Original Article

FUTURE JOURNAL OF PHARMACEUTICALS AND HEALTH SCIENCES

Published by Pharma Springs Publication Journal Home Page: https://pharmasprings.com/fjphs

Formulation and evaluation of nifedipine fast dissolving tablets

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Article History:

Received on: 13 Jan 2024
Revised on: 18 Feb 2024
Accepted on: 20 Feb 2024

Keywords:

Nifedipine,
Disintegration,
Fast Dissolving,
Tablets

Abstract

The current study aims to formulate and evaluate the fast-dissolving tablet. The optimal concentration of Guar gum super disintegrate was found to be 20 mg, with a disintegration time of 27 seconds. This study assessed the disintegration time of tablets containing natural super disintegrant for the Disintegration test at various weight concentrations (6,8,10,12,14,16,18, and 20 mg). As a result, the Nifedipine fast dissolving tablets with Guar gum super disintegrant provide a quick therapeutic effect, a high dissolve rate, and a shorter disintegration time. In this study, the use of a natural (guar gum) super disintegrating agent increases the rate of dissolution as well as length of disintegration of fast-dissolving tablets. In vitro drug release of 96% is demonstrated in 6 minutes with a disintegrating efficiency of 27 seconds for Nifedipine FDTs (guar gum). Consequently, our study has shown that formulations made with a natural super disintegrating agent exhibit shorter disintegration times as well as higher rates of dissolution along with drug release.

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eISSN: 2583-116X
DOI: https://doi.org/10.26452/fjphs.v4i2.599

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INTRODUCTION

Since FDDS dissolves easily in saliva and can be eaten without water, it is a great substitute for pills, syrups, and capsules for both paediatric and geriatric patients. This is a significant advantage over traditional lozenge form. Due to its special qualities, it is very important in the pharmaceutical sector [1]. Since oral drug delivery is inexpensive, easy to administer compared to other methods, and a convenient means of self-medication and pain relief, it has been in use for a long time. There can be a lot of issues with elderly people and patients who are not cooperative. Disintegrating or fast-disposing tablets (FDTs) are intended as substitute oral dose forms to get around these problems [2]. The Food and Drug Administration (FDA) describes FDTs as a "solid dosage form containing medicinal substances that, when placed on the tongue, dissolve instantly within seconds." European Pharmacopoeia states that the FDT should scatter or dissolve in less than three minutes. The development of FDT that uses super disintegrates—a tablet that quickly dissolves on the tongue to release the medicine into saliva—is the most crucial step. Super disintegrates are used to quickly dissolve or disintegrate the tablets. The FDT are also referred to as rapid melts, porous, melt-in-mouth, oral

Table 1 Formulation of Nifedipine FDTS

Ingredients(mg)	F1	F2	F3	F4	F5	F6	F7	F8
Nifedipine solid dispersion	10	10	10	10	10	10	10	10
Guar gum	6	18	10	12	14	16	18	20
Dextrose	76	74	72	70	68	66	64	62
Magnesium stearate	4	4	4	4	4	4	4	4
Talc	4	4	4	4	4	4	4	4
Total	100	100	100	100	100	100	100	100

Table 2 Flow properties of blended granules

Flow Property	Angle of Repose(ϴ)	Carr's Index (%)	Hausner's Ratio
Excellent	<25	<10	1.00-1.11
Good	25-30	11-15	1.12-1.18
Fair	31-35	16-20	1.19-1.25
Passable	41-45	21-25	1.26-1.34
Poor	46-55	26-35	1.35-1.45
Very Poor	56-65	32-37	1.46-1.59
Very Very Poor	>66	>38	>1.6

dispersible, mouth dissolving, and quick dissolving tablets, among other terms [3].

MATERIALS AND METHODS

Materials:

Nifedipine was bought from Carbanio, an online supplier for API in Hyderabad. Guar gum and acetone were bought from High Pure Fine Chemicals in Chennai, while PEG6000 and dextrose were obtained from Research Lab Fine Chemicals in Mumbai. S.R. Scientifics, Tirupati, supplied the magnesium stearate and talcum powder.

Methodology:

Preparation of solid dispersion of Nifedipine-PEG6000:

The solid dispersions of Nifedipine-PEG6000 were produced using the solvent evaporation method. This method used solvent evaporation to prepare a solid dispersion of Nifedipine. [4] The physical mixture of Nifedipine and PEG6000 was dissolved in an appropriate amount of acetone in a beaker, and the solution was heated on a heating plate until the solvent was evaporated; to remove excess solvent, place it in a desiccant overnight. The obtained substance was scraped and pulverised. The percentage yield was determined to be 85%.

Formulation of Nifedipine FDTS

The direct compression method was used to manufacture fast dissolving tablets containing Nifedipine solid dispersion. The tablet formulation is made with different amounts of guar gum, a natural super disintegrant. All of the materials and additives were sieved separately through a 60# sieve, Magnesium stearate and Talc through a 40# sieve, and then co-ground in a motor pestle. These combined blended drug-excipients were compressed using a single punch tablet machine to make convex-face tablets.

EVALUATION PARAMETRS OF FDTS

PRE-COMPRESSION PARAMETERS [5-7]:

Prior to the compression of tablets, the powder's pre-compression properties were investigated.

A. Angle of repose (θ):

The flow characteristic of every particular powder sample is its angle of repose. The formula yields the angle of repose, often known as the critical angle of repose.

$$\mathbf{Tan\theta = h/r}$$

B. Carr's index (%):

The Carr's index, commonly known as the compressibility index. It serves as an indicator of how easily powder can be compacted. The compressibility index is a measurement of a powder's capacity to be compressed. Using the

bulk as well as tapped densities, the following formula is used to get Carr's index:

Carr'sindex = [Vt – Vb/Vt] × 100

The Carr's index is widely used to determine how easily a powder flow.

C. Bulk density (g/cm^3):

The mass to volume ratio of an untapped powder sample, accounting for the inter-particulate void volume, is known as the bulk density of a powder. Because of this, the bulk density is dependent on both the powder particle density as well as the powder bed's particle configuration in space.

Bulkdensity = M/Vb

D. Tapped density (g/cm^3):

The term "tapped density" describes the rise in bulk density that results from mechanically tapping a powder sample container. Following the initial measurement of the powder's mass or volume, the measuring cylinder or vessel is mechanically tapped, and measurements of mass or volume are gathered until minimal changes in mass or volume are noted. It was specified how long the powder would be tapped for and how many times. After tapping, the powder's mass and volume were determined.

Tapped density = M/Vt

E. Hausner's ratio:

The flow capacity of a powder or granular material can be determined using a measurement called the Hausner's ratio. A powder's flowability is shown by the Hausner's ratio, which is utilised in many different sectors.

Appearance

In order to detect any physical or surface roughness in the tablet formulation, twenty tablets of each formulation were obtained. We used calibrated vernier callipers to measure the diameter, thickness, and dimensions. Each formulation had five randomly selected tablets, as well as the dimensions were noted [8].

Uniformity of Weight

Twenty tablets were selected at random from each batch to be tested. 7.5% is the greatest variation that can occur between two or more individuals [9].

Measurement of Tablet Friability

The friability of the tablets was measured, according to I.P., using Roche's Friabilator. Using the following formula, friability is determined:

F=WA-WB/WA×100

Limit of friability for tablets under 1% is acceptable [10].

Measurement of Tablet hardness

Monsanto Hardness with which the tablet's crushability was measured using a tester.

Wetting Period

One double-folded sheet of tissue paper is put in a tiny petri dish with six millilitres of phosphate buffer (pH 6.8) in it. After setting the tablet on it, the amount of time needed for the tablet to get completely wet was recorded [11].

Water absorption ratio [12]

After being folded twice, a piece of tissue paper was put in a tiny petri dish with six millilitres of water. A tablet was left on the paper so that it could get completely soaked. The wetted tablet's weight was recorded.

Using the formula, the water absorption ratio, or R, was calculated.

R=(WA-WB)/WB×100

***In vitro* disintegration time**

The process of a tablet disintegrating into tiny pieces is known as disintegration. Disintegration test equipment in accordance with I.P. requirements was used to calculate a tablet's in-vitro disintegration time. All of the tablets are positioned on each of the six tubes in the basket. Fill each tube with a disc, then operate the device with an immersion liquid of distilled water kept at 37± 2º C. The assembly needs to be raised and lowered 30 times per minute in a pH 7.4 solution kept at 37 ± 2 °C. The duration required for the tablet to completely dissolve and retain no mass inside the device was timed and noted [13].

***In vitro* dissolution studies [14]**

Phosphate buffer with a pH of -6.8 was used as the dissolving medium, and the USP type-2 equipment [50 rpm] was used to measure the dissolution rate. The dissolving media was kept at 37.5º C in temperature. During testing, the bath liquid is

maintained in a steady state. At regular intervals, the sample was taken out, filtered, and, if needed, diluted with a medium. Using a standard calibration curve, the absorbance of the filtered solution was measured at 250 nm using the UV-Spectrometric method to quantify the drug's concentration.

Drug content

Twenty tablets were powdered, weighed, and selected at randomly. Phosphate buffer with a pH of 6.8 was used to dissolve the 50 mg powder aliquots after they were precisely weighed. A thorough shaking of the solution was done. Through Whatman filter paper, the undissolved material was filtered. Next came the series of dilutions. A measurement was made at 250 nm of the diluted solutions' absorbance. A standard curve of nifedipine in phosphate buffer with a pH of 6.8 was used to calculate the drug concentration [15].

RESULTS AND DISCUSSION

Pre-Compression Studies

Table 3 displays the findings of the blended powder characterisation. It was discovered that the Angle of Repose was 17.20–26.25º. The angle of repose was used to assess the blended powder's flow capabilities. The combined powder with agar has good flow characteristics.

The Bulk Density of blended powder varied between 0.425-0.40 g/cm^3

With these bulk as well as tapped density data, Hausner's ratio and Carr's Compressibility Index were computed, and the tapped density was discovered to be between 0.508 and 0.567 g/cm^3. Specifically, all formulas' blended powders have Hausner's Ratios of less than 1.2, which indicates good flow properties. Blends with a compressibility index value of less than 20% were deemed to have good flow characteristics.

The compressibility index values ranged from 13.6 to 16.2. These powder blends are well-compressive and flowable.

Post-Compression Studies

Eight formulations with varying amounts of the super disintegrant, guar gum, were created for nifedipine FDTs. The blend of powder was compressed using the direct compression method. For each batch of prepared Nifedipine FDTs, a number of post-compression parameters were tested. The tablets were discovered to be identical in weight because of the same die fill. The results obtained from post-compression parameters, including weight fluctuation, friability, wetting time, water absorption ratio, and drug content, are displayed in the tables below. The figures below indicate the disintegration time and in vitro drug release.

Weight variation

Since the proportion of weight fluctuation was within the pharmacopeial limitations, all of the Nifedipine FDTs passed the weight variation test. As of right now, all of the FDTs were discovered to weigh similarly, which suggests that the materials were mixed uniformly.

Thickness

The thickness of all formulations ranges from 2.23-3.38 mm.

Friability

The calculated friability values satisfy the official standards and are less than 1%. It was discovered that the tablets' friability ranged from 0.36 to

Table 3 Pre compression parameters for nifedipine FDTs

Formulation	Angle of repose	Bulk density (gm/cm^3)	Tapped density (gm/cm^3)	Hausner's ratio	Carr's compressibility index (%)
F1	28.61	0.50	0.61	1.22	16.42
F2	31.12	0.51	0.60	1.21	14.34
F3	29.40	0.52	0.62	1.28	15.48
F4	30.60	0.53	0.60	1.24	19.29
F5	28.28	0.50	0.63	1.22	17.56
F6	26.36	0.52	0.60	1.16	14.81
F7	31.46	0.56	0.61	1.18	16.28
F8	24.62	0.58	0.62	1.20	16.32

Table 4 Post-compression parameters of Nifedipine FDTs

Formulation	Hardness(kg/cm²)	Friability (%)	Thickness(mm)	Weight variation (mg)
F1	2.08	0.420	2.561	150.75±0.6
F2	2.48	0.431	2.542	149.45±0.4
F3	2.02	0.586	2.528	150.25±0.2
F4	2.08	0.628	2.563	148.25±0.3
F5	2.50	0.412	2.563	150.35±0.8
F6	2.24	0.402	2.563	151.40±0.4
F7	1.98	0.689	2.541	150.38±0.4
F8	2.28	0.433	2.564	149.65±0.2

Table 5 Post-compression parameters of Nifedipine FDTs

Formulation	Water absorption ratio	Wetting time(sec)	Disintegration time(sec)	Drug content
F1	56.08	45	38	92.96
F2	58.56	42	36	90.02
F3	56.04	42	36	92.16
F4	58.64	39	34	93.61
F5	56.45	38	32	89.96
F6	58.62	36	30	94.08
F7	56.08	34	28	96.80
F8	56.02	32	27	98.63

0.72%. which suggests that tablets have strong mechanical indications.

Hardness

For every formulation, the hardness was found to range from 3.13 to 4.63 kg/cm2, indicating strong mechanical strength and the ability to bear both physical and mechanical stress while handling.

Disintegration time

For every formulation, the hardness was found to range from 3.13 to 4.63 kg/cm2, indicating strong mechanical strength and the ability to bear both physical as well as mechanical stress while handling.

Wetting time and water absorption ratio

Every formulation had a water absorption ratio that ranged from 55 to 62 seconds. Because of this, tablets in every formulation were quickly wet, as seen by wetting times that ranged from 35 to 55 seconds.

Drug content

The percentage of drug content of all the tablets was found between 89-96%.

Drug release study

In order to promote the gastrointestinal pH state, the dissolving investigations were conducted in a phosphate buffer with a pH of 6.8. These Nifedipine FDTs are designed to improve the drug's bioavailability and its ability to dissolve in the oral cavity. To observe the drug's release pattern from the complex, a dissolution study of the formulations was conducted. The outcome was shown in Fig. Better medication release is demonstrated by the cumulative proportion of drug released from batch F3, which suggests improved bioavailability. These nifedipine FDTs are designed to increase the medication's bioavailability. Eight batches of nifedipine FDTs were made using the current findings, varying in the amount of super disintegrants. The invitro drug release profile of the formulated batches is shown in Figure 1, which compares all of the created batches. Significant variations were noted in the dissolution profiles of particular batches. The fact that over 95% of the mark dosage was dissolved in less than 12 minutes suggests that all of the chosen compositions have an acceptable level of acceptability. These findings demonstrate that the FDTs are prepared using super disintegrants in order to increase the rate of

Table 6 In-vitro drug release of nifedipine FDTs at different time intervals

Time	F1	F2	F3	F4	F5	F6	F7	F8
1	16.34	17.68	19.48	21.62	23.68	25.84	27.46	31.68
2	24.86	26.68	28.24	30.28	32.46	36.82	39.28	41.86
3	36.42	38.74	41.68	44.42	44.68	49.26	52.86	54.68
4	52.32	56.84	58.76	61.63	63.48	65.42	68.98	74.62
5	60.64	64.48	68.12	72.48	76.48	79.64	82.73	86.96
6	72.86	76.94	82.96	86.64	88.96	90.48	92.46	96.24

Nifedipine FDT disintegration. Agar FDTs, the control batch, demonstrate 90% drug release in less than 12 minutes.

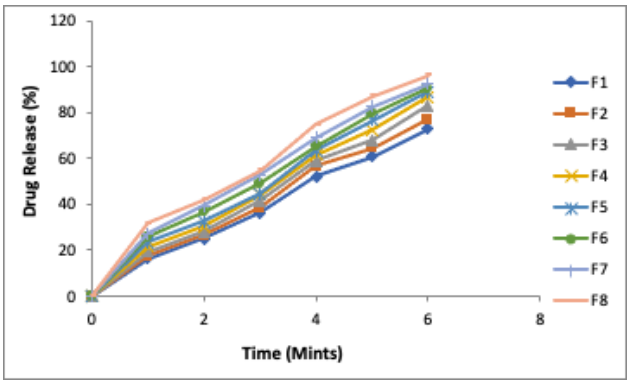

Figure 1 In – vitro drug release of nifedipine

Concentration(µg/ml)	Absorbance(nm)
5	0.124
10	0.235
15	0.354
20	0.484
25	0.605

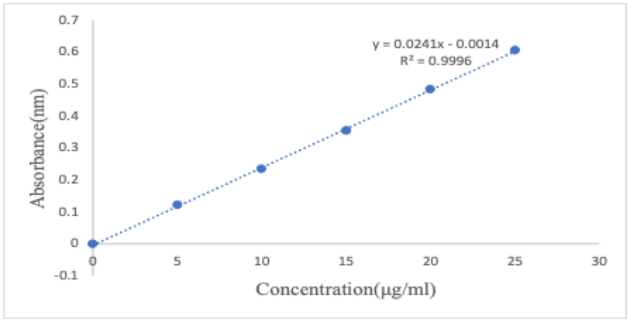

Figure 2 Calibration curve for Nifedipine FDTs

DISCUSSION

The optimum concentration of Guar gum super disintegrant was found to be 20 mg, with a disintegration time of 27 seconds. This was determined by evaluating the disintegration time of tablets containing natural super disintegrant for the Disintegration test at various weight concentrations (6,8,10,12,14,16,18, and 20 mg). As a result, the Guar gum super disintegrant in Nifedipine fast dissolving tablets provides a high dissolve rate, a shorter disintegration time, and a quicker therapeutic effect.

CONCLUSION:

Ultimately, based on this research, it has been concluded that employing natural guar gum (a super disintegrating agent) increases the pace of breakdown and length of the disintegrating period of fast dissolving tablets. Nifedipine FDTs (guar gum) had a disintegrating efficiency of 27 seconds and an in-vitro drug release of 96% in 6 minutes. As a result, our study has shown that formulations made with a natural super disintegrating agent exhibit higher drug release and a reduction in disintegration time.

ACKNOWLEDGEMENT:

The authors are heartily thankful to Dr C. Appa Rao M.Pharm, Ph. D., Principal, Department of Bio-chemistry, Sri Venkateswara University of pharmaceutical sciences, Tirupati-517501, Andhra Pradesh, India for permitting to do the work and providing all the necessary facilities

Funding Support: The Author declares that there is no funding.

Conflict of Interest: The Author declares that there is no conflict of interest.

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