dust.

- *Weight variation*

The purpose of this research is to examine the mass 20 of the formulation's tablets were measured using an electronic balance in accordance with the established protocol. In 20 tablets were chosen at random from each batch and weighed separately to ensure uniformity in weight.

- *Wetting time and water absorption rate*

Although it is not a USP standard test, the wetting test is helpful for evaluating these orodispersible tablets and ensuring quality control. Wetting tests, in contrast to disintegration tests, utilize far less water, suggesting they may be more indicative of the amount of salivary moisture present in the mouth. Wetting time for tablets was measured according to the protocol described by Bi *et al.*[16] In a small petri dish with an internal diameter of 6.5 cm, 6 mL of buffer with a pH of 6.8 and a small volume of orange-red dye were added to a sheet of tissue paper that had been folded twice (12 x 10.75 cm). The time it took for the tablet to completely moisten the paper was then measured. Three tablets were tested, and the mean and standard deviation were determined. The wetted tablet was then weighed. Water absorption ratio R, was obtained using the following equation,

$$R = 100 * (W1 - W2) / W1$$

Where;
W1 = tablet weights before.
W2 = tablet weights after.
R = water absorption ratio.

- *Disintegration test*

Using a disintegration apparatus (Electrolab), tablets are broken down. Six tablets were chosen at random from every formulation. To ensure that the tablets do not float during the disintegration test, they are inserted one by one in each tube of the equipment. The time it took for the full tablet to disintegrate completely was recorded and the phosphate buffer pH 6.8 was kept at a temperature of 37° ± 2°C.

- *In-vitro drug release/Dissolution studies*

Orodispersible tablet dissolution studies were conducted using an Electrolab TDL08L, which is a category II dissolution equipment according to the US Pharmacopeia. The release was accomplished at 37° ± 0.5°C by keeping the paddle's rotation speed at 50 rpm, with 900 mL of phosphate buffer (pH 6.8) serving as the dissolving media. At certain times, 5 mL of the sample was removed and kept in a sink. The samples were examined using a UV spectrophotometer set to

Table 9: Ratios and their solubility

Solid dispersion	*Ratio (% w/w)*	*Physical mixture solubility (mg/mL)*	*Lyophilized solid dispersion solubility (mg/mL)*
Aceclofenac + PVP K 30	1:1	0.080	0.225
	1:2	0.083	0.410
Aceclofenac + PEG 6000	1:1	0.070	0.079
	1:2	0.075	0.095
Aceclofenac + Mannitol	1:1	0.091	0.1
	1:2	0.093	0.11

Table 10: Pre-compression characterization of tablets

Batches	*Bulk density (gm/mL)*	*Tapped density (gm/mL)*	*Hausner's ratio*	*Carr's index (%)*	*Angle of repose (0)*
A1	0.483	0.584	1.20	17.29	27.02^0
A2	0.483	0.564	1.16	14.36	28.81^0
A3	0.475	0.586	1.23	11.11	28.81^0
A4	0.495	0.564	1.23	11.87	30.11^0
B1	0.483	0.555	1.14	12.97	26.50^0
B2	0.483	0.564	1.16	14.36	27.02^0
B3	0.475	0.564	1.18	15.78	28.36^0
B4	0.495	0.555	1.11	10.40	32.21^0

Table 11 : Determination of post compression parameters for orodispersible tablet of aceclofenac

Batch code	*Hardness (Kg/cm^3)*	*Friability (%)*	*Thickness (mm)*	*Weight variation (%)*	*Wetting time (sec)*	*Disintegration Time(sec)*
A1	2.87 ± 0.216	0.76	4.07 ± 0.08	350 ± 17.5	28.46 ± 0.69	39.95 ± 1.06
A2	2.8 ± 0.2	0.61	4.075 ± 0.08	350 ± 17.3	35.28 ± 0.47	49.69 ± 1.01
A3	2.8 ± 0.141	0.92	4.05 ± 0.05	350 ± 17.6	43.1 ± 3.9	52 ± 0.70
A4	2.9 ± 0.1	0.61	4.05 ± 0.05	350 ± 17.5	412.33 ± 9.8	589.5 ± 13.94
B1	2.875 ± 0.19	0.61	4.05 ± 0.08	350 ± 17.6	25.66 ± 0.42	36 ± 1.30
B2	2.8 ± 0.14	0.76	4.05 ± 0.05	350 ± 17.3	33.63 ± 0.37	50.05 ± 1.09
B3	2.92 ± 0.19	0.78	4.05 ± 0.08	350 ± 417.5	42.1 ± 1.55	55.45 ± 0.89
B4	3 ± 0.12	0.92	4.05 ± .0.05	350 ± 17.3	408.5 ± 14.1	582.8 ± 22.76

a specified wavelength of 276 nm after passing them through whatman filter paper. The experiment was repeated three times for each formulation, and the total percentage of drug release was determined.

- *Content uniformity*

A 100 mL volumetric flask was filled with powder that was 100 mg strong, which was made by weighing and grinding

Table 12 (A): Dissolution study of formulation

Time (min)	*Cumulative drug release (%)*			
	A1	*A2*	*A3*	*A4*
10	38.33 ± 15.43	24.67 ± 10.32	27.64 ± 11.13	3.19 ± 1.52
20	52.12 ± 7.57	40.64 ± 4.85	42.08 ± 1.68	22 ± 1.69
30	69.06 ± 5.29	51.08 ± 2.70	48.48 ± 1.78	29.20 ±2.38
40	80.40 ± 2.15	63.79 ± 1.15	58.63 ± 2.28	36.41 ± 2.58
50	80.40 ± 2.15	63.79 ± 1.15	60.16 ± 1.72	44.37 ± 1.16
60	80.40 ± 2.15	63.79 ± 1.15	60.16 ± 1.68	47.38 ± 2.03

Table 12 (B): Dissolution study of formulation

Time (min)	*Cumulative Drug Release (%)*			
	B1	*B2*	*B3*	*B4*
10	40.13 ± 16.53	36.35 ± 14.84	26.01 ± 11.28	10.65 ± 4.77
20	57.05 ± 6.02	49.29 ± 2.98	38.72 ± 5.53	31.23 ± 3.94
30	81.27 ± 3.46	67.29 ± 2.08	45.70 ± 7.24	38.94 ± 3.64
40	95.45 ± 1.79	81.44 ± 2.18	57.70 ± 4.37	48.96 ± 2.14
50	95.55 ± 1.79	81.48 ± 2.18	76.27 ± 1.67	55.91 ± 2.50
60	95.55 ± 1.79	81.48 ± 2.18	76.23 ± 1.52	60.49 ± 0.81

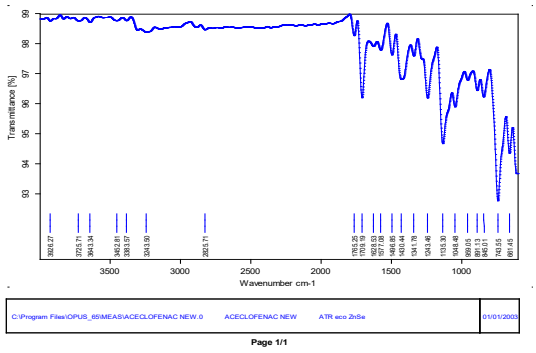

Figure 1: FTIR Spectra of aceclofenac

five tablets. The required amount of ethanol was added by shaking, and the volume was then adjusted accordingly. A 100 mL volumetric flask was filled to the mark with 1-mL of filtered solution. A blank solution of ethanol was used to measure absorbance at 276 nm.[21]

RESULT AND DISCUSSION

Identification and Characterization of Drug

Organoleptic characteristics

Aceclofenac's color, smell, and taste, which are organoleptic traits were studied. The substance was determined to have an off-white hue, and its aroma could be detected solely by smelling it (Table 5).

There was no discernible difference between the drug's organoleptic properties and the standard features [IP].

- *Melting point*

Practically it was found that drug melts at 150ºC the standard melting point of the Aceclofenac is 149 to 153ºC.

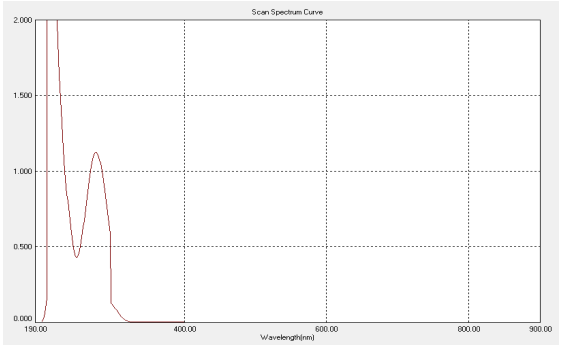

Figure 2: Determination of λ_{max} of aceclofenac in ethanol

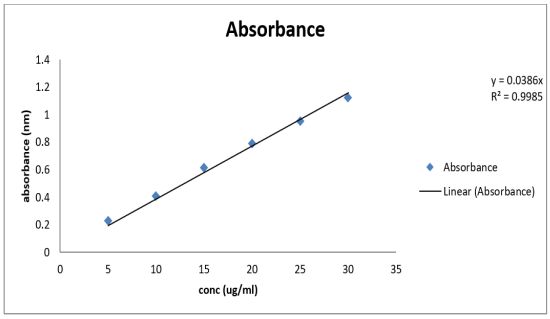

Figure 3: Calibration curve of Aceclofenac

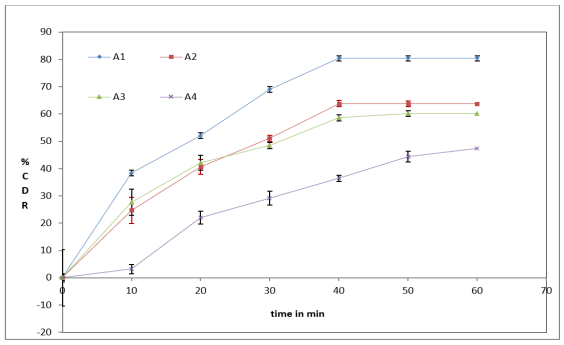

Figure 4 (A): Dissolution profile of formulations

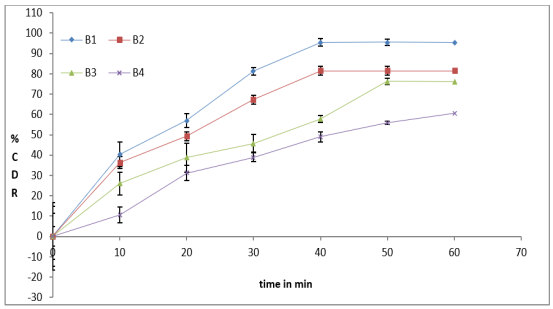

Figure 4(B): Dissolution profile of formulations

- *Loss on drying*

Loss on drying of aceclofenac sample was observed to be 0.4%.

FTIR study

The FTIR spectra of aceclofenac were observed as follows (Figure 1, Table 6).

- *UV Spectrophotometric method for Aceclofenac*

Using a UV spectrophotometer we measured the drug solution's maximal absorbance in the 200 to 800 nm range relative to that of blank ethanol and drug solutions.

- *Determination of λ_{max}*

λ max of aceclofenac obtained in ethanol in the 200 to 800 nm range.

- *Preparation of stock solution*

λ_{max} of aceclofenac obtained as shown in Figure 2.

Calibration curve of aceclofenac in ethanol

A concentration of 10 µg/mL of aceclofenac is achieved by appropriately diluting the stock solution with ethanol. Using a UV spectrophotometer, we measured the drug solution's maximal absorbance in the 200 to 800 nm range relative to that of blank ethanol. The drug's absorbance maximum is the peak in the spectra that shows the highest absorption (Figure 3).

- *Assay of aceclofenac*

The sample of aceclofenac was evaluated for assay and results were obtained as per Table 7.

- *Solubility study*

The solubility of aceclofenac was determined and results were obtained as per Table 8.

Formulations and development

- *Selection of carriers or Optimization of carriers*

Prepared solid dispersion and physical mixtures with different polymers with different ratios was evaluated for its solubility (Table 9).

- *Precompression study*

The freeze-dried powder was mixed with excipients and these powders were subjected for evaluation of the following parameters. Results are presented in Table 10.

- *Post-compression evaluation*

Tablets were prepared and evaluated for the following parameters (Table 11).

- *In-vitro drug release study*

We dissolved each formulation in phosphate buffer (pH 6.8) for 60 minutes to determine their *in-vitro* drug release characteristics. The results suggest that formulation B1, which contains 35 mg of superdisintegrant croscarmellose sodium and a carrier concentration of 1:2 (aceclofenac: PVP K30), has the best release rate. B1 is considered for kinetic release study (Table 12A and 12B, Figure 4A and Figure 4B).

CONCLUSION

The purpose of this research was to develop an orodispersible tablet containing the nonsteroidal anti-inflammatory drug aceclofenac. Improving overall therapy outcomes is the goal of this investigation. We used fourier transform infrared (FTIR) spectroscopy to investigate drug excipient compatibility. After analyzing the FTIR results, it was determined that the medicine

and excipient are compatible because their IR spectra do not overlap. Based on the results of this study, lyophilization, also known as freeze drying, is a very effective approach for increasing the solubility of drugs. The direct compression method was used to make the tablets. The tablet was prepared using croscarmellose sodium, a superdisintegrant, to ensure an appropriate disintegration and dissolution time. Here we show an orodispersible tablet that uses the idea of co-processed excipients to allow for the customization of solid-form medication dosages. The results of the aforementioned research led to the following conclusions: There is agreement between the drug's infrared spectra and the frequencies of its typical functional groups. No interactions were observed between the medication and the excipients. The medicine was safe to use with all of the excipients. No drug-excipient interaction was found in the IR tests. This study shows that the solubility of aceclofenac may be enhanced from 0.079 to 0.410 mg/mL by employing the freeze-drying process. It is evident from the *in-vitro* drug release analysis that batch B1 provides the greatest drug release of 95.55% in 1-hour. The goal of an orodispersible tablet was thus accomplished by the B1 batch formulation. According to the results of the aforementioned studies, it is evident that the batch B1 formulation accomplished all of the research goals. Its outstanding flowability capabilities were observed in the evaluation of the freeze-dried solid dispersion and physical mixture. The produced tablets satisfied all of the required pharmacopoeial standards (IP, BP, USP) and were mechanically stable, according to evaluation criteria such as hardness and friability. The B1 formulation of tablets had the quickest wetting and disintegration times according to the evaluation criteria. This study found that the release of aceclofenac rises with increasing polymer content.

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