

Topic Name Times New Roman,
14, Bold, Align text Center

Formulation and Optimization of Paracetamol Orally Disintegrating Tablets Using a 3² Factorial Design

Author ^{*1}, Author ², Author³, Author⁴

Asterisk (*) for the
corresponding author

Superscripts for
indicating affiliations of
authors and co authors

Affiliation Times New
Roman, 9, Normal, Align
text Centre

¹Department of Pharmaceutics, Rajiv Academy for Pharmacy, Kota

²Department of Pharmaceutics, Anand College of Pharmacy, Sonipat

Authors name Times
New Roman, 12, Bold,
Align Text, Centre

asterisk (*) for the
corresponding author

*For Correspondence: Corresponding Author
College of Pharmacy,
College address, State, Country, Pincode.
Email ID: Author@gmail.com

Abstract and Key words bold,
heading alignment and text
should be justified, 12 Size,
Times New Roman

ABSTRACT

Pharmaceutical research increasingly requires the integration of innovative drug delivery approaches, advanced formulation technologies, and systematic evaluation methods to improve therapeutic outcomes. This study aimed to develop and evaluate a novel pharmaceutical formulation using a systematic formulation-development approach. The formulation was prepared by selecting suitable drug, excipients, and processing conditions based on their physicochemical characteristics and compatibility. The prepared formulation was evaluated for relevant pharmaceutical properties, including appearance, particle size, surface characteristics, drug content, entrapment efficiency, in vitro drug-release behavior, and stability. The formulation variables were optimized to obtain desirable physicochemical and performance characteristics. The optimized formulation demonstrated satisfactory physical properties, uniform drug distribution, and improved drug-release characteristics compared with the conventional formulation. The obtained results indicated that the selected formulation strategy could enhance drug performance and provide controlled and reproducible drug delivery. Stability evaluation further demonstrated that the optimized formulation retained its essential characteristics under the investigated storage conditions. The findings support the potential application of the developed approach as a promising pharmaceutical delivery system. Further studies involving comprehensive characterization, in vivo evaluation, and scale-up investigations are warranted to establish its translational applicability.

Keywords: *Orally disintegrating tablets, Famotidine, Crospovidone, 3² full factorial design.*

Heading Times New
Roman, 12, Alignment text
Left, and matter should be
justified

References should be cited using
superscript Arabic numerals, e.g.,
1,2,1-3.

INTRODUCTION

Oral drug delivery remains one of the most widely accepted approaches¹ because of its convenience, ease of administration, and suitability for self-medication. However, conventional solid dosage forms can be difficult to administer to patients who experience swallowing difficulties. Orally disintegrating tablets (ODTs) have therefore attracted considerable interest as patient-oriented dosage forms that rapidly disintegrate or dissolve in the oral cavity without the need for water.²

The performance of an ODT depends on several formulation factors, including the choice of diluents, binders, lubricants, porosity, compression force, and disintegrating agents. Super disintegrants such as crospovidone, croscarmellose sodium, and sodium starch glycolate facilitate rapid tablet breakup through mechanisms including wicking, swelling, and strain recovery.³ the concentration and type of super disintegrant can

consequently influence wetting, disintegration time, mechanical strength, and drug dissolution.

Famotidine has been investigated as a model drug for the development of rapidly disintegrating oral dosage forms. Previous studies have explored taste-masked famotidine particles, fast-disintegrating tablets, and formulation approaches aimed at improving dissolution characteristics.^{4,5} Thus, systematic optimization of formulation variables can provide an effective approach for developing a rapidly disintegrating famotidine dosage form with suitable mechanical properties, rapid disintegration, acceptable taste, and efficient drug release.⁶

MATERIALS AND METHODS

Heading Times New Roman, 12,
Alignment text Left, and matter
should be justified

Paracetamol was selected as the model drug for the present formulation study. Microcrystalline cellulose, crospovidone, sodium starch glycolate, mannitol, and sodium saccharin were used as pharmaceutical excipients for tablet preparation. The drug and excipients were procured from authorized pharmaceutical suppliers. All other chemicals and reagents used during the formulation and evaluation studies were of analytical grade.

3² FULL FACTORIAL DESIGNS

Heading Times New Roman, 12, Alignment
text Left, and matter should be justified

A 3² full factorial design was employed to investigate the influence of two formulation variables at three different levels^{7,8}. The concentrations of crospovidone (X₁) and sodium starch glycolate (X₂) were selected as the independent variables. The disintegration time (Y₁) and wetting time (Y₂) were considered the dependent responses. Nine formulations representing all possible combinations of the selected factor levels were prepared and evaluated. The experimental data were analyzed using Design-Expert software, and polynomial equations were generated to determine the effect of the formulation variables on the selected responses^{9,10}.

Polynomial equation:

$$Y = B_0 + B_1 X_1 + B_2 X_2 + B_{11} X_1^2 + B_{22} X_2^2 + B_{12} X_1 X_2$$

Subheading should be Italic,
Bold, Justify, 12 sizes

Where Y is the dependent variable; B₀ is the intercept; B₁ to B₂₂ are the regression coefficients;
And X₁ and X₂ are the independent formulation variables⁹.

Subheading should be italic, bold, justify, 12 sizes,
times new roman, matter should be justified.

Optimization

The runs or formulations, which are designed based on 3 full factorial designs, are evaluated for the response variables. The response values are subjected to multiple regression analysis to find out the relationship between the factors used and the response values obtained. The response values subjected for these analyses are;

RESULTS

Data Analysis

Heading Times New Roman, 12,
Alignment text Left, and matter should
be justified, Upper case

The prepared paracetamol formulations were evaluated for disintegration time and wetting time. The experimental results showed variation in both responses with changes in the concentrations of crospovidone and sodium starch glycolate. Increasing the concentration of the superdisintegrants generally influenced the rate of tablet wetting and disintegration.

The data obtained from all nine experimental formulations were subjected to statistical analysis using Design-Expert software. The factorial model was used to determine the individual and combined effects of the independent variables on the selected responses. The fitted polynomial equations and response-surface plots demonstrated the relationship between the formulation variables and the observed responses.

Based on the desirability criteria, an optimized formulation was identified with the desired disintegration and wetting characteristics. The predicted responses of the optimized formulation were subsequently compared with the experimentally obtained values to determine the validity of the developed formulation.

If there is need of points then
mark only with these bullets
do not use numbering

- The formulation variables produced noticeable changes in the disintegration time of the prepared tablets.
- Variations in crospovidone and sodium starch glycolate concentrations also affected the wetting time of the formulations.
- Regression analysis demonstrated a strong relationship between the selected independent variables and the observed responses.
- The polynomial models showed good agreement between the experimental and predicted values.

DISCUSSION

Heading Times New Roman, 12, Alignment text
Left, and matter should be justified, Upper Case

Effect of formulation variables on WY

The Model F-value of 12.42 implies the model is significant. There is only a 3.22% chance that a Model F-Value" this large could occur due to noise. Values of "Prob > F" less than 0.0500 indicate model terms are significant. In this case X1, X2 are significant model terms.

CONCLUSION

Heading Times New Roman, 12,
Alignment text Left, and matter
should be justified, Upper Case

The present investigation established the feasibility of developing paracetamol orally disintegrating tablets using suitable superdisintegrants. The formulation variables showed a measurable influence on the wetting and disintegration characteristics of the tablets. Application of factorial experimental design enabled systematic evaluation of these variables with a limited number of experimental batches. The optimized formulation exhibited desirable tablet characteristics and rapid disintegration, indicating its potential as a convenient oral dosage form. The study demonstrates that appropriate selection and optimization of excipient concentrations can contribute to the development of an effective and patient-friendly paracetamol orally disintegrating tablet.

ACKNOWLEDGEMENTS

Heading Bold, Times New Roman, 12, Alignment
text Left, and matter should be justified, Upper
Case

The authors gratefully acknowledge the support and cooperation received from the concerned pharmaceutical organizations for providing the required materials. The authors also thank the management and staff of the institution for providing the necessary laboratory facilities and technical assistance to successfully complete the study.

REFERENCES

Reference Heading,
Bold, Justify, 12, Upper

1. Dixit S, Deora S, Nathawat P, Ganguly M. Metal nanocrystals and nanoclusters with paracetamol passivation and for paracetamol detection: a critical review. Nanoscale Advances. 2026 Jul 6. <https://doi.org/10.1039/d6na00268d>
2. Freo U, Ruocco C, Valerio A, Scagnol I, Nisoli E. Paracetamol: a review of guideline recommendations. Journal of clinical medicine. 2021 Jul 31;10(15):3420. <https://doi.org/10.3390/jcm10153420>
3. McCrae JC, Morrison EE, MacIntyre IM, Dear JW, Webb DJ. Long-term adverse effects of paracetamol—a review. British journal of clinical pharmacology. 2018 Oct;84(10):2218-30. <https://doi.org/10.1111/bcp.13656>
4. Prescott LF. Kinetics and metabolism of paracetamol and phenacetin. British journal of clinical pharmacology. 1980 Apr;10(S2):291S-8S. <https://doi.org/10.1111/j.1365-2125.1980.tb01812.x>

JTPST follows the Vancouver referencing style. References should be numbered consecutively in the order in which they are first cited in the text, using superscript Arabic numerals, such as ¹, ², or ¹⁻³. The reference list should be arranged in the same numerical order at the end of the manuscript. DOI numbers & Links should be included wherever available.

The Reference number should follow the following format

For journal reference

Mukesh PR, Mohanta GP, Upadhyay L. Review on: Fast dissolving tablet. Journal of pharmacy research, 2009; 2(1): 5-12.

YEAR: Volume
(issue): page no.

For Book reference

Sathoskar RS, Bhandarkar Nirmala NR, Pharmacology and pharmacotherapeutics, popular prakashan, Mumbai, 2005; 620.

For Chapters in book reference

P.S. Meltzer, A. Kallioniemi, and J.M. Trent. Chromosome alterations in human solid tumors. In: B. Vogelstein, and K.W. Kinzler (eds.), *The Genetic Basis of Human Cancer*, McGraw-Hill, New York, 2002; 93-113.

For Patent reference

H. Aviv, D. Friedman, A. Bar-Ilan, and M. Vered. Submicron emulsions as ocular drug delivery vehicles, U.S. Patent US 5496811, 1996.

TABLES, GRAPH AND FIGURE

Bold, Left, Alignment, 12 Size

Table 1. Formulation Composition of Paracetamol Orally

Ingredients	R1	R2	R3	R4	R5	R6	R7	R8	R9
Paracetamol	—	—	—	—	—	—	—	—	—
Avicel PH 102	—	—	—	—	—	—	—	—	—
Sodium starch glycolate	—	—	—	—	—	—	—	—	—
Crospovidone	—	—	—	—	—	—	—	—	—
Pregelatinized starch	—	—	—	—	—	—	—	—	—
Aspartame	—	—	—	—	—	—	—	—	—
Magnesium stearate	—	—	—	—	—	—	—	—	—
Talc	—	—	—	—	—	—	—	—	—
Total weight	—	—	—	—	—	—	—	—	—

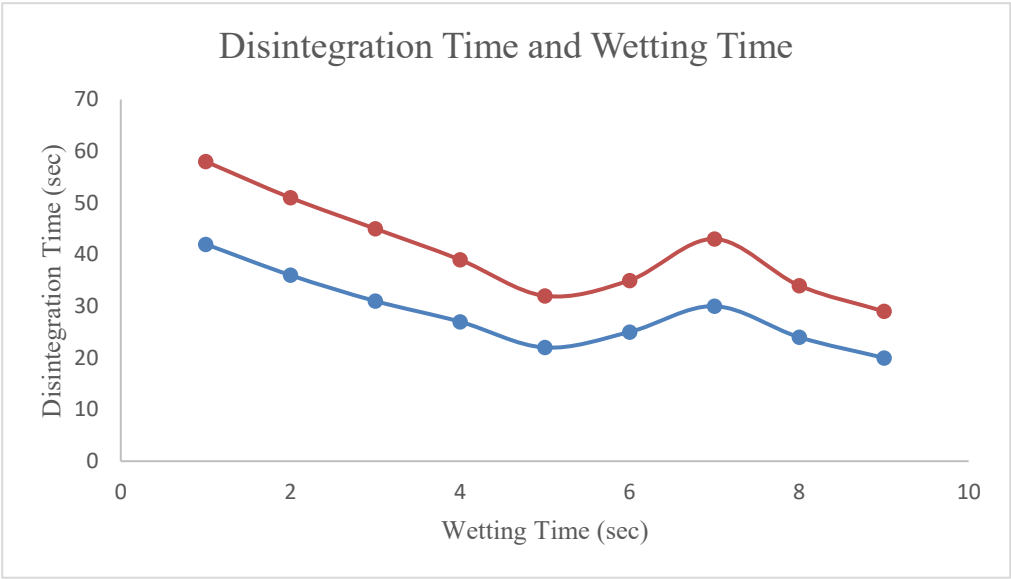


Figure 1. Disintegration Time and Wetting Time

Position of figure heading is in bottom of figure, Figure heading should be bold, heading is in centre of the figure (Times New Roman, 12 Size)

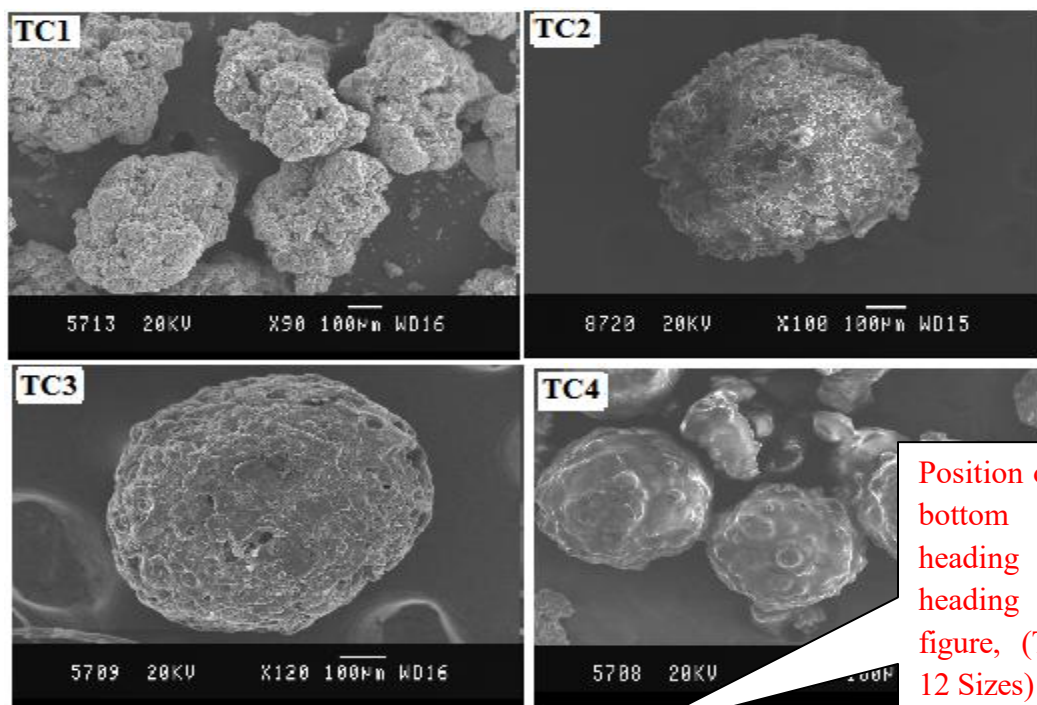


Figure should be in Jpeg Format, Height = 8.4 cm or 8.4 m Width = 8.4 cm or 8.4 m, Colour only black and white, alignment left

Position of figure heading is in bottom of figure, Figure heading should be bold, heading is in centre of the figure, (Times News Roman, 12 Sizes)

Fig. Scanning Electron Micrographs (SEM) of paracetamol