RESEARCH ARTICLE

Comparative Study on Fast Dissolving Tablets of Piroxicam Prepared by Direct Compression and Sublimation Methods

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ABSTRACT

Fast dissolving tablets (FDTs) are designed to disintegrate rapidly in the oral cavity without the need for water, enhancing patient compliance. Piroxicam, a non-steroidal anti-inflammatory drug (NSAID) with poor solubility, can be formulated as FDTs to improve its bioavailability and therapeutic efficacy. In this study, FDTs of piroxicam were prepared using direct compression and sublimation techniques. Various sublimating agents, such as camphor, was employed to create a porous structure, enhancing the dissolution rate. The prepared tablets were evaluated for post-compression parameters, including weight variation, friability, hardness, wetting time, disintegration time, and in vitro drug release. The results demonstrated that tablets formulated using sublimation exhibited faster disintegration and improved dissolution compared to those prepared by direct compression alone.

Keywords: Fast dissolving tablets, Piroxicam, Direct compression, Sublimation, Disintegration, Bioavailability.

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INTRODUCTION

Oral drug administration remains the most preferred and convenient route for drug delivery, but conventional tablets and capsules may pose swallowing difficulties for certain patient groups. Fast dissolving tablets (FDTs), also known as orally disintegrating tablets (ODTs), are designed to dissolve or disintegrate rapidly in the oral cavity, usually within seconds, without the need for water [1].

This feature makes FDTs particularly beneficial for pediatric, geriatric, and dysphagic patients who struggle with conventional dosage forms. The development of FDTs relies on advanced formulation technologies and specialized excipients that enhance disintegration, palatability, and stability.

Various methods, including direct compression, sublimation, freeze-drying, and spray drying, are employed to achieve the desired tablet characteristics. [2,3]

Piroxicam is a non-steroidal anti-inflammatory drug used in the treatment of osteo arthritis, rheumatoid arthritis, ankylosing spondylitis, classified in the Bio pharmaceutical Drug Classification system as a Class II drug because it has low solubility and high permeability. It demonstrates a slow and gradual absorption via the oral route and has a long half-life of elimination, rendering a prolonged therapeutic action and a delayed onset of anti-inflammatory and analgesic effect. [4]

Aim of the present work is to formulate and evaluate fast dissolving tablet of Piroxicam by using different superdisintegrants and different methods to improve its therapeutic efficiency and their by improving patient compliance.

Preparation of Fast Disintegrating Tablets

fast dissolving tablets of Piroxicam were prepared by direct compression method according to the formula given in Table-1. All the ingredients were passed through 60 mesh sieve separately. The drug and microcrystalline cellulose was mixed by small portion of both each time and blending it to get a uniform mixture kept aside. Then the ingredients were weighed and mixed in geometrical order and tablets were compressed of 8mm sizes flat round punch to get tablet using Rimek Compression Machine.

B. Sublimation Method

Method

Piroxicam tablets were prepared by sublimation technique. The basic principle involved in preparing fast dissolving tablets by sublimation technique is inert solid ingredients (E.g. urea, urethane, ammonium carbonate, camphor, naphthalene) were added to other tablet excipients and the blend was compressed into tablet.

Removal of volatile material by sublimation generated a porous structure. Compressed tablets containing mannitol and camphor have been prepared by sublimation technique. The tablets dissolve within 10-20 sec. and exhibit sufficient mechanical strength for practical use. Six formulations were developed by varying concentration of subliming agent i.e. camphor.

Accurately weighed ingredients were sifted through sieve no.44 and thoroughly mixed for 10 min and magnesium stearate and other ingredients were added to the blend and thoroughly mixed.

The tablets were compressed using Rimek tablet punching machine. The compressed tablets were than subjected to sublimation at 50°C for 60 min.

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Table 1: Formulation of Piroxicam fast dissolving tablets by Direct compression method.

Ingredient (mg)	Formulation code								
	DCF1	DCF2	DCF3	DCF4	DCF5	DCF6	DCF7	DCF8	DCF9
Piroxicam	20	20	20	20	20	20	20	20	20
Aspartame	16	16	16	16	16	16	16	16	16
D-mannitol	90	84	78	90	84	78	90	84	78
Croscarmellose sodium	6	12	18	--	--	--	--	--	--
Crospovidone	--	--	--	6	12	18	--	--	--
Sodium starch glycolate	--	--	--	--	--	--	6	12	18
MCC (Avicel PH-102)	60	60	60	60	60	60	60	60	60
Methyl cellulose	3	3	3	3	3	3	3	3	3
Talc	2	2	2	2	2	2	2	2	2
Mg stearate	3	3	3	3	3	3	3	3	3
Total	200	200	200	200	200	200	200	200	200

Table 2: Formulation of Piroxicam fast dissolving tablets by sublimation method.

Ingredient (mg)	Formulation code					
	SMF1	SMF2	SMF3	SMF4	SMF5	SMF6
Piroxicam	20	20	20	20	20	20
D-Mannitol	60	50	40	60	50	40
MCC (Avicel PH-102)	60	60	60	60	60	60
Croscarmellose sodium	25	25	25	--	--	--
Crosspovidone	--	--	--	25	25	25
Aspartame	6	6	6	6	6	6
Camphor	10	20	30	10	20	30
PVP	15	15	15	15	15	15
Talc	2	2	2	2	2	2
Mg stearate	2	2	2	2	2	2
Total	200	200	200	200	200	200

Table 3: Results of Post-compression parameters for Direct Compression

Formulation Code	Hardness (Kg/cm²) ± SD	Friability (%)	Thickness (mm) ± SD	Weight variation (mg)± SD
DCF1	3.82 ± 0.07	0.59 ± 0.12	3.415 ± 0.014	199.47 ± 1.8
DCF2	3.23 ± 0.12	0.56 ± 0.06	3.425 ± 0.018	200.42 ± 0.5
DCP3	3.12 ± 0.13	0.55 ± 0.06	3.439 ± 0.021	201.09 ± 1.7
DCF4	4.01 ± 0.11	0.71 ± 0.4	3.409 ± 0.017	199.15 ± 1.0
DCF5	3.22 ± 0.13	0.64 ± 0.14	3.431 ± 0.019	199.75 ± 0.7
DCF6	2.89 ± 0.09	0.51 ± 0.04	3.452 ± 0.012	200.34 ± 1.9
DCF7	3.98 ± 0.15	0.66 ± 0.07	3.413 ± 0.019	198.33 ± 1.1
DCF8	3.87 ± 0.14	0.63 ± 0.12	3.421± 0.024	200.17 ± 1.5
DCF9	2.95 ± 0.19	0.59 ± 0.13	3.443 ± 0.020	199.81 ± 1.9

Table 4 Results of Post-compression parameters for sublimation method

Formulation Code	Hardness (Kg/cm²) ± SD	Friability (%)	Thickness (mm) ± SD	Weight variation (mg)± SD
SMF1	3.02 ± 0.17	0.61 ± 0.13	3.516 ± 0.013	198.89 ± 1.3
SMF2	2.84 ± 0.16	0.63 ± 0.17	3.503 ± 0.016	198.98 ± 1.1
SMF3	2.67 ± 0.10	0.67 ± 0.09	3.496 ± 0.023	200.11 ± 1.3
SMF4	3.16 ± 0.17	0.70 ± 0.08	3.493 ± 0.015	199.81 ± 1.7
SMF5	2.92 ± 0.08	0.67 ± 0.09	3.481 ± 0.013	200.87 ± 1.4
SMF6	2.79 ± 1.1	0.63 ± 0.9	3.475 ± 0.012	201.38 ± 1.3

Table 5: Post-compression parameters for Direct Compression

Formulation code	Disintegration time (sec)± SD	Wetting time (sec) ± SD	Water absorption ratio ± SD	Drug Content (%) ± SD
DCF1	46.34 ± 1.6	41.78 ± 1.3	86.31 ± 1.2	97.58 ± 1.8
DCF2	41.56 ± 1.5	43.23 ± 0.8	82.61 ± 1.1	97.87 ± 0.7
DCP3	34.23 ± 1.4	51.52 ± 0.9	81.44 ± 1.4	98.43 ± 1.9
DCF4	35.81 ± 1.5	34.67 ± 1.4	75.63 ± 1.7	99.12 ± 0.9
DCF5	28.94 ± 0.9	36.21 ± 1.6	72.21 ± 1.9	99.38 ± 1.8
DCF6	23.34 ± 1.3	31.37 ± 1.2	78.33 ± 1.5	99.85 ± 0.9
DCF7	51.46 ± 1.8	39.78 ± 1.7	81.13 ± 1.3	99.01 ± 1.8
DCF8	44.23 ± 1.2	42.23 ± 1.3	76.54 ± 1.8	98.78 ± 1.5
DCF9	38.82 ± 1.6	46.34 ± 1.5	72.40 ± 1.7	99.65 ± 0.8

The tablets were evaluated for disintegration time and mean tablet weight. Fast dissolving tablets of Piroxicam were prepared by sublimation method according to the formula given in Table 2.

Evaluation of Prepared Tablets (FDTs)

After formulation of tablets, they are evaluated for various parameters. Prepared FDTs were evaluated for following parameters:

Shape and Size

Diameter and thickness of prepared FDTs were determined using Vernier callipers. Three tablets from each formulation were taken and average was calculated. [5]

Thickness variation

Thickness of prepared FDTs were determined using Vernier callipers. Three tablets from each formulation were taken and average was calculated. [6]

Hardness

Pfizer hardness tester was used to determine the hardness of the formulated tablets. The hardness was calculated as kg/cm^2. Three tablets from each formulation were taken and average was calculated.

Weight variation

This test is performed to check the uniformity of weight of the prepared tablets, as drug content is directly related to the weight of tablet. In this process, 20 tablets were weighed individually. The average weight of one tablet was calculated by taking average mean. As per IP, not more than two tablets deviate by more than the limit prescribed and none tablets deviate by more than twice of the limit prescribed in individual monograph. [7,8]

Friability

The Roche friabilator was used to measure friability of the formulated tablets. Weight of 20 tablets was measured and placed in the friabilator chamber. The friabilator was rotated at speed of 25 rpm for 4 min. After completion of 100 revolutions, the tablets were weighted again and % weight loss is calculated, which corresponds to friability. [9,10]

$$\%\ Friability = \frac{Initial\ weight - Final\ weight}{Initial\ weight} \times 100$$

Drug content

The drug content was calculated by triturating ten tablets in a mortar with pestle to get fine powder. Powder equivalent to weight of one tablet was taken and was dissolved in distilled water. Measure the absorbance of diluted sample of MS at 283 nm using UV-Visible Spectrophotometer. The drug content was calculated by using standard calibration curve.

Wetting time

The wetting time was calculated by placing the tablets in Petri dish containing wet tissue paper. Wet tissue was placed in a petri dish and the tablet was placed over it. The time required for complete wetting of tablets was noted. [11]

Water absorption ratio

For the determination of water absorption ratio, firstly weighed the tablets from each formulation before placing them into the petri plate containing 2 ml of amaranth dye and 10 ml of simulated saliva. Tablets were carefully removed from petri dish and weigh the wetted tablet. The water absorption ratio was calculated using the formula: [12,13]

$$R = \frac{Wa - Wb}{Wa} \times 100$$

Where, R is water absorption ratio, Wb is weight of tablet before water absorption, and Wa is weight of tablet after water absorption.

In vitro Disintegration time

The process of breakdown of a tablet into smaller particles is called as disintegration. The in-vitro disintegration time of a tablet was determined using disintegration test apparatus as per I.P. specifications.

I.P. Specifications: Place one tablet in each of the 6 tubes of the basket. Add a disc to each tube and run the apparatus using pH 6.8 (simulated saliva fluid) maintained at 37°±2°C as the immersion liquid. The assembly should be raised and lowered between 30 cycles per minute in the pH 6.8 maintained at 37°±2°C. The time in sec. taken for complete disintegration of the tablet with no palpable mass remaining in the apparatus was measured and recorded. [14]

Table 6: Post-compression parameters for sublimation method

Formulation code	Disintegration time (sec)± SD	Wetting time (sec) ± SD	Water absorption ratio ± SD	Drug Content (%) ± SD
SMF1	32.37 ± 1.1	28.61 ± 0.9	86.73 ± 1.4	98.71 ± 0.9
SMF2	26.81 ± 1.3	24.89 ± 1.0	90.48 ± 1.8	99.09 ± 0.6
SMF3	18.78 ± 1.6	21.31 ± 1.2	88.23 ± 2.1	99.29 ± 0.6
SMF4	28.54 ± 1.9	26.22 ± 1.4	87.21 ± 1.7	98.12 ± 1.4
SMF5	20.42 ± 1.5	25.17 ± 1.3	86.62 ± 1.0	99.19 ± 1.3
SMF6	19.07 ± 1.3	20.01 ± 1.8	87.09 ± 1.2	98.82 ± 1.8

Table 7: Release profile of Piroxicam fast dissolving tablets prepared by direct compression

Time (Min.)	Formulation Code								
	DCF1	DCF2	DCF3	DCF4	DCF5	DCF6	DCF7	DCF8	DCF9
0	0	0	0	0	0	0	0	0	0
1	7.52	11.49	15.42	9.61	13.72	17.32	7.26	9.42	16.74
3	23.02	26.41	30.18	23.31	25.54	33.53	22.22	28.62	32.69
5	38.27	37.74	44.63	33.53	35.62	45.66	34.75	38.84	42.76
7	43.38	48.45	54.66	45.13	56.13	62.78	51.22	56.56	60.58
9	52.35	65.45	68.22	58.61	65.95	75.48	53.65	63.58	67.58
11	72.54	78.86	79.53	71.34	74.37	84.68	65.35	71.61	74.55
13	85.59	86.58	91.37	85.67	85.64	94.39	81.15	83.29	99.72
15	93.09	94.81	98.53	94.09	94.98	99.22	98.14	98.22	

***In vitro* Dissolution Test**

Dissolution testing measures the extent and rate of solution formation from a dosage form. The dissolution of a drug is important for its bioavailability and therapeutic effectiveness. Dissolution of prepared mouth dissolving tablets was determined in phosphate buffer pH 6.8 using paddle apparatus, 50 RPM at 37^0C. [15,16,17]

***In-vitro* drug release studies details**

Apparatus used : USP XXIII dissolution test apparatus
Dissolution medium : phosphate buffer pH 6.8.
Dissolution medium volume : 900 ml
Temperature : 37±0.5°C
Speed of basket paddle : 50 rpm
Sampling intervals : 1 min
Sample withdraw : 5

RESULTS AND DISCUSSION

The harness of the tablets formed by direct compression was ranging with 2.89 to 4.01. Friability was lying between 0.55 – 0.71% which was accepted. Thickness of the tablet was between 3.409 to 3.452. Tablets shows weight variation between 199.15 to 201.09. The outcomes of hardness, friability, thickness and weight variation are displayed in table 3.

The harness of the tablets formed by sublimation was ranging with 2.67 to 3.16. Friability was lying between 0.61 – 0.70% which was accepted. Thickness of the tablet was between 3.475 to 3.516. Tablets show weight variation between 198.89 to 201.38. The outcomes of hardness, friability, thickness and weight variation are displayed in table 4.

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The results of disintegration time, wetting time, water absorption and drug content prepared by direct compression are shown in table 5. Disintegration time ranges between 23.34 to 51.46 sec. Tablet wetting time was from 31.37 to 51.53 sec. Water absorption ratio was lying between 72.21 to 86.31 and drug content ranges from 97.58 – 99.87 for all the formulations.

The results of disintegration time, wetting time, water absorption and drug content prepared by sublimation method are shown in table 6. Disintegration time ranges between 18.78 to 26.81 sec. Tablet wetting time was from 20.01 to 28.61 sec. Water absorption ratio was lying between 86.62 to 90.48 and drug content ranges from 98.12 – 99.19 for all the formulations.

In case of tablets prepared by direct compression technique the t50% and t90% values decreased with increase in the concentration of croscarmellose sodium, crospovidone. However, t50% and t90% values increased with increase in concentration of sodium starch glycolate. The rapid increase in dissolution of Piroxicam with the increase in croscarmellose sodium may be due to rapid swelling and disintegrating tablets rapidly. While tablets formulated with sodium starch glycolate, disintegrate by rapid uptake of water, followed by rapid and enormous swelling into primary particle but more slowly due to the formation of a viscous gel layer by sodium starch glycolate. Crospovidone and croscarmellose sodium containing tablets rapidly exhibits high capillary activity and pronounced hydration with a little tendency to gel formation and disintegrates the tablets rapidly but into larger masses of aggregated particles.

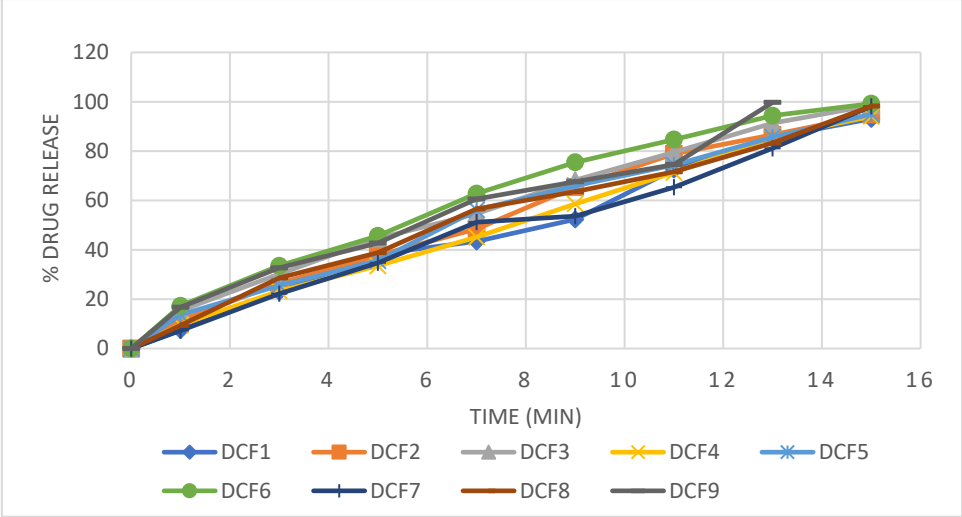

Figure 1: Release profile of formulation (DCF1-DCF9)

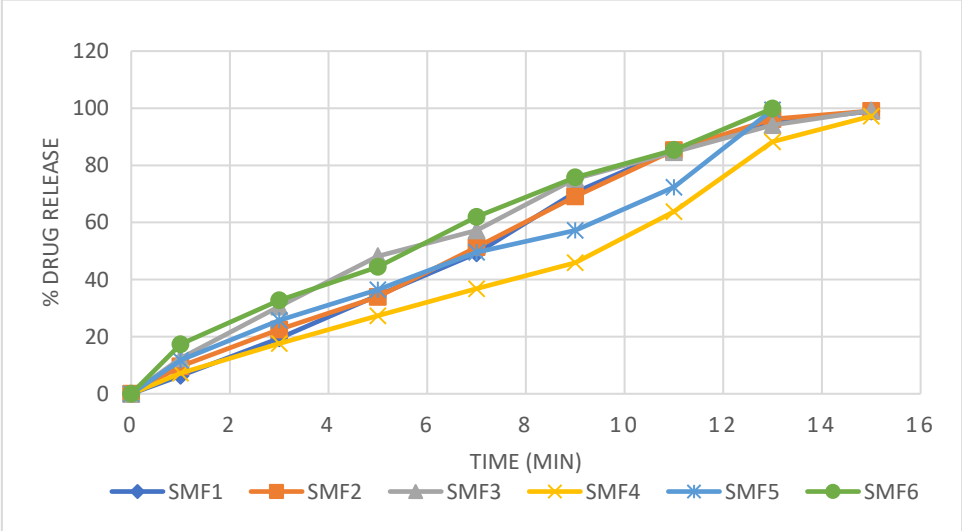

Figure 2: Release profile of formulation (SMF1-SMF6)

Thus difference in the size distribution generated with different superdisintegrants might have contributed to difference in the t50% and t90% values with the same amount of superdisintegrants in the tablets.

Although, disintegration times are lesser in crospovidone and croscarmellose sodium containing tablets, comparatively higher t50% and t90% values are observed in croscarmellose sodium containing tablets. Figure 1 represents the release profile of tablets prepared by direct compression.

As the method of preparation of tablets changed to sublimation, the dissolution of the drug from the tablets prepared by camphor sublimation method was quicker than those prepared by other method. This may be due to their lowest hardness and the porous structure is responsible for faster water uptake, hence it facilitates wicking action of croscarmellose sodium in bringing about faster disintegration, shown in the table 7-8. Figure 2 represents the release profile of tablets prepared by sublimation method.

CONCLUSION

Fast dissolving tablets of Piroxicam were prepared using direct compression and sublimation methods with superdisintegrants like sodium starch glycolate, croscarmellose sodium, and crospovidone. Camphor was used as a subliming agent in the sublimation method. Tablets were evaluated for weight variation, hardness, friability, in-vitro disintegration, drug content uniformity, water absorption ratio, wetting time, and in-vitro drug release.

Direct compression tablets showed weight variation (198.33–201.09 mg), hardness (2.95–4.01 Kg/cm²), friability (0.51–0.71%), disintegration time (23.43–51.46 s), drug content (97.58–99.85%), water absorption (72.21–86.21%), wetting time (31.37–51.52 s), and peak drug release within 13 min.

Table 8: Release profile of Piroxicam fast dissolving tablets prepared by sublimation method

Time (Min.)	Formulation Code					
	SMF1	SMF2	SMF3	SMF4	SMF5	SMF6
0	0	0	0	0	0	0
1	6.34	9.61	12.46	7.23	11.76	17.35
3	19.45	22.51	30.59	17.61	25.73	32.73
5	34.45	33.96	48.22	27.33	36.46	44.46
7	49.23	51.34	57.24	36.81	49.55	61.98
9	70.58	69.12	75.35	45.92	57.23	75.78
11	85.51	85.31	84.64	63.78	72.34	85.38
13	95.29	96.23	94.12	88.27	99.45	99.92
15	98.92	99.05	99.21	97.24		

Sublimation tablets exhibited weight variation (198.89–201.38 mg), lower hardness (2.67–3.16 Kg/cm²), friability (0.61–0.70%), faster disintegration (18.78–32.37 s), higher drug content (98.12–99.29%), improved water absorption (86.73–90.48%), shorter wetting time (20.01–28.61 s), and peak drug release within 13 min. Sublimation resulted in faster disintegration and enhanced drug release compared to direct compression.

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