

## FORMULATION AND EVALUATION OF FAST DISSOLVING TABLETS OF BUSPIRONE USING COPROCESSED SUPERDISINTEGRANTS

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### ABSTRACT

**Objective:** The present study aims to formulate and evaluate Fast dissolving tablet of Buspirone, the drug that is used for management of anxiety, by direct compression method using various Super disintegrants.

**Methods:** Ten formulations (F1-F10) of fast dissolving tablets of Buspirone were prepared by using various Superdisintegrants. The prepared tablets were evaluated for hardness, friability, thickness, drug content uniformity, water absorption, wetting time, and disintegration time and *in vitro* dissolution study.

**Results:** Among all the formulations, F10 (containing 5 mg of Coprocessed (CS: SSG 1:2) Superdisintegrants) was considered to be the best formulation, which released up to 98% drug in 20 min as compared to a marketed conventional dosage form which dissolves in approx 60 min. The results of stability study of formulation F10 after a period of two months indicated that the formulation was stable.

**Conclusion:** It was concluded that a fast-dissolving tablet of Buspirone containing various Superdisintegrants is better and effective to meet patient compliance.

**Keywords:** Buspirone, Superdisintegrants, Fast dissolving tablets, Croscarmellose sodium, Sodium starch glycolate

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### INTRODUCTION

The tablet is the most widely used dosage form existing today because of its convenience in terms of self-administration, compactness, and ease in manufacturing. However, geriatric, pediatric and mentally ill patients experience difficulty in swallowing conventional tablets, which leads to poor patient compliance [1]. To overcome these problems, scientists have developed innovative drug delivery system known as mouth dissolving/disintegrating tablets (ODTs) or fast-dissolving tablets [2]. The benefits of FDTs is to improve patients compliance, rapid onset of action, increased bioavailability and good stability which make these tablets popular as a dosage form of choice in the current market [3]. FDT tablets were prepared by using Superdisintegrants such as croscarmellose sodium and sodium starch glycolate which provide rapid disintegration of the tablet in mouth. Many techniques are provided to formulate ODT like direct compression, tablet moulding, spray drying, cotton candy process, mass extrusion and freeze-drying [4]. Of all these above-mentioned techniques, direct compression technique is most convenient and economical as it does not require any special manufacturing process [5].

Buspirone is an anxiolytic agent and a serotonin receptor agonist belonging to the azaspirodecanedione class of compounds. Its structure is unrelated to those of the benzodiazepines, but it has an efficacy comparable to diazepam. Buspirone is used in the treatment of generalized anxiety where it has advantages over other anti-anxiety drugs because it does not cause sedation (drowsiness) and does not cause tolerance or physical dependence [6].

### MATERIALS AND METHODS

Buspirone was gift sample from Concern Pharma, Ludhiana (India). Croscarmellose sodium, Sodium starch glycolate and microcrystalline cellulose were obtained from DFE Pharma Ltd. All the chemicals and reagents used were of analytical or pharmacopoeial grade.

#### Calibration curve of buspirone

Calibration curve of Buspirone was prepared by using Sorensen buffer (pH 6.8) and Hydrochloride Acid buffer (pH 1.2). The solution

was scanned between 200-400 nm using UV-VIS 1700 (Shimadzu) double beam spectrophotometer at 240 nm.

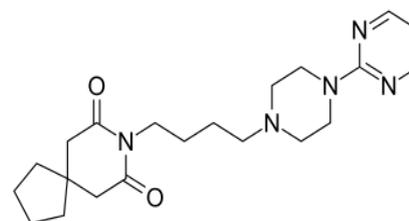


Fig. 1: Structure of Buspirone

#### FT-IR spectroscopic analysis

Drug polymer interactions were studied by FT-IR spectroscopy. 10 mg of Buspirone alone, a mixture of drug and polymer were weighed and mixed properly with potassium bromide uniformly. A small quantity of the powder was compressed into a thin semitransparent pellet by applying pressure. The IR-spectrum of the pellet from 450-4000  $\text{cm}^{-1}$  was recorded taking air as the reference and compared to study any interference.

#### Preparation of Co-processed superdisintegrants

The Co-processed Superdisintegrants were prepared by a solvent evaporation method. A blend of Croscarmellose sodium and Sodium starch glycolate (in the ratio of 1:1, 1:2 and 2:1) was added to 10 ml of isopropyl alcohol. The contents of the beaker (250 ml capacity) were stirred on a magnetic stirrer. The temperature was maintained between 65 °C to 70 °C, and stirring was continued till most of isopropyl alcohol evaporated. The wet coherent mass was granulated through #60-sieve. The wet granules were dried in a hot air oven at 60 ° for 20 min. The dried granules were sifted on #60-sieve and stored in an airtight container till further use. The

prepared mixture was evaluated for flow properties and polymer-polymer compatibility studies such as FTIR study [7].

#### Preparation of fast dissolving tablets of buspirone

Fast dissolving tablets of Buspirone were prepared by direct compression method, using synthetic super disintegrant Croscarmellose sodium and Sodium starch glycolate in different ratios. Dextrose, Mannitol, Microcrystalline cellulose was used as excipients. The formula is shown in table 1.

Following steps were used in the preparation of fast dissolving tablets:

1. Weighed 10 mg drug (Buspirone) along with super disintegrant (Croscarmellose sodium and sodium starch glycolate) in mortar.
2. Dextrose, Mannitol and Microcrystalline cellulose were added in a mortar, mixed with pestle and then added Magnesium stearate to it. These ingredients were then passed through sieve no 80 to remove impurities.
3. The blend was compressed into tablets on the tablet punching machine to obtain 100 mg core tablet.
4. The fast-dissolving tablets were prepared and collected.

**Table 1: Composition of fast dissolving tablets of buspirone**

FC (%)	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Buspirone	10	10	10	10	10	10	10	10	10	10
CS	2	-	3	-	4	-	5	-	-	-
SSG	-	2	-	3	-	4	-	5	-	-
Dextrose	20	20	20	20	20	20	20	20	20	20
Mannitol	36	36	35	35	34	34	33	33	35	33
MCC	30	30	30	30	30	30	30	30	30	30
Magnesium Stearate	2	2	2	2	2	2	2	2	2	2
Coprocessed CS: SSG(1:2)	-	-	-	-	-	-	-	-	3	5

\*FC=Formulation Component, \*CS= Crosscarmellose sodium, \*SSG= Sodium starch Glycolate, \*MCC= Microcrystalline Cellulose

#### Evaluation parameters

##### Precompression studies

All the physical parameters namely, angle of repose, bulk density; compressibility index and Hausner's ratio were performed.

##### Angle of repose

The angle of repose gives an indication of the flowability of the substance. Funnel is adjusted such that the stem of the funnel lies 2 cm above the horizontal surface. The drug powder was allowed to flow from the funnel under the gravitational force till the apex of the pile just touched the stem of the funnel, so the height of the pile is taken as 2 cm. Drawing a boundary along the circumference of the pile and taking the average of six diameters determined the diameter of the pile. These values of height and diameter were then substituted in the following equation:

$$\text{Angle of Repose}(\theta) = \tan^{-1} \left\{ \frac{2h}{d} \right\}$$

Where h-Height of the pile and d-Diameter of the pile

##### Bulk density

Powder weighing 10 g was placed into 100 ml measuring cylinder. Volume occupied by the powder was noted without disturbing the cylinder and bulk density is calculated by the following equation:

$$\text{Bulk Density} = \frac{\text{Mass of bulk}}{\text{Volume of bulk drug}}$$

##### Tapped density

It is the ratio of the total mass of powder to the tapped volume of powder.

The required quantity of powder blend was transferred in 100 ml graduated cylinder which was operated for a fixed number of taps until the powder bed volume has reached a minimum Tapped density using the was calculated by formula given below:

$$\text{Tapped density} = \frac{\text{Mass of bulk drug}}{\text{Volume of bulk drug on tapping}}$$

##### Compressibility

It is a simple test to evaluate bulk and tapped density of a powder. The formula for Carr's index is as below:

$$\% \text{Compressibility} = \left\{ \frac{[(\text{Tapped density}) - (\text{Bulk density})]}{\text{Tapped density}} \right\} * 100$$

##### Hausner's ratio

Hausner's of the drug is found out using the following formula [8, 9]:

$$\text{Hausner Ratio} = \frac{\text{Tapped density}}{\text{Bulk density}}$$

##### Post-compression studies

##### Weight variation

10 tablets were selected and weighed collectively and individually. From the collective weight, the average weight was calculated. Each tablet weight was then compared with average weight to assure whether it was within permissible limits or not. Not more than two of the individual weights deviated from the average weight by more than 10% for 100 mg tablets and none by more than double that percentage.

$$\% \text{Weight Variation} = \frac{\text{Average weight} - \text{Individual weight}}{\text{Average weight}} \times 100$$

##### Hardness test

Hardness of tablet is defined as the force applied across the diameter of the tablet in order to break the tablet. The hardness of the tablets was determined by diametric compression using Monsanto hardness tester.

##### Thickness

The thickness was measured by placing tablet between two arms of the vernier calipers. Five tablets were taken and their thickness was measured.

##### Friability test

This test was performed to determine the effects of friction and shock. Pre weighed sample of 10 tablets was placed in the Roche friabilator and rotated at 25 rpm for about 4 min. The tablets were dedusted and reweighed, and the friability percentage was calculated. Compressed tablets should not lose more than 1% of the weight.

$$\% \text{Friability} = \frac{[(W1 - W2)100]}{W1}$$

Where, W1= Weight of tablet before test, W2 = Weight of tablet after test

### Wetting time

The wetting time of the tablets was measured using a simple procedure. Five circular tissue papers of 10 cm diameter were placed in a Petri dish with a 10 cm diameter. Ten milliliters of water containing eosin, a water-soluble dye, was added to the Petri dish. A tablet was carefully placed on the surface of tissue paper. The time required for water to reach the upper surface of the tablets was noted as the wetting time. The wetting times were measured.

### Water absorption ratio

A piece of tissue paper folded twice was placed in a small Petri dish (internal diameter=6.5 cm) containing 6 ml of water. A tablet was placed on the paper and the time required for complete wetting was then measured. The water absorption ratio (R) was determined using the following equation.

$$R = \frac{W_a - W_b}{W_a} * 10$$

Where  $W_b$  is the weight of the tablet before water absorption and  $W_a$  is the weight of the tablet after water absorption.

### Content uniformity

Ten tablets of each batch were weighed and powdered. Aliquot of this powder containing Buspirone equivalent to 10 mg of Buspirone was accurately weighed, suspended in approximately 50 ml of 0.1 N HCl and shaken for 15 min. Final volume was adjusted to 100 ml with 0.1 N HCl and filtered (Whatman No.1 filter paper). From this 10 ml was diluted to 100 ml. The final volume was made by taking 2 ml of the above solution and diluted to 10 ml with 0.1 N HCl.

Absorbance of this solution was recorded at 240 nm using UV/VIS spectrophotometer against a blank reagent.

### In-vitro disintegration test

The *in-vitro* disintegration studies were carried out using a digital tablet disintegration test apparatus. One tablet was placed in each of the 6 tubes of the basket assembly and then disk was added to each tube. This assembly was then suspended in a 1-liter beaker containing water with its temperature being maintained at  $37 \pm 2$  °C. The basket was then moved up and down through a distance of 5 to 6 cm, at the frequency of 28 to 32 cycles per minute. The time required for complete disintegration of the tablet was recorded.

### In vitro dissolution test

*In vitro* dissolution study is performed by using USP Type II Apparatus (Paddle type) at 50 rpm. The amount of drug dissolved is determined by a suitable analytical technique.

### Stability study

The optimized formulation of FDTs is subjected to stability study as per ICH guidelines to assess their stability with respect to their physical appearance and release characteristic. The stability study was carried out at  $40 \pm 2$  °C/ $75 \pm 5\%$  RH for two months [10-18].

## RESULTS AND DISCUSSION

### Standard calibration curve of buspirone

The standard calibration curve of Buspirone in Sorensen buffer (pH 6.8) and Hydrochloride Acid buffer (pH 1.2) showed good correlation with regression value of 0.993 and 0.997 in fig. 2 and 3.

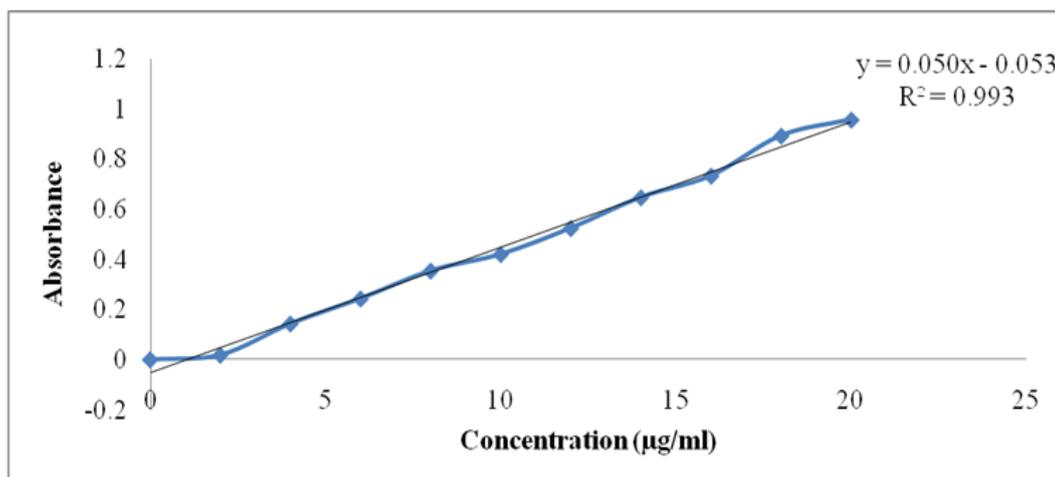


Fig. 2: Calibration curve of buspirone in Sorensen buffer (pH 6.8)

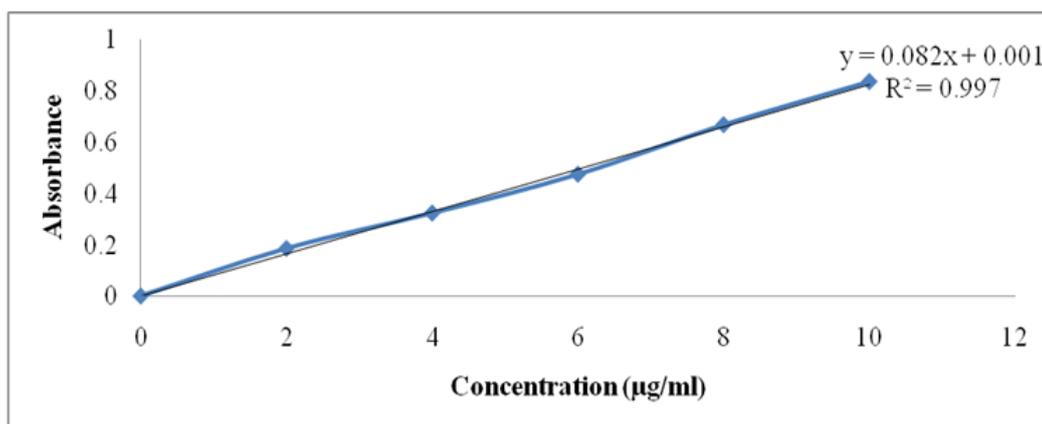
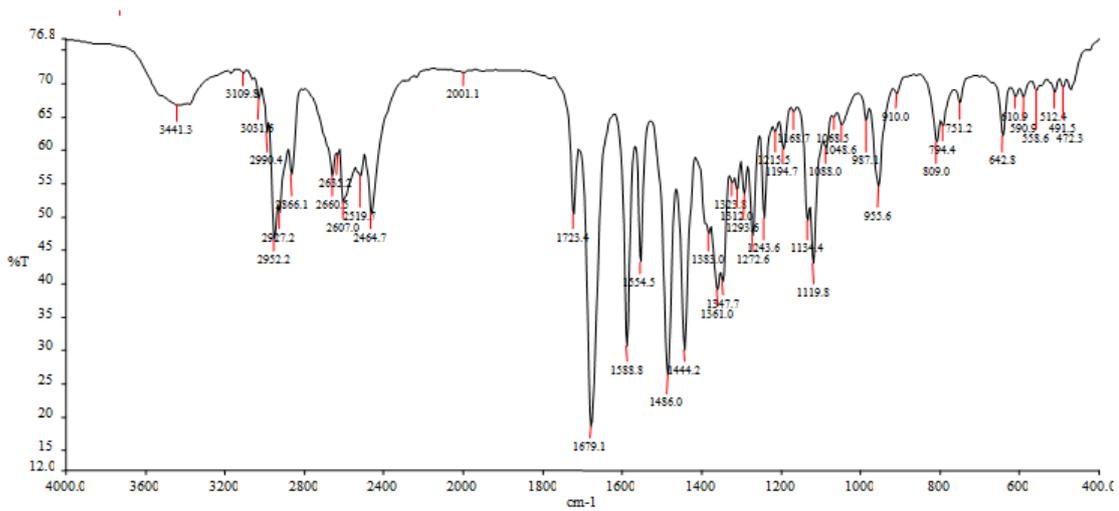


Fig. 3: Calibration curve of buspirone in Hydrochloride buffer (pH 1.2)

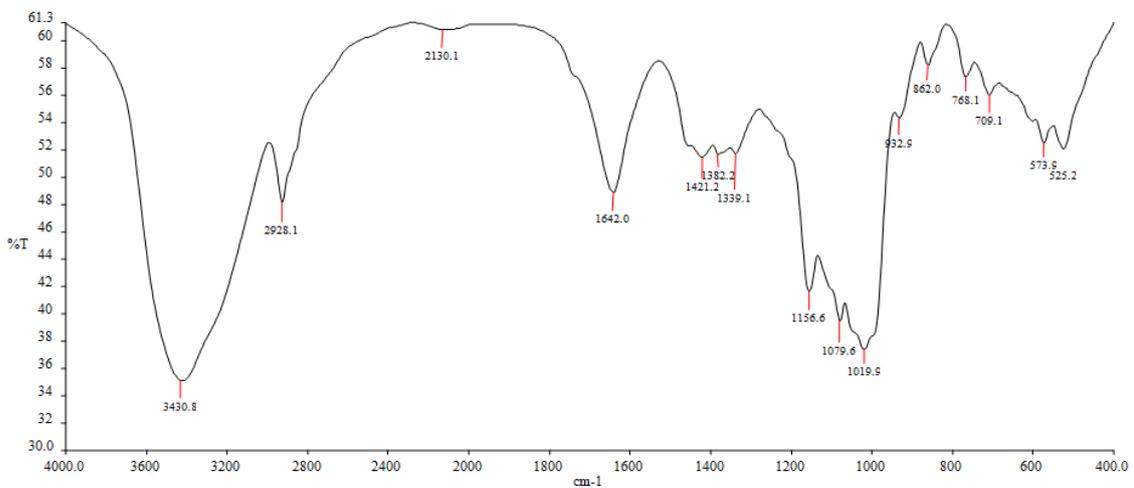
**FT-IR studies**

The spectral data suggest that the major peaks for drugs are obtained as nearer value and there were no considerable changes in

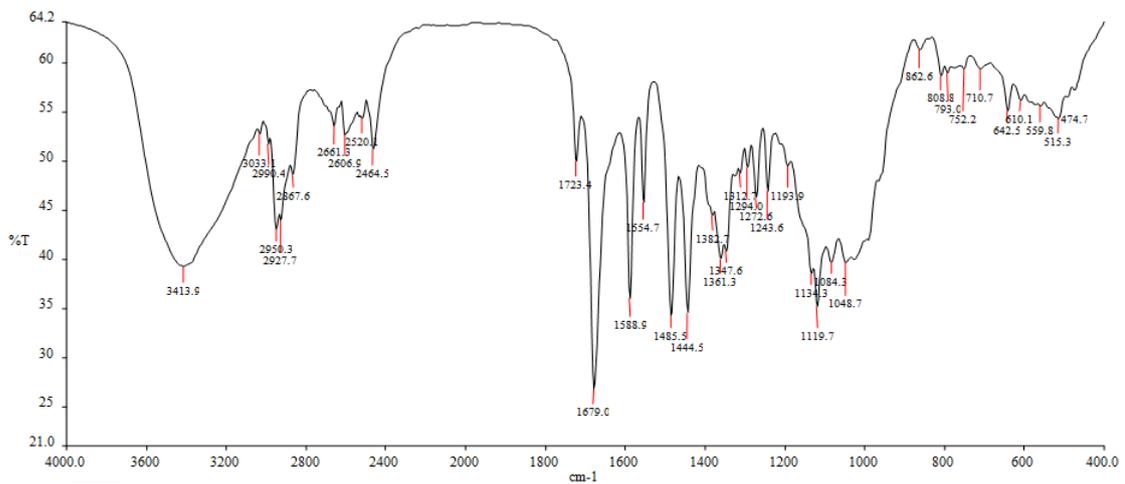
IR peaks in all physical mixtures of drug and Superdisintegrants. This indicates that the drugs were molecularly dispersed in the polymers or in drug-loaded formulations thus thereby indicating the absence of any interactions as shown in fig. 4, 5 and 6.



**Fig. 4: FTIR graph for buspirone**



**Fig. 5: FTIR spectra of co-processed superdisintegrants (Crosscarmellose sodium and sodium starch glycolate)**



**Fig. 6: FTIR spectra of buspirone and co-processed superdisintegrants**

**Pre-compression study****Evaluation of blend**

Physical properties such as bulk density, tapped density, percent compressibility index, Hausner's ratio, angle of repose were determined in table 2 for the prepared tablet blend. The tablet blend batches in

which microcrystalline cellulose was used as the diluent, the angle of repose is between 27.5 °to 34.4 °; this indicated the passable flowability.

This property may be attributed due to the presence of microcrystalline cellulose having filamentous particles as diluent. Also, Carr's index and Hausner's ratio were found to be in the range of  $\leq 18$  and 1.08 to 1.17 respectively, indicating good flow and compressibility of the blends.

**Table 2: Pre-compression parameters data**

Formulation component	Bulk density (g/cc) $\pm$ SD	Tapped density (g/cc) $\pm$ SD	Carr's index (%) $\pm$ SD	Hausner's ratio	Angle of repose ( $\theta$ ) $\pm$ SD
F1	0.49 $\pm$ 0.01	0.56 $\pm$ 0.02	12.50 $\pm$ 0.01	1.14 $\pm$ 0.02	32.7 $\pm$ 1.21
F2	0.52 $\pm$ 0.02	0.61 $\pm$ 0.01	14.75 $\pm$ 0.02	1.17 $\pm$ 0.01	27.5 $\pm$ 0.09
F3	0.55 $\pm$ 0.01	0.61 $\pm$ 0.03	9.84 $\pm$ 0.01	1.11 $\pm$ 0.03	29.7 $\pm$ 0.01
F4	0.45 $\pm$ 0.03	0.52 $\pm$ 0.01	13.46 $\pm$ 0.01	1.16 $\pm$ 0.05	33.5 $\pm$ 0.02
F5	0.59 $\pm$ 0.02	0.67 $\pm$ 0.01	11.94 $\pm$ 0.03	1.14 $\pm$ 0.06	31.9 $\pm$ 0.73
F6	0.55 $\pm$ 0.02	0.62 $\pm$ 0.02	11.29 $\pm$ 0.02	1.13 $\pm$ 0.04	31.6 $\pm$ 0.78
F7	0.49 $\pm$ 0.03	0.57 $\pm$ 0.01	14.04 $\pm$ 0.01	1.16 $\pm$ 0.03	33.8 $\pm$ 0.43
F8	0.46 $\pm$ 0.01	0.51 $\pm$ 0.03	9.80 $\pm$ 0.01	1.11 $\pm$ 0.02	34.4 $\pm$ 0.34
F9	0.48 $\pm$ 0.03	0.53 $\pm$ 0.01	10.41 $\pm$ 0.03	1.12 $\pm$ 0.01	28.4 $\pm$ 0.23
F10	0.51 $\pm$ 0.01	0.55 $\pm$ 0.02	7.27 $\pm$ 0.02	1.08 $\pm$ 0.02	27.5 $\pm$ 0.09

\*All readings are in triplicate (n=3) and SD= Standard deviation

**Post-compression studies**

The data obtained of post-compression parameters such as hardness, thickness, friability, weight variation, amount of drug content, disintegration time and water absorption ratio are shown in table 3 and 4. Tablets obtained were of uniform weight (due to uniform die fill) with an acceptable variation. Hardness of the tablets was found to be 2.62 $\pm$ 0.07 to 3.06 $\pm$ 0.03 kg/cm<sup>2</sup>, indicating satisfactory mechanical

strength. The thickness of tablets was found to be 3.11 $\pm$ 0.03 to 3.19 $\pm$ 0.07 mm. The result revealed that the tablets of all the formulations showed uniform thickness. In all the formulations, the friability values were less than 1% w/w. The results of *in vitro* disintegration time of all the formulations were found to be within the prescribed limits and satisfied the criteria of fast dissolving tablets. The values were found to be in the range of 22 to 90 sec. The water absorption ratio for all formulations was found to be in the range of 81 $\pm$ 0.08 to 96 $\pm$ 0.12%.

**Table 3: Evaluation parameters of fast dissolving tablets**

Formulation code	Weight variation (mg) $\pm$ SD	Hardness (kg/cm <sup>2</sup> ) $\pm$ SD	Thickness (mm) $\pm$ SD	Friability (%) $\pm$ SD
F1	98.62 $\pm$ 0.91	2.73 $\pm$ 0.08	3.17 $\pm$ 0.07	0.32 $\pm$ 0.06
F2	97.58 $\pm$ 0.81	2.62 $\pm$ 0.07	3.12 $\pm$ 0.08	0.36 $\pm$ 0.03
F3	98.34 $\pm$ 0.79	2.93 $\pm$ 0.12	3.19 $\pm$ 0.05	0.41 $\pm$ 0.07
F4	101.3 $\pm$ 0.90	2.82 $\pm$ 0.03	3.15 $\pm$ 0.19	0.36 $\pm$ 0.07
F5	99.24 $\pm$ 0.88	2.84 $\pm$ 0.02	3.18 $\pm$ 0.06	0.43 $\pm$ 0.06
F6	97.78 $\pm$ 0.93	3.04 $\pm$ 0.17	3.14 $\pm$ 0.09	0.38 $\pm$ 0.04
F7	102.7 $\pm$ 0.89	2.98 $\pm$ 0.06	3.11 $\pm$ 0.03	0.29 $\pm$ 0.03
F8	98.94 $\pm$ 0.96	3.01 $\pm$ 0.08	3.16 $\pm$ 0.04	0.41 $\pm$ 0.04
F9	102.7 $\pm$ 0.87	2.97 $\pm$ 0.06	3.18 $\pm$ 0.09	0.32 $\pm$ 0.06
F10	99.61 $\pm$ 0.91	3.06 $\pm$ 0.03	3.19 $\pm$ 0.07	0.23 $\pm$ 0.05

\*All readings are in triplicate (n=3) and SD= Standard deviation

**Table 4: Evaluation parameters of fast dissolving tablets**

Formulation code	Water absorption ratio	Drug content uniformity	Wetting time (sec)	Disintegration time (sec)
F1	90 $\pm$ 1.25	98.12 $\pm$ 0.12	97 $\pm$ 0.52	90 $\pm$ 1.23
F2	81 $\pm$ 1.31	96.31 $\pm$ 0.16	93 $\pm$ 0.96	92 $\pm$ 0.72
F3	82 $\pm$ 0.18	97.32 $\pm$ 0.11	90 $\pm$ 0.56	83 $\pm$ 0.68
F4	93 $\pm$ 0.14	95.82 $\pm$ 0.13	91 $\pm$ 0.67	87 $\pm$ 0.57
F5	89 $\pm$ 0.12	97.42 $\pm$ 0.12	63 $\pm$ 0.71	60 $\pm$ 0.83
F6	88 $\pm$ 0.12	98.33 $\pm$ 0.14	69 $\pm$ 0.94	62 $\pm$ 0.74
F7	84 $\pm$ 0.09	98.11 $\pm$ 0.15	49 $\pm$ 0.61	42 $\pm$ 1.13
F8	81 $\pm$ 0.08	93.41 $\pm$ 0.14	52 $\pm$ 0.48	46 $\pm$ 0.48
F9	89 $\pm$ 0.13	97.62 $\pm$ 0.13	33 $\pm$ 0.54	29 $\pm$ 0.79
F10	96 $\pm$ 0.12	98.39 $\pm$ 0.12	25 $\pm$ 0.68	22 $\pm$ 0.82

\*All readings are in triplicate (n=3) and SD= Standard deviation

**In vitro dissolution study**

The *in vitro* dissolution profile indicated faster and maximum drug release from formulations F10 in fig. 7 and 8. Formulation F10

shows 98% respectively drug release at the end of 20 min when compared with another formula. The rapid drug dissolution might be due to the easy breakdown of particles due to porous structure formation rapid absorption of drugs into the dissolution medium.

Table 5: *In vitro* release data of buspirone tablets

Time (min)	0	5	10	15	20	25	30
F1	0	17±0.58	34±0.63	55±0.59	64±0.59	81±0.47	91±0.58
F2	0	7±0.59	14±0.41	29±0.66	41±0.43	69±0.51	84±0.64
F3	0	11±0.61	26±0.69	42±0.63	58±0.51	73±0.67	89±0.54
F4	0	15±0.42	28±0.44	46±0.49	63±0.66	78±0.59	90±0.43
F5	0	19±0.68	45±0.54	66±0.61	78±0.54	86±0.48	93±0.69
F6	0	20±0.49	43±0.53	59±0.55	72±0.49	88±0.52	96±0.52
F7	0	23±0.63	45±0.61	76±0.47	89±0.64	97±0.69	-
F8	0	25±0.52	48±0.49	71±0.59	86±0.51	93±0.42	-
F9	0	30±0.69	48±0.64	69±0.53	82±0.57	97±0.55	-
F10	0	32±0.46	60±0.58	90±0.41	98±0.62	-	-

\*All readings are in triplicate (n=3) and SD= Standard deviation

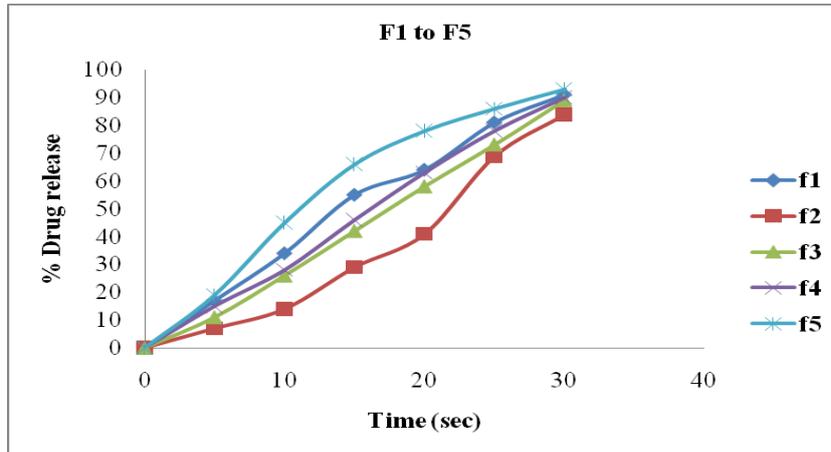


Fig. 7: Dissolution profile for F1, F2, F3, F4 and F5 formulations

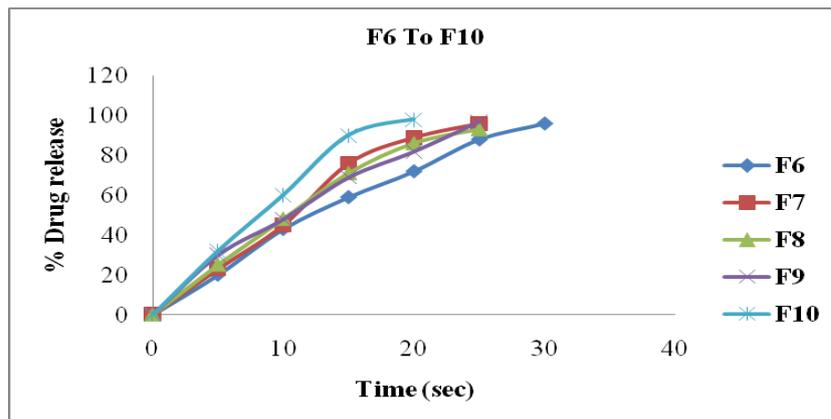


Fig. 8: Dissolution profile for F6, F7, F8, F9 and 10 formulations

**Stability study of formulations (F10)**

The stability study of formulation (F10) was carried out at 40±2 °C/75±5% RH for two months. The tablets were wrapped in the aluminum foil and stored in a stability chamber at accelerated

conditions. The drug content was checked at regular time intervals of 15, 30, 40 and 60 d respectively and was evaluated for physical appearance. The results of drug content are shown in table 6. There was no significant change in physical appearance, Drug content at the end of one month.

Table 6: Drug content during stability study

Time (days)	Accelerated conditions (40±2 °C/75±5% RH)	
	Physical appearance	Drug content
0	+	98.39±0.12
5	+	97.84±0.14
10	+	97.04±0.04
20	+	96.32±0.19
30	+	95.72±0.06

**CONCLUSION**

In the present work, an attempt has been made to develop orally disintegrating tablets of buspirone. The IR spectra revealed that there was no interaction between disintegrants and drug. The result of physical parameter of all formulations by direct compression showed good flow property. Formulation F10 was the optimized formulation having least disintegration time as well as other parameters within acceptable range. *In vitro* release of optimized formulation of buspirone orally disintegrating tablets of F10 was found to be 98% drug release within 20 min with *in vitro* disintegration time being 22 sec. From this observation it was concluded that the formulated tablets of buspirone (F10) were superior and effective in achieving patient compliance.

**AUTHORS CONTRIBUTIONS**

All the author have contributed equally

**CONFLICT OF INTERESTS**

Declare none

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