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Research Article

Design, optimization and evaluation of ibuprofen fast dissolving tablets employing starch tartrate: A new superdisintegrant

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ABSTRACT

The current scenario deals with the study of fast dissolving tablets for the patients suffering from swallowing, sickness, etc. The present investigation involves in the evaluation of starch tartrate as a superdisintegrant in the formulation of fast dissolving tablets of poorly soluble drugs employing 2³ factorial design. Starch tartrate was synthesized by esterification process. The synthesized starch tartrate was subjected to physical and micromeritic evaluation. All fast dissolving tablets were evaluated for drug content, hardness, friability, disintegration time and other dissolution characteristics like percent dissolved in 5 min (PD₅), dissolution efficiency in 5 min (DE₅%) and first order rate constant (K₁). The starch tartrate prepared was found to be fine, free flowing slightly crystalline powder. Starch tartrate exhibited good swelling in water. Fourier transform infrared spectra (FTIR) and Differential scanning calorimetry (DSC) study indicated the absence of interaction between ibuprofen and starch tartrate. All the fast dissolving tablets formulated employing starch tartrate were of good quality with regard to drug content (200±5%), hardness (3.6–3.9 kg/sq. cm), and friability (0.12–0.15%). The optimized formulation F2 has the least disintegration time i.e., 9±0.03s. The *in-vitro* wetting time was less (i.e., 60s) in optimized formulation F2. The water absorption ratio of the formulated tablets was found to be in the range of 27.53±0.12 to 69.75±0.18%. The cumulative drug dissolved in the optimized formulation F2 was found to be 100.17±0.56% in 5 min. Starch tartrate was found to be a superdisintegrant which enhanced the dissolution efficiency with the ibuprofen and hence it could be used in the formulation of fast dissolving tablets to bring immediate release of the contained drug within 5 minutes.

Keywords: Fast dissolving, Superdisintegrant, Starch tartrate, Dissolution efficiency.**Article Info:** Received 28 Jan 2019; Review Completed 05 March 2019; Accepted 06 March 2019; Available online 15 March 2019**Cite this article as:**

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INTRODUCTION

Fast dissolving tablets (FDT) are solid dosage form disintegrate and dissolve rapidly, usually within few seconds when placed upon tongue requiring no additional water to facilitate swallowing. Fast dissolving tablets offer great advantages for the patients having difficulty in swallowing and mainly for paediatric and geriatric patients.

It has been stated that dysphasia (difficulty in swallowing) is common among all groups and more specific with paediatric, geriatric population along with patients suffering from nausea, and motion sickness ¹. Fast dissolving tablets overcome this problem and provide compliance for paediatrics, geriatric ²⁻³, bedridden, disabled patients and also for who may have difficulty in swallowing tablets, capsules and liquid orals. FDT will rapidly disintegrate in the mouth without the requirement of water ⁴⁻⁵. Fast dissolving tablet formulation provides sufficient strength, quick disintegration/ dissolution in the mouth without water ⁶, rapid dissolution and absorption of the drug, which will produce the quick onset of action. Pre gastric absorption of

FDT can result in enhanced bioavailability and as a consequence of reduced dose ⁷. Various techniques can be used to formulate fast dissolving tablets. Direct compression method does not require the use of water or heat during the formulation procedure and it is the important method for moisture and heat-labile medication. The aim of the present work was to formulate and characterize fast-dissolving tablets of ibuprofen by using optimization techniques for rapid dissolution of drug and absorption employing a new superdisintegrant i.e., starch tartrate.

Optimization and evaluation technique provide both a depth of understanding and an ability to explore and define ranges for formulation and processing factors with a rational approach to the selection of various experimental and manufacturing step for a given product, to quantitatively select a formulation. It is at this mark that optimization can become a useful tool to quantitate a formulation that has been qualitatively determined.

The present investigation deals with an attempt of systematic formulation approach for optimization of

ibuprofen fast dissolving tablets employing starch tartrate, crospovidone, and croscarmellose sodium as superdisintegrants. A 2³ factorial design was applied to investigate the main and interaction effects of the three formulation variables i.e., starch tartrate (A), crospovidone (B), croscarmellose sodium (C) in each case to find the formula with less disintegration time and more dissolution efficiency in 5 min and to authorize the arbitrary selection of tablets with immediate release of drug within 5 min.

MATERIALS AND METHODS

Materials:

Sodium hydroxide, Carbon disulphide, Mannitol was purchased from Finar chemicals Ltd, Ahmedabad. Potato starch, Ibuprofen, crospovidone, croscarmellose sodium was obtained from Yarrow Chem. Products, Mumbai. Microcrystalline cellulose was bought from qualigens fine chemicals, Mumbai. Talc and magnesium stearate was obtained from molychem, Mumbai.

Preparation of starch tartrate (a novel Superdisintegrant):

Initially 10g of tartaric acid dissolved in 25ml of distilled water. To this potato starch was added to produce dispersion. Then pH of solution was adjusted to 3.5 using 10M sodium hydroxide. The solution was conditioned for 16hrs. It was kept in the oven at 60°C until it gets dried. After drying the mass was washed with distilled water to remove the unreacted tartaric acid. The product was kept in the oven at 60°C until it dried. The product obtained was ground and sieved through sieve no 80.

Characterization of starch tartrate:

The starch tartrate prepared was evaluated for the following

Solubility:

The solubility of starch tartrate was tested in water, aqueous buffer of pH 1, 2, 3, 4, 5, 6 and 7.2 and organic solvents such as alcohol, dichloromethane, chloroform, acetone and petroleum ether.

pH:

The pH of 1% w/v slurry was determined by pH meter.

Melting point:

The melting point was measured by using melting point apparatus.

Viscosity:

The viscosity of 1% dispersion in water was calculated using ostwald viscometer.

Swelling index:

The starch tartrate (200 mg) was added to 10 ml of water and light liquid paraffin, taken in two different graduated test tubes and mixed. Then for 12 h the dispersion in the tubes was allowed to stand. The volumes of the sediment in the tubes were noted. The swelling index of the material was determined as follows.

$$S.I(\%) = \frac{\text{Volume of sediment in water} - \text{Volume of sediment in light liquid paraffin}}{\text{Volume of sediment in light liquid paraffin}} \times 100$$

Test for gelling property:

The gelling property (gelatinization) of the starch and starch tartrate prepared was evaluated by heating 7% w/v dispersion of each, in water at 100°C for 30 min.

Particle size:

The particle size analysis was performed by sieving using standard sieves.

Density:

The density (g/cc) was calculated by liquid displacement method using benzene as liquid.

Bulk density:

Both loose bulk density (LBD) and tapped bulk density (TBD) were measured by transferring the accurate weigh amount of sample in 50 ml measuring cylinder, the granules without any agglomerates and calculated the volume of packing and tapped 50 times on a plane surface and tapped volume of packing recorded LBD and TBD calculated by following formula⁸.

$$LBD = \frac{\text{Mass of powder}}{\text{Volume of packing}}$$

$$TBD = \frac{\text{Mass of powder}}{\text{Tapped volume of packing}}$$

Percentage compressibility index

The percentage compressibility of powder mix was calculated by Carr's compressibility index calculated by the following formula [9].

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

Where, TBD= Tapped bulk density; LBD= Loose bulk density.

Angle of repose

The frictional forces in loose powder or granules can be calculated by the angle of repose. This is the utmost angle possible between the surface of a mass of powder or granules and the horizontal plane. Angle of repose is determined by applying the next equation;

$$\tan \theta = h/r \quad \theta = \tan^{-1} \frac{h}{r}$$

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

Fourier transform infrared (FTIR) spectroscopy:

FTIR spectra of starch tartrate was recorded on samples prepared in potassium bromide (KBr) disks using a BRUKER FT -IR, (Tokyo, Japan). At a hydrostatic press of 6-8 tons' samples were prepared in (KBr) disks. The scanning range was 500 to 4000 cm⁻¹.

X - ray diffraction:

Diffraction pattern of starch tartrate was recorded with an x-ray diffractometer (Analytical spectra's Pvt. Ltd., Singapore). X-ray diffraction was performed at room temperature (30°C) with a diffractometer; target, Cu (λ 1.54 Å), filter, Ni; voltage, 40 kV; current 30mA; time constant 10mm/s; scanning rate 2°/min; calculated from 2.5-50° at full scale 200.

Drug - excipients compatibility studies:

The compatibility of starch tartrate with the selected drug (ibuprofen) was evaluated in DSC and FTIR studies.

Differential scanning calorimetry (DSC):

DSC thermograms of ibuprofen and their mixtures (1: 1) with starch tartrate were recorded on Perkin Elmer thermal analyser samples (2- 5 mg) were sealed into aluminium pans

and scanned at a heating rate of $10^{\circ}\text{C min}^{-1}$ over a temperature range 30 – 350°C .

Infrared spectroscopy:

Fourier transform infra-red (FTIR) spectra of ibuprofen, and their mixtures (1: 1) with starch xanthate were recorded on a Perkin Elmer, IR Spectrophotometer model: Spectrum RXI, using KBr disc as reference.

Preparation of ibuprofen fast dissolving tablets:

The tablets were prepared by direct compression method employing 2^3 factorial design in which 3 independent variables {superdisintegrants i.e., starch tartrate (A), crospovidone (B), croscarmellose sodium(C)} and 1 dependent variable (dissolution efficiency in 5 min) were selected. The composition of different formulation of

ibuprofen fast dissolving tablets is shown in Table no 1, in which superdisintegrants were selected at 2 levels i.e., lower and higher. For starch tartrate (A), the lower level i.e., 5% concentration and upper level i.e., 10% concentration. For crospovidone (B) and croscarmellose sodium(C), the lower level is zero concentration and higher level i.e., 5% concentration. For uniformity in particle size each ingredient was passed through the # 100 mesh sized screen before mixing. Starch tartrate, crospovidone, croscarmellose sodium, mannitol and microcrystalline cellulose were accurately weighed and mixed using mortar and pestle, and the added to ibuprofen. Finally, to the powder mixture talc and magnesium stearate were added. Then the mixed blend was compressed by using eight station rotator press Karnawathi Machinerics Pvt, Ltd., Ahmedabad, India).

Table: 1: Formulae of ibuprofen fast dissolving tablets employing starch tartrate prepared.

Ingredients(mg/tablet)	F1	F2	F3	F4	F5	F6	F7	F8
Ibuprofen	200	200	200	200	200	200	200	200
Starch tartrate	---	25	---	25	---	25	---	25
Croscarmellose Sodium	---	---	25	25	---	---	25	25
Crospovidone	---	---	---	---	25	25	25	25
Mannitol	80	55	55	30	55	30	30	5
Micro crystalline cellulose	200	200	200	200	200	200	200	200
Talc	10	10	10	10	10	10	10	10
Magnesium stearate	10	10	10	10	10	10	10	10
Total	500	500	500	500	500	500	500	500

Evaluation of ibuprofen fast dissolving tablets:

Hardness test

Hardness implies the ability of a tablet to withstand mechanical shocks while handling. The hardness of the tablet was determined using Monsanto hardness tester and expressed in kg/cm^2 ¹⁰

Uniformity of weight:

Weight variation test was performed with 20 tablets. It is the individual tablet weight variation from the average weight of 20 tablets.

Friability:

The friability of tablets was determined using a Roche friabilator. At 25 rpm the tablets were rotated for 4 minutes or up to 100 revolutions. After the removal of fines the tablets were reweighed and the percentage of weight loss was determined.

$$F = \frac{100 \times W(\text{initial}) - W(\text{final})}{W(\text{initial})}$$

Drug content uniformity:

For drug content uniformity, ten tablets were weighed and powdered a quantity of powder equivalent to 10mg of ibuprofen, which was extracted into 7.2 phosphate buffer and filtered. The ibuprofen content was calculated by measuring the absorbance spectrophotometrically at 221 nm after appropriate dilution with 7.2 phosphate buffer. The drug content was measured as an average of three determinations ¹¹.

Wetting Time:

The wetting time of tablets was determined using a very simple procedure five circular tissue papers of 10 cm

diameter were placed in a Petri dish with a 10 cm diameter. 10 ml of water containing a water soluble dye (amaranth) was added to the petri dish. A tablet was gently placed on the tissue paper. Time needed for water to reach the upper surface of the tablet was noted as wetting time ^{12,13}.

Water absorption ratio:

A piece of tissue paper folded twice and kept on a small petri dish, to that 6 ml of water was poured. A tablet was put on the tissue paper allowed to wet completely. The wetted tablet was then weighed. Water absorption ration R was calculated using following equation.

$$R = \frac{100(W_f - W_g)}{W_g}$$

Where,

W_f = weight of tablet after water absorption.

W_g = weight of tablet before water absorption.

In - vitro disintegration time:

Disintegration time for FDTs was performed using USP disintegration apparatus 0.1 N HCl buffer. The volume of medium was 900 ml and temperature was $37 \pm 0.2^{\circ}\text{C}$. The time in second taken for complete disintegration of the tablet with no palatable mass present in the apparatus was measured ¹⁴.

In - vitro dissolution studies:

The *in- vitro* dissolution rate study of ibuprofen fast dissolving tablets were performed using 8 stage dissolution test apparatus (Electrolab TDT-08L) fitted with paddles (50 rpm) at $37 \pm 0.5^{\circ}\text{C}$, using 7.2 phosphate buffer of 900 ml as a dissolution media. At the predetermined time intervals, 5 ml samples were withdrawn, filtered through 0.45μ membrane filter, diluted and assayed at 221 nm using a Analytical

technology T360 UV/Visible Double beam spectrophotometer. Cumulative percentage release was determined using standard absorbance from the calibration curve. All the dissolution experiments were performed in triplicate (n = 3).

RESULTS AND DISCUSSION

The starch tartrate prepared was found to be fine, free flowing slightly crystalline powder. The physical and micromeritics properties of the starch tartrate are compiled in table 2. It was insoluble in aqueous solvents and insoluble in organic solvents tested (methanol, petroleum ether, dichloromethane, and chloroform) the pH of 0.1% aqueous dispersion was 3.85.

Starch tartrate exhibited good swelling in water. The swelling index was found to be 66.5%. All micrometric properties indicated good flow and compressibility needed

for solid dosage from manufacturing. The density of starch tartrate was found to be 0.625 g/cc. The angle of repose and compressibility index showed good flow properties of starch tartrate. The FTIR spectrum of potato starch and starch tartrate is shown in Fig: 1 and 2. The presence of peaks absorption at 1736.63 cm^{-1} characteristic peak of ester, so from FTIR studies it was concluded that starch tartrate (ester) was formed when starch was allowed to react with tartaric acid. The X-ray diffraction pattern (Fig: 3) of starch tartrate showed characteristic peaks, which indicates that the structure is slightly amorphous. The disappearance of pink color in the ester test confirmed the presence of ester, i.e., starch tartrate. As the starch tartrate was slightly crystalline powder and it had got all the characteristic of superdisintegrants it was concluded that starch tartrate can be used as novel superdisintegrant in the formulation of fast dissolving tablets.

Table: 2. Physical and micromeritics properties of the starch tartrate prepared

Parameters	Observation
Solubility	Insoluble in all aqueous and organic solvents tested
pH(1% w/v aqueous dispersion)	3.85
Melting Point	Charred at 270°C
Viscosity(1% w/v aqueous dispersion)	1.1034cps
Swelling index	66.5%
Gelling property	No gelling at 100°C but formed to clear solution. Where as in the case of starch, it was gelatinized and formed gel.
Particle Size	$142\text{ }\mu\text{m}$ (80 mesh)
Density	0.625g/cc
Bulk Density	0.714 g/cc
Angle of Repose	23.6°
Compressibility Index	13%

*SD Standard Deviation from mean,

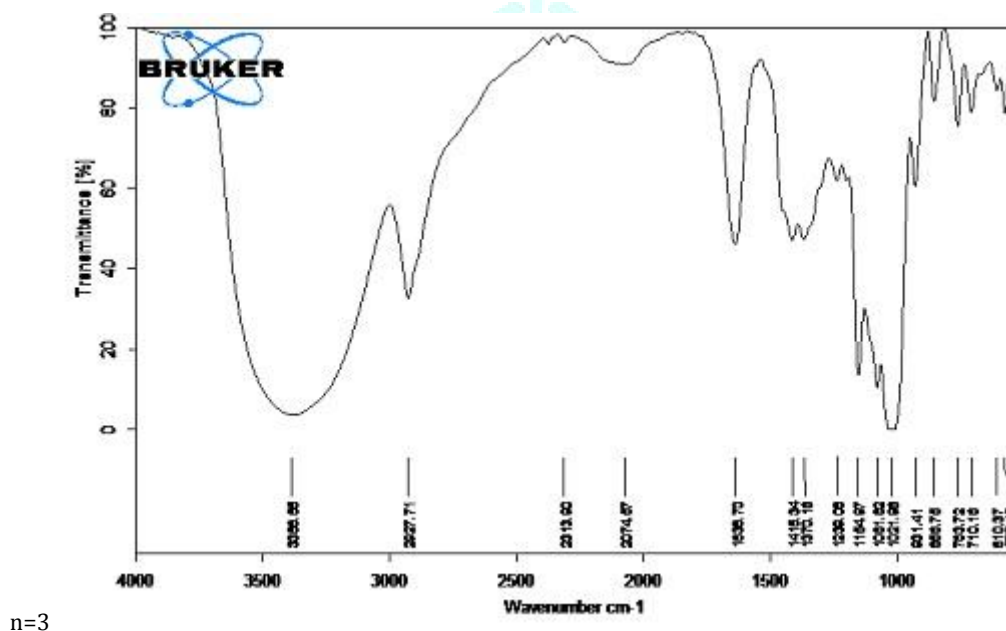


Figure 1: Fourier transform infrared spectra of potato starch.

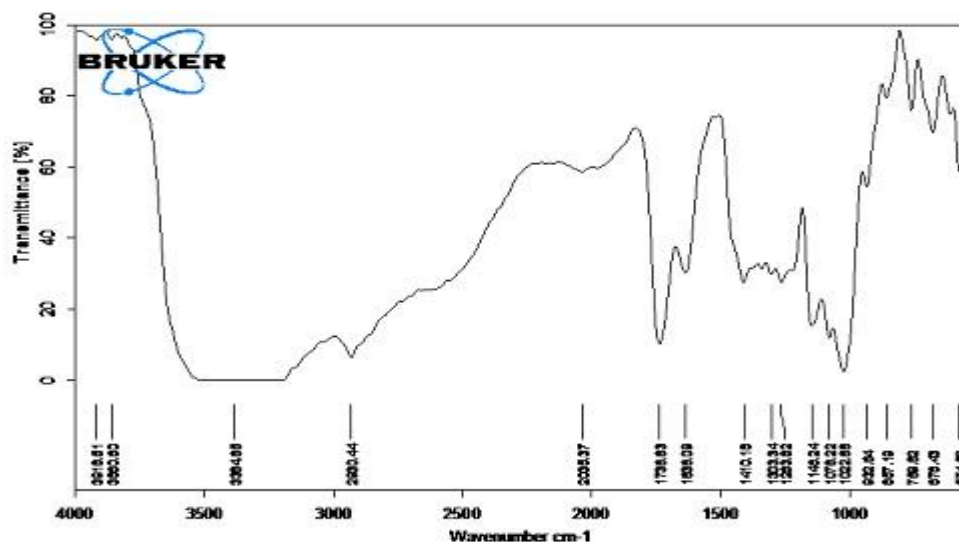


Figure 2: Fourier transform infra red spectra of starch tartrate

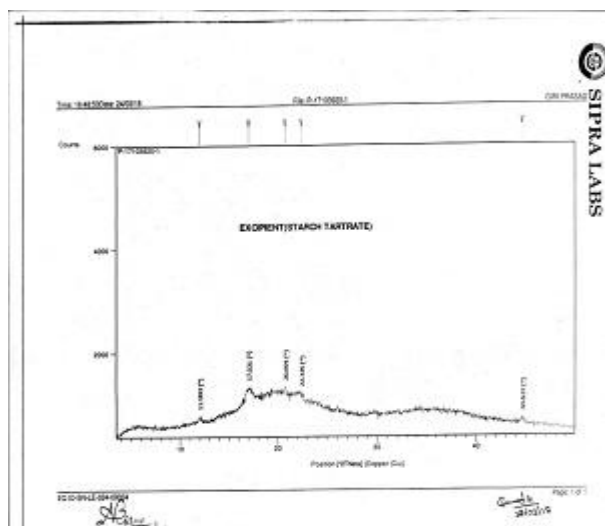


Figure 3: X-Ray diffraction pattern of starch tartrate

The X-ray diffraction pattern of starch tartrate showed no characteristic peaks, which indicates that structure is amorphous shown in Fig.3. The compatibility of starch tartrate with the selected drug (Ibuprofen) was evaluated by DSC, FTIR studies. The DSC thermograms of ibuprofen and ibuprofen – starch tartrate are shown in Fig.4 and 5. The DSC

thermograms of ibuprofen and ibuprofen – starch tartrate exhibited exothermic peaks at 78.48°C and 76.98°C respectively. These melting peaks of ibuprofen and ibuprofen – starch tartrate are nearer to the melting points of ibuprofen (75-78°C). The peaks observed in the DSC thermograms of ibuprofen and ibuprofen – starch tartrate mixtures correspond to the melting points of the respective drug indicating no interactions between the selected drug and starch tartrate polymer. The DSC study, thus, indicated no interaction between starch tartrate and selected drug.

The FTIR spectra of ibuprofen and ibuprofen – starch tartrate are shown in Figs.5.4 and 5.5. The characteristic FTIR bands of ibuprofen at 2923.39 cm⁻¹(OH), and ibuprofen- starch tartrate at 2923.39 cm⁻¹(OH), ibuprofen 2871.45 (C-H) and ibuprofen- starch tartrate 2871.45 (C-H) ibuprofen 1720.93(C=O) and ibuprofen – starch tartrate 1720.93 (C=O) ibuprofen 1419.42 (C-O-H) and with starch tartrate 1419.42 (C-O-H) were all observed in the FTIR spectra of both ibuprofen and ibuprofen – starch tartrate. These FTIR spectra observations also indicated no interaction between starch tartrate and the drug selected.

Thus the result of DSC, FTIR indicated no interaction between the selected drug and starch tartrate, the new superdisintegrant. Hence, starch tartrate could be used as a superdisintegrant in the design of fast dissolving tablets of the selected drug.

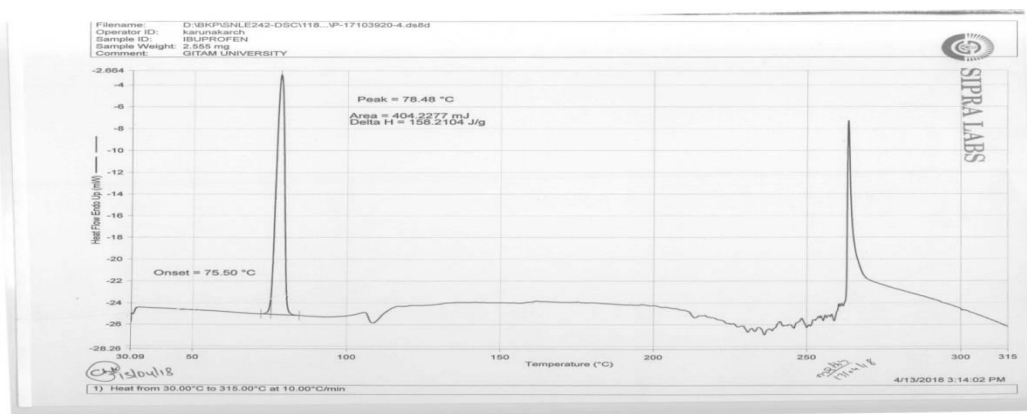


Figure 4: DSC Thermogram of ibuprofen pure drug

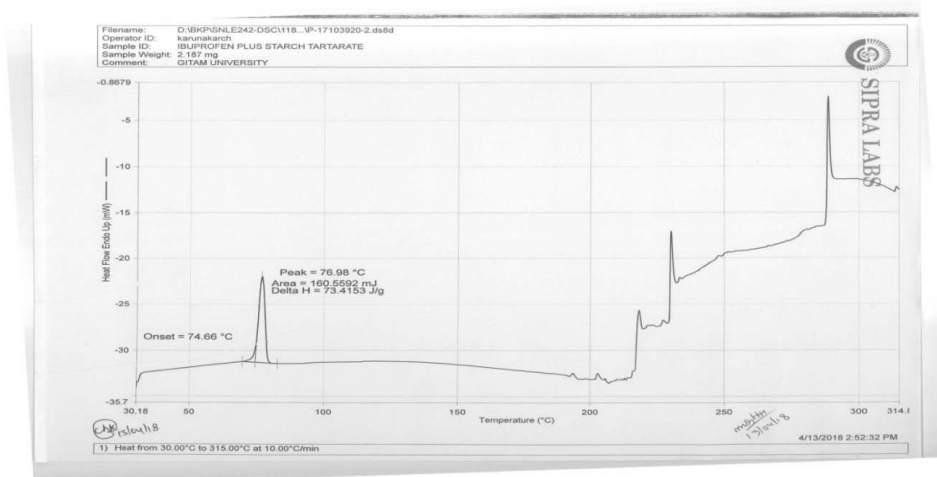


Figure 5: DSC Thermo gram of ibuprofen with starch tartrate

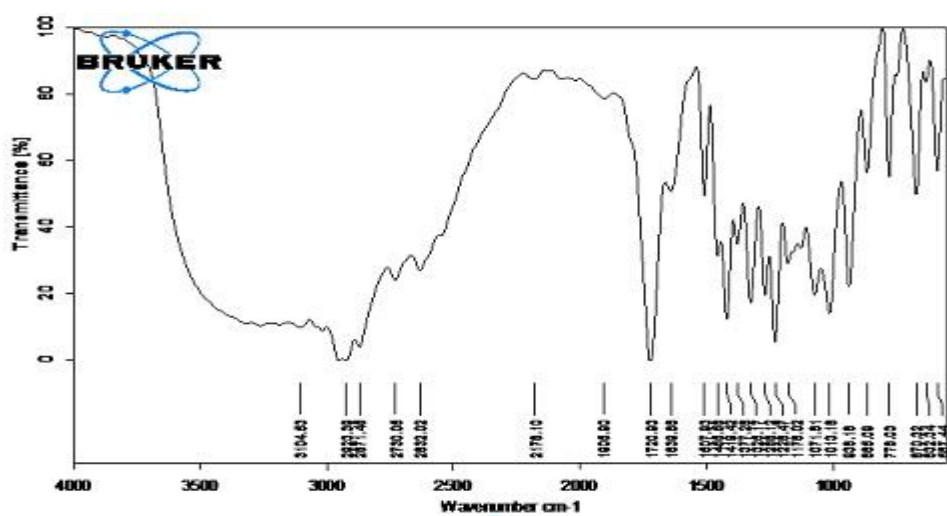


Figure 6: FTIR spectra of ibuprofen

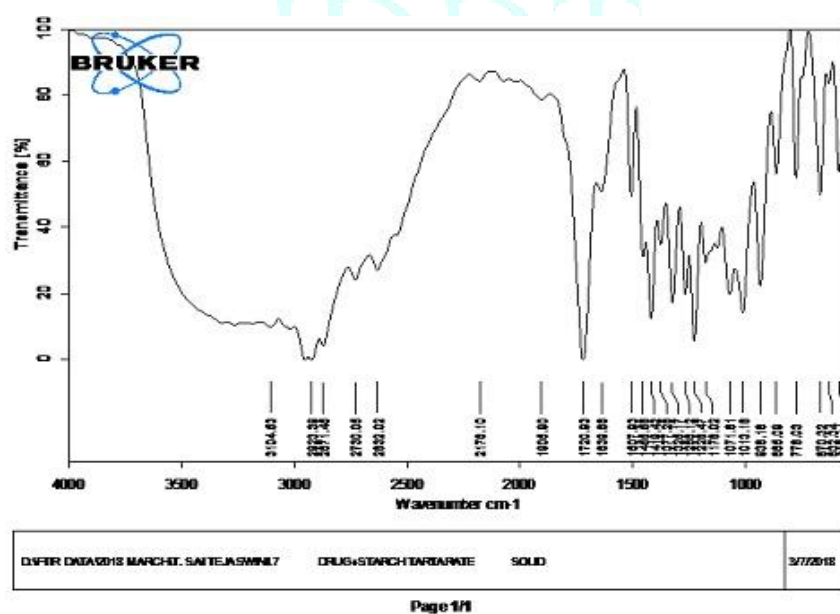


Figure 7: FTIR Spectra of ibuprofen with starch tartrate

Evaluation of tablets

Hardness

Hardness of tablets from all batches was found to be in the range of 3.6 ± 0.03 kg/cm² to 3.9 ± 0.01 kg/cm². All tablets were found to be strong enough to withstand the handling and storage conditions of without getting broken.

Friability

All the tablets shown acceptable friability as none of the tested batches exhibited percentage friability that exceeded 1%. As per IP, % friability of less than 1% is an indication of good mechanical resistance of the tablets. Percent friability of all batches were found in the range of 0.12%-0.15 %. Thus, it was concluded that tablets could withstand the pressure, mechanical shocks during handling, transportation, storage and manufacturing processes.

Drug content ¹⁵

Drug content of all the formulation batches was found to be between 97.34 ± 0.71 to 99.83 ± 0.56 . Hence, it can be decided that all the formulations are having an accurate amount of drug distributed uniformly in powder mass and followed acceptable limits as per IP in range of 85 to 115 % of average content table 3.

Disintegration studies

In vitro disintegration time was performed by the USP dissolution apparatus. The disintegration rate has a correlation with water absorption capacity of disintegrate and the *in vitro* disintegration time was found between 9 ± 0.02 to 3800 ± 0.02 s. The outcomes were tabulated and data demonstrated in table 3. The disintegration times of all the formulation were less than 180 s. It was found that the formulation F2 has least disintegration time 9s when compared to other formulations. The order of a disintegration time in fast dissolving tablets was found to be $F2 < F5 < F7 = F8 < F6 < F3 < F4 < F1$. The order of disintegration time may be due to the interaction and main effects of the super disintegrants used in the fast dissolving tablets.

Water absorption ratio and wetting time

The water absorption ratio was in between 27.53 ± 0.16 - 69.75 ± 0.18 . The wetting time found between 60.01 ± 0.12 - 2220 ± 0.17 s. The outcomes were tabulated and data demonstrated in table 3 and Fig. 8 and 8a. It was found that the formulation F2 containing 5 %starch tartrate showed less wetting time i.e. 60.01 ± 0.12 s as compared to other formulations.

In vitro dissolution studies

Dissolution rate depends on the wetting time of the disintegrant, among all the formulations F2 has less wetting time and has greater dissolution rate which give the other conformance test for correct selection of desirable. *In vitro* dissolution studies of all the formulation were performed and depicted in fig. 9. In all formulations F2 formulation was selected as the promising formulation containing 5 % starch tartrate with 100.17% release in 5 min which may be due to the interaction effect between the one super disintegrants i.e., starch tartrate at a concentration of 5 %. The dissolution parameters of the formulation from (F1-F8) which were made by direct compression method were shown in the table: 4. In all these cases the PD₅ (percent dissolved in 5 minute) was more in F2 which consists at 5 % starch tartrate. The same was in the case of DE₅ % (dissolution efficiency in 5 min). The PD₅ & DE₅ % reveals that starch tartrate was effective at 5%. When the formulations were made by direct compression using these superdisintegrants. The number of folds are in the order of $F3 < F4 < F5 < F6 < F8 < F7 < F2$ in DE₅ % were given to the table 4. From the results, it was concluded that starch tartrate (new superdisintegrant) could be used as a super disintegrant in the formulation of fast dissolving tablets of ibuprofen. To assess the individual and combined effects of the three factors involved, fast dissolving tablets were formulated employing selected combinations of the factors as per 2³-factorial design. The fast dissolving tablets and the release parameters (percent drug released in 5 min) of the fast dissolving formulated were analyzed as per ANOVA of 2³-factorial design. ANOVA of fast disintegrating times(table 5) indicated that the individual effects of starch tartrate (A),crospovidone (B) and croscarmellose sodium (C), as well as the combined effects of AB, AC, BC and ABC factors, were significant ($P < 0.05$) on disintegration time and dissolution efficiency in 5 min of ibuprofen fast dissolving tablets.

Fast dissolving tablets formulated employing starch tartrate (5%),crospovidone (5%) and croscarmellose sodium (5%) as super disintegrants exhibited in disintegration and dissolution efficiency in 5 min. Formulation F2 gave release of 100.17% in 5 min fulfilling the official specification, based on disintegration time and dissolution efficiency in 5 min. Formulation F2 is considered as a good fast dissolving tablet formulations of ibuprofen which was found to better than the ibuprofen fast dissolving tablets formulated by Sai Kishore *et al* ¹⁵.

Table 3: Physical Properties: Hardness, Friability Drug Content of ibuprofen fast dissolving tablets prepared.

Formulation	Hardness (kg/cm ²) $\pm$ S.D	Friability (%) $\pm$ S.D	Drug Content mg/tab) $\pm$ S.D	Disintegration Time (sec) $\pm$ S.D	Water Absorption Ratio (%) $\pm$ S.D
F1	3.6 ± 0.01	0.12 ± 0.013	197.58 ± 0.71	3800 ± 0.02	27.53 ± 0.12
F2	3.6 ± 0.03	0.13 ± 0.015	198.1 ± 0.79	9 ± 0.03	69.75 ± 0.18
F3	3.6 ± 0.01	0.14 ± 0.012	199.45 ± 0.63	30 ± 0.02	56.89 ± 0.16
F4	3.6 ± 0.04	0.12 ± 0.014	198.56 ± 0.55	66 ± 0.02	52.38 ± 0.15
F5	3.7 ± 0.03	0.14 ± 0.012	199.83 ± 0.56	10 ± 0.01	50.49 ± 0.21
F6	3.9 ± 0.01	0.15 ± 0.012	199.34 ± 0.18	26 ± 0.02	57.26 ± 0.12
F7	3.7 ± 0.02	0.14 ± 0.014	199.56 ± 0.57	13 ± 0.01	55.35 ± 0.15
F8	3.6 ± 0.04	0.12 ± 0.013	199.17 ± 0.11	13 ± 0.02	47.39 ± 0.27

*SD Standard Deviation from mean, n=3

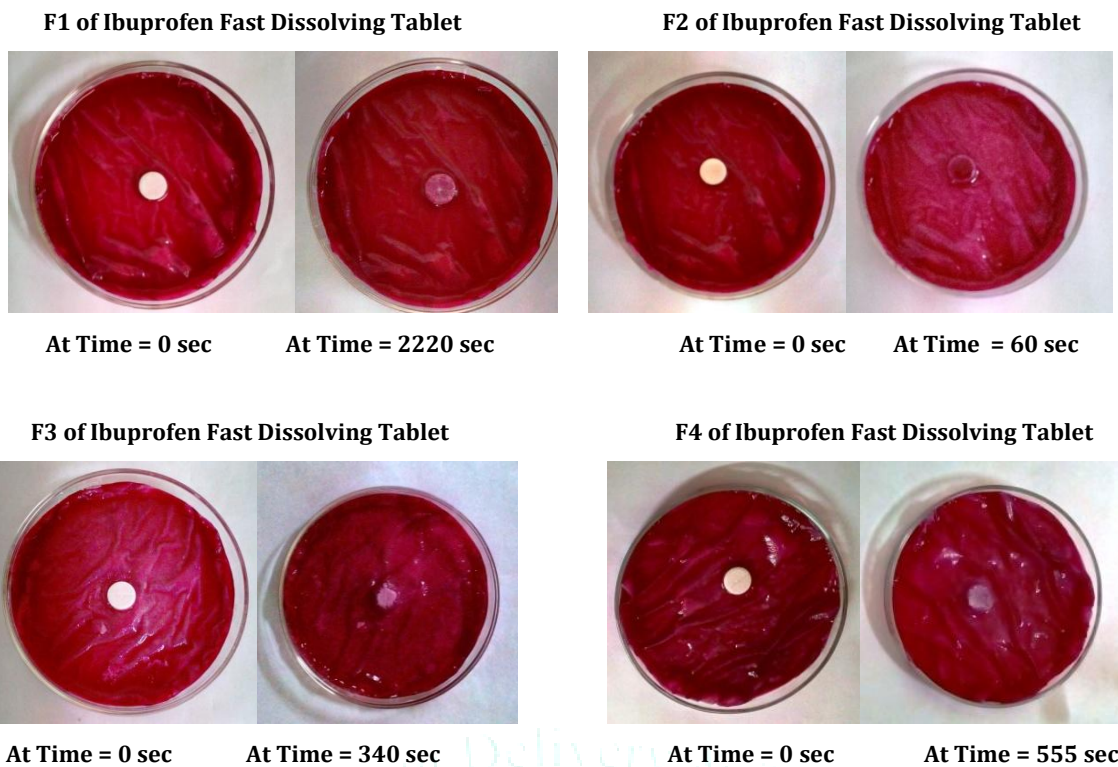


Figure 8: Ibuprofen fast dissolving tablets prepared employing starch tartrate

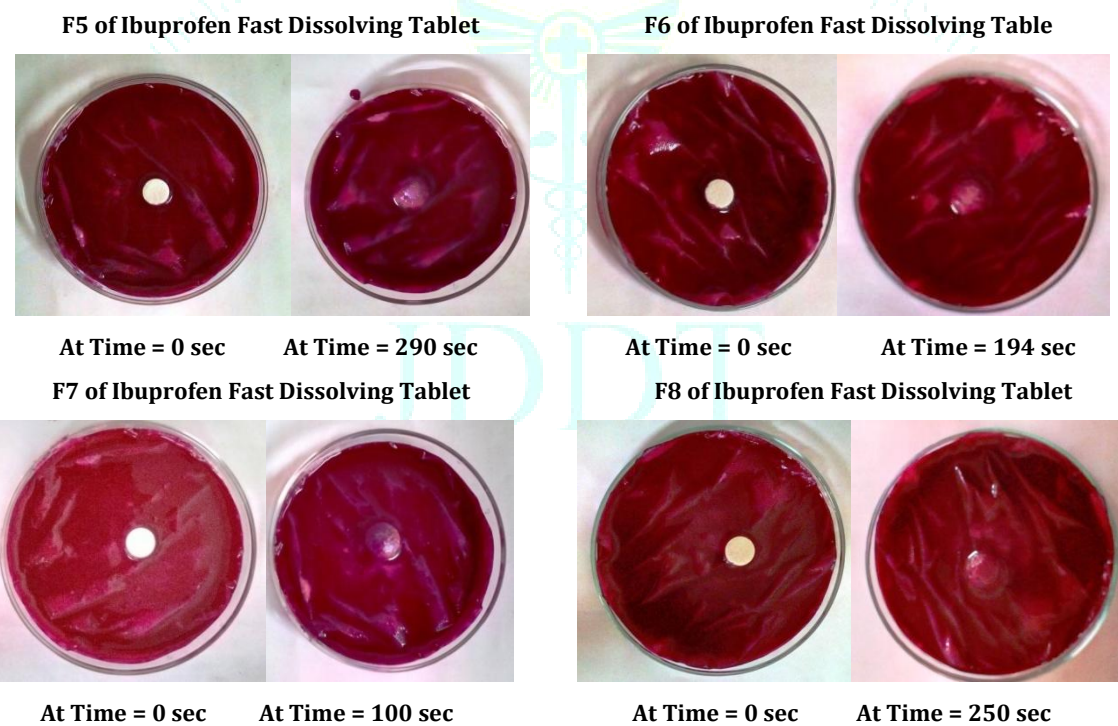


Figure 8a: Ibuprofen fast dissolving tablets prepared employing starch tartrate

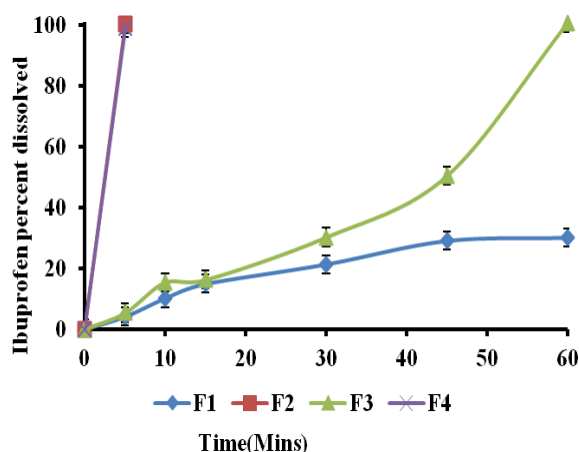


Figure 9: Dissolution profiles of ibuprofen fast dissolving tablets prepared employing starch tartrate (F1- F4) (n=3, mean±SD)

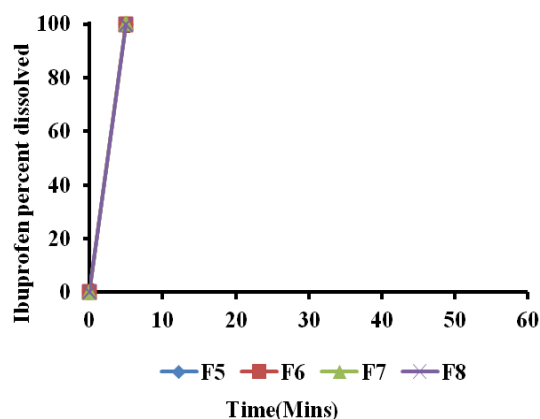


Figure 9(a): Dissolution profiles of ibuprofen fast dissolving tablets prepared employing starch tartrate (F5- F8) (n=3, mean±SD)

Table 4: Dissolution parameters of ibuprofen fast dissolving tablets formulated employing starch tartrate and other known superdisintegrants

Time(min)	F1	F2	F3	F4	F5	F6	F7	F8
PD ₅	4.07	100.17	5.3	98.88	99.89	99.99	100.0	99.9
DE ₅ %	1.8	99.5	2.4	95.9	97.4	97.7	98.8	98
No of folds increase in DE ₅ %	---	55.27	1.33	53.27	54.11	54.27	54.88	54.44

*SD Standard Deviation from mean, n=3, PD₅-Percent dissolved in 5 min., DE₅%-Dissolution efficiency in 5 min., K₁ =First Order Rate Constant.

Table 5: ANOVA of dissolution efficiency in 5 min of ibuprofen fast dissolving tablets formulated employing starch tartrate

Source of Variation	d. f	S.S	M.S.S	Variance ratio	Result
Replicates	2	9.33	4.665	2.577	P > 0.05
Treatments	7	36635941.29	5233705.899	2891550.215	P < 0.05
Starch tartrate(A)	1	3884126.04	3884126.04	2145925.98	P < 0.05
Croscarmellose(B)	1	6778751.04	6778751.04	3745166.3	P < 0.05
Starch tartrate X Croscarmellose sodium (AB)	1	4049995.04	4049995.04	2237566.32	P < 0.05
Crospovidone (C)	1	7149325.04	7149325.04	3949903.337	P < 0.05
Starch tartrate X Crospovidone (AC)	1	3952005.04	3952005.04	2183428.19	P < 0.05
Croscarmellose sodium X Crospovidone (BC)	1	6702437.04	6702437.04	3703003.89	P < 0.05
Starch Tartrate X Croscarmellose sodium X Crospovidone (ABC)	1	4119302.042	4119302.042	2275857.482	P < 0.05
Error	14	25.34	1.8100	--	--
Total	23	--	--	--	--

*SD Standard Deviation from mean, n=3, P<0.05 indicate significance; p>0.05 indicate non-significance, d. f-Degree of Freedom

*S. S-Sum of Square *M. S.-Mean Sum of Squares, ANOVA= Analysis of Variance

CONCLUSION

Starch tartrate is an efficient superdisintegrant for fast dissolving tablets. The disintegration and dissolution efficiency of the fast dissolving tablets of ibuprofen was good and depended on the concentration of superdisintegrant employed i.e., starch tartrate (5%). The formulated fast dissolving tablets of ibuprofen employing starch tartrate exhibited good dissolution efficiency in 5 min which can be used for the fast therapeutic action of ibuprofen.

Overall, Starch tartrate was found to be a super-disintegrant in the formulation of fast dissolving tablets to provide immediate release of the poorly soluble drugs.

ABBREVIATIONS

FTIR - Fourier transform infrared spectra

DSC - Differential scanning calorimetry

ANOVA - Analysis of variance

REFERENCES

1. Suresh B, Rajender KM, Ramesh G, Yamsani MR. Orodispersible tablets: An overview. Asian J Pharm 2008; 2:2-11.
2. Seager H. Drug delivery product and zydis-fast dissolving dosage form. J Pharm Pharmacol 1998; 50:375-82.
3. Abdelbary G, Prinderre P, Couani C, Taochim J, Reynier JP, Riccerelle P. The preparation of orally disintegrating tablets using a hydrophilic waxy binder. Int J Pharm 2004; 278:423-33.
4. Sastry SV, Nyshadham JR, Fix JA. Recent technological advances in oral drug delivery: a review. Pharm Sci Technol Today 2000; 3:138-45.
5. Lachman L, Libermann HA, Kanig JL. The theory and practice of industrial pharmacy. 3rd edition; 1991. p. 233-5.
6. Biradar S, Bhagavati S, Kuppasad I. Fast dissolving drug delivery system: A brief overview. Internet J Pharmacol 2005;4:2. edition; 1991. p. 233-5.
7. Indurwade NH, Rajyaguru TH, Nakhat PD. Novel approach-fast dissolving tablets. Indian Drug 2002; 38:405-9.
8. The United States Pharmacopoeia 29, National Formulary 24, Asian Edition. Rockville, MD: United States Pharmacopoeia Convention, Inc; 2006. p. 1890.
9. Jacob S, Shirwaikar A, Joseph A, Srinivasan KK. Novel co-processed excipient of mannitol and microcrystalline cellulose for preparing fast dissolving tablet of Glipizide. Indian J Pharm Sci 2007; 69:633-9.
10. Hiremath JG, Shastri CS, Srinath MS. Pharmaceutical approaches of taste masking in oral dosage forms. Indian Drugs 2004; 41:253-7.
11. Abdelbary A, Elshafeey AH, Zidan G. Comparative effects of different cellulosic-based directly compressed orodispersible tablets on oral bioavailability of famotidine. Carbohydrate Polymers 2009; 77:799-806.
12. Battu SK, Michael AR, Soumyajit M, Madhusudan Y. Formulation and evaluation of rapidly disintegrating fenoverine tablets: effect of super disintegrants. Drug Dev Ind Pharm 2007; 33:1225-32.
13. Goel H, Vora N, Rana V. A novel approach to optimize and formulate fast disintegrating tablets for nausea and vomiting. AAPS PharmSciTech 2008; 9:774-8.
14. Puttewar TY, Kshirsagar MD, Chandewar AV, Chikhale RV. Formulation and evaluation of orodispersible tablet of taste masked doxylamine succinate using ion exchange resin. J King Saud University (Sci) 2010; 22:229-40.
15. Sai Kishore V, Gowtham Kumar D, Sudheer B, Sandeep M. Design and development of fast dissolving tablets of ibuprofen. Res Rev Pharm Pharm Sci 2013; 2:65-71.

